British Journal of Environmental Sciences

Vol.9, No.6, pp. 1-18, 2021

ISSN 2054-6351 (print),

ISSN 2054-636X (online)

THE EFFECT OF BOKO HARAM ACTIVITIES ON LAND USE AND LAND COVER AT YANKARI GAME RESERVE, BAUCHI STATE, NIGERIA

Ukah Chinomso[1], Ejaro Sunday P.[2], Makwe Edith[3] and Iwara Anthony I.[4]

[1]Environmental Management Department, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.

[2,3 and 4]. Geography and Environmental Management Department, University of Abuja, FCT-Abuja, Nigeria.

ABSTRACT: *The study examined the effect of Boko Haram activities on Land Use Land Cover change at Yankari Game Reserve, Bauchi State, Nigeria. Vegetation in 2003 was 64.36% but later decreased to 48.35% in 2010 and recently increased to 61.78% in 2016. The decrease in vegetation cover from 64.36% in 2003 to 48.35% in 2010 can be attributed to massive infrastructural development during this era. Similarly, the decrease in 2010 (48.35%) could be attributed to human interference such as fetching of firewood, farming, lumbering, etc. which are the agents of vegetal degradation. It is noteworthy that Boko Haram rampage was at its peak during this period and as such tourists' patronage (especially foreigners) to the Game Reserve reduced drastically for fear of being bombed, kidnapped, etc. But the increase between 2010 and 2016 can be attributed to regeneration as the fight against Boko Haram is being won by the government. It is also be due to considerable reduction in human activities consequent on patronage by tourist (as there is strict regulatory control of unlawful human activities) and time for vegetation regeneration. It is recommended that the people of the host community of Yankari Game Reserve should be educated through enlightenment campaigns on the consequences of indiscriminate felling of trees. In addition to that, alternative sources of cooking energy should be provided to the local inhabitants. The management of Yankari Game Reserve should adopt Remote Sensing and Geographic Information System techniques which have proven to be effective and efficient in the monitoring of vegetation cover. This would help to control encroachment and illegal logging in the area.*

KEYWORDS*:* vegetation, remote sensing, geographic information system, terrorism and natural regeneration.

INTRODUCTION

Tourism is among the world's biggest industry (Eilat and Einav 2004). It is globally recognized as one of the several industries that provide revenue, income and create employment

ULR:https://doi.org/10.37745/bjes.2013

opportunities to nations and places endowed with natural or manmade structures. Many countries of the world have been able to use their natural endowment to attract economic development. Terrorism is one major factor affecting game reserves or tourism in general.

Terrorism in Nigeria is carried out by Boko Haram Islamic sect. Boko Haram is an aggressive Islamist group causing destruction through series of bombings, bloodbath, suicides and major damage of infrastructural facilities (Chothia 2012). The deadly Islamic group or sect was created in 2002 by Mohammed Yusuf under the support of Jama'atu-Ahlis-Sunna-Lidda-Awati-Wal-Jihad. The sect claims to fight for the abolishment of the Nigerian constitution, enthronements of Sharia Law, the declaration of Nigeria as an Islamic state and for Nigeria to discard the western education (Eme et al. 2012). In 2010, the first terrorist attack was carried out by the sect in Maiduguri, resulting in the death of four people. Several places in Borno, Yobe, Bauchi, Gombe and Adamawa States of Nigeria were bombed. After which waves of bombing began with the suicide bomb attack of police headquarters in Abuja in August 2011 killing several police officers. The next of the series of bombing by this deadly Islamic sect was another attack at the United Nation's Building on the 26th of August, 2011 where more than 24 people feared dead (Mathew and Fada 2014). Quite a number of suicide attacks were also experienced in major cities, towns and villages in the northern part of Nigeria. Some of the areas are Maiduguri, Suleja, Bama, Kawuri and Baga among others (Eme et al. 2012; Nnamdi et al. 2015). Awojobi (2014), has opined that the frequent bombings and clashes between the insurgents and the security agents have weighed heavily on the commercial and business activities in the region, while many people have fled the area.

The operations of Boko Haram in the northeastern region have had a spillover effect on tourism activities in Bauchi State. This is because the waves of violence, carnage and destruction of infrastructure have dissuaded tourists from choosing the Yankari Game Reserve as their destination. The patronage level of the game reserve is seriously affected because no tourist will visit a destination that is unsecured and that is characterized by suicide attacks, bombings and kidnapping. The insecurity nature of the northeast of which Bauchi State falls into calls for investigation on the effect the activities of Boko Haram have on the Land Use Land Cover change at the Yankari Game Reserve. It is intended to know if there is any change in LULC at the largest wildlife park has increased or decreased over time in the region. So many works have been done on terrorism and tourism with little or no emphasis on Land Use Land Cover change before and after the emergence of Boko Haram as regards to Yankari Game Reserve. Studies have been on effect on patronage and socio-economic activities (such as the works done by Ukah and Ejaro 2019; Yama 2011; Fada 2013; Mathew and Fada 2014; Adebayo and Adebayo 2015).

This study examined the LULC in the Yankari Game Reserve before and after the emergence of Boko Haram.

LITERATURE REVIEW

Terrorism however, is a more challenging concept to define. For decades, scholars have debated the "terrorist versus freedom fighter" dilemma. Malden (2004) defines terrorism as an asymmetrical warfare of threat and violence targeted against enemies by deploying unconventional means not within the forms of political struggle routinely operating within some current regime. This symbolism is reflective of the European Union's definition that terrorism is geared to intimidate the population or to compel a government to unduly carry out or abstain from performing a particular act, or to cause a major political, social or constitutional order to destabilize the polity. Terrorism is the illicit way of hostility carried out to accumulate ransom, bring down a government, get the release of hostages, ensure total breakdown of economic activities or penalize unbelievers of religion and lots more (Ball et al., 2013). On a similar angle, Gilham (2001) recognized the purposes terrorist attacks might be intended to achieve to include: to work as a vehicle for a further broad aim, to compel issues, to control political activities, to create demands, to aggravate reaction which could enable them to achieve local and worldwide attention. Domboróczky (2010) asserted that there has been a prototype change from political and authority to terrorism that was fashionable in the 1960s and 1970s to sacred faith-based and tribal terrorism formed out of ethnic depression, particularly in the Islamic groups.

Since 2009, Boko Haram insurgency has become a serious social problem facing Nigeria and this has had considerable impact on the numbers of tourist arrivals to many tourism sites in the northeast. The operation (such as bombing and suicide attacks among others) of the group has also resulted in the damage of private and public properties that are worth billions of naira as well as loss of lives. The activities of Boko Haram have seriously threatened national security and grossly affected socioeconomic activities in and around the zone of operation. UNHCR (2017) noted that the outbreak of the Boko Haram insurgency in 2009 has steadily become the single greatest cause of displacement in the Lake Chad Basin region, with more than 2.3 million people becoming refugees, internally displaced people (IDPs) or returnees as a result. In recent years, terrorists unleashed attacks of mass shootings, large-scale explosions, suicide bombings and vehicle ramming to ratchet up the killing and maiming of their victims (Arce, 2018). Environmentally, the ecosystem is affected directly by bombings and other toxic materials or gases. Direct impacts include bomb and blast damage of settlements, rural areas and communication networks. Defoliation and ecosystem destruction, the dumping of the machinery of war and the destruction of resources such as oil fields also occur. Indirect impacts are many and varied and are often long lasting than the direct impacts. They include the construction of various camps (although ephemeral, camps cause impairment of soil and vegetation through trampling by personnel and vehicles and the disposal of waste materials) such as refugee camps and the distortion of population composition as young males join the conflict; in countries where agriculture is a major activity this may result in land abandonment and degradation may ensure

(Mannion, 2003). Other indirect impacts include loss of wildlife as animals are hunted for bush meat. Particularly, long lasting effects include the use of land for war graves, war memorials and museums. Along with battlefields themselves these reminders of conflicts have, in many nations, become the focus of the tourist industry and thus a source of wealth generation.

METHODOLOGY

Data on LULC change in the Game Reserve before and after the emergence of Boko Haram were obtained using satellite imageries of the study area from 2003, 2010 and 2016; this was used to assess the rate of change in land use land cover that has taken place in the period under review. It is assumed that before the emergence of Boko Haram, the rate of tourist arrivals to the Game Reserve was high which would have prompted or facilitated the need for more infrastructural construction which resulted in vegetation loss (for any development to occur on the environment, vegetation must be affected), but with the spate of Boko Haram activities in the area, tourist arrivals have reduced and this have influence on infrastructural development to meet the demands of tourists.

Table 1 and 2 shows the materials and methods for LULC change detection analysis. The data used for the study include; Landsat ETM+ and L8 OL1/TIR which were sourced from GloVis (USGS) and Earth Explorer (USGS). While the materials used include; ArcGIS 10.4, Idrisi Terrset, ENVI 5.0, GPS, etc.

Table 1: Data used for the analysis

Data type	Sources	Year of acquisition	Spatial resolution
Landsat ETM+	Glovis (USGS)	2003	30m
Landsat ETM +	Earth Explorer (USGS)	2010	30m
L8 OL1/TIR	Earth Explorer (USGS)	2016	30m

Table 2: Materials used for the analysis

Material	Type	Uses
Hardware	PC, GPS, Camera, etc.	Data acquisition, processing and analysis
Software	ArcGIS 10.4, Idrisi Terrset, ENVI 5.0	Map presentation, Land Change Modeller (LCM) to determine change detection of LULC between 2003, 2010 and 2016

Summary of the work flow diagram in Fig 2 is as follows:

i. Data Acquisition: Remotely sensed data were acquired using GloVis (USGS) and Earth Explorer (USGS) to get 2003, 2010 and 2016 Images.

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ii. Pre-Processing: Inverse pan-sharpening of individual bands to get rid of clouds and other atmospheric distortions.
iii. Band Combination: Band 4 3 2 was combined for Landsat ETM+ 2003 and 2010 while band 5 4 3 was combined to form a false colour image of the study area.
iv. Subsetting Area of Interest: Vector shape file of the study area was overlaid on the false colour image to extract the Area of Interest.
v. Supervised Classification: this was carried out using maximum likelihood algorithm in ENVI 5.0.
vi. Change Detection Analysis: This was carried out in Idrisi Terrset to determine LULC between 2003, 2010 and 2016.
vii. Result Presentation: Change Detection Map was generated from Land Change Modeller to show the detailed change of LULC.

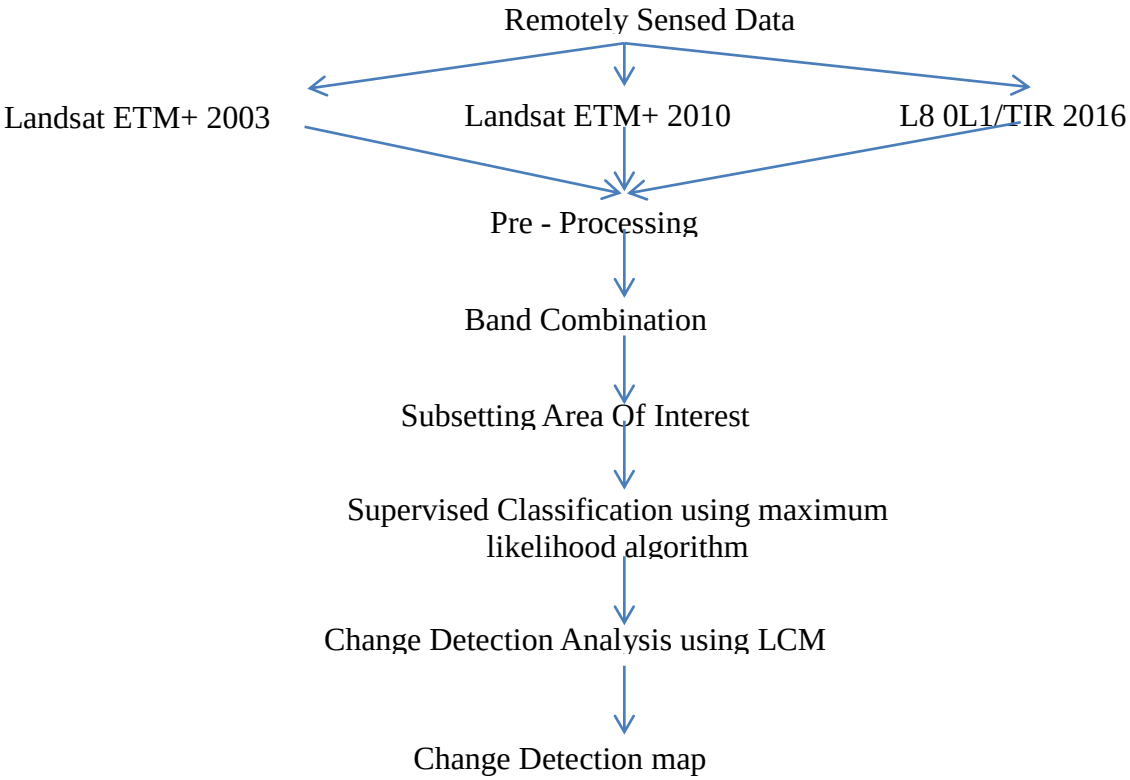

Figure 2: Work flow diagram
Source: Authors' design (2019)

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RESULT/FINDINGS

Landuse Landcover distribution of Yankari Game Reserve 2003, 2010 and 2016

Table 3 shows the summary of landuse landcover (LULC) of Yankari Game Reserve for the period of the Study i.e. 2003, 2010 and 2016 respectively. The table contains the proportion of each landuse landcover type in square kilometer and percentage.

Table 3: Statistics of LULC of Yankari Game Reserve for 2003, 2010 & 2016

	2003		2010		2016	
LULC Classes	Area in SqKm	Area in %	Area in SqKm	Area in %	Area in SqKm	Area in %
Bare Surface	47.9754	0.98	74.9268	1.54	48.2517	0.99
Built Up	909.3924	18.63	504.8622	10.35	1232.7318	25.26
Rocks Outcrop	680.0841	13.94	1359.6957	27.86	478.7325	9.81
Vegetation	3140.9685	64.36	2359.6758	48.35	3015.0522	61.78
Water	101.8116	2.09	18.4491	0.38	105.4638	2.16
Total Area	4880.232	100	4880.232	100	4880.232	100

Landuse Landcover of Yankari game reserve for the Year 2003

Figure 3 is the LULC Map of Yankari Game Reserve for the Year 2003. It shows the proportion of various land use land cover in the Reserve. Based on the results obtain in the analysis, Bare land constitute 0.98% amounting to 47.9754 Km^2, Built up constitute 18.63% (909.3924), Rock outcrop has 13.94 % (680.0841), Vegetation and Water has 64.36% (3140.969) and 2.09% (101.8116) respectively.

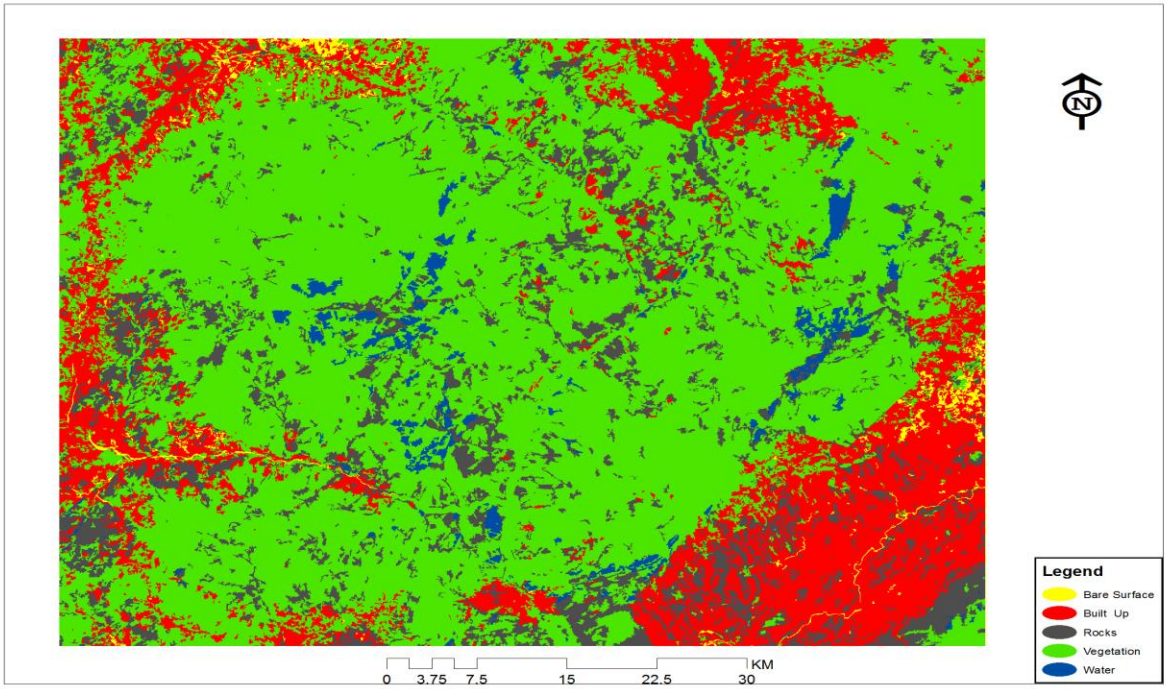

Figure 3: Landuse Landcover of Yankari Game Reserve for the Year 2003
Source: GloVis 2018

Landuse Landcover of Yankari Game Reserve for the Year 2010

Figure 4 is the LULC Map of Yankari Game Reserve for the Year 2010. It shows the proportion of various land use land cover in the Reserve. Based on the results obtain in the analysis, Bare land constitute 1.54% amounting to 74.9268Km^{2,} Built up constitute 10.35% (504.8622), Rock outcrop has 27.86% (1359.696), Vegetation and Water has 48.35% (2359.676) and 0.38% (18.4491) respectively.

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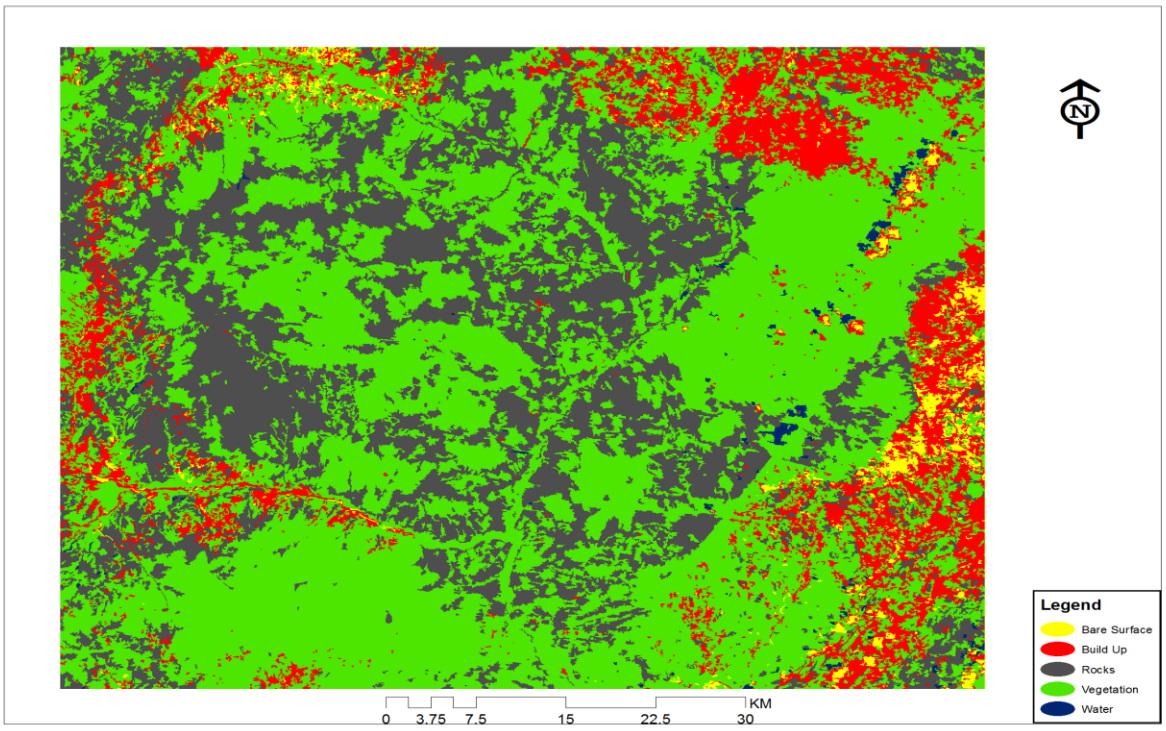

Figure 4: Landuse Landcover of Yankari Game Reserve for the Year 2010
Source: GloVis 2018

Landuse Landcover of Yankari Game Reserve for the Year 2016

Figure 5 is the LULC Map of Yankari Game Reserve for the Year 2016. It shows the proportion of various land use land cover in the Reserve. Based on the results obtain in the analysis, Bare land constitute 0.99% amounting to 48.2517 Km^2. Built up constitute 25.26% (1232.732), Rock outcrop has 9.81% (478.7325), Vegetation and Water has 61.78% (3015.052) and 2.16% (105.4638) respectively.

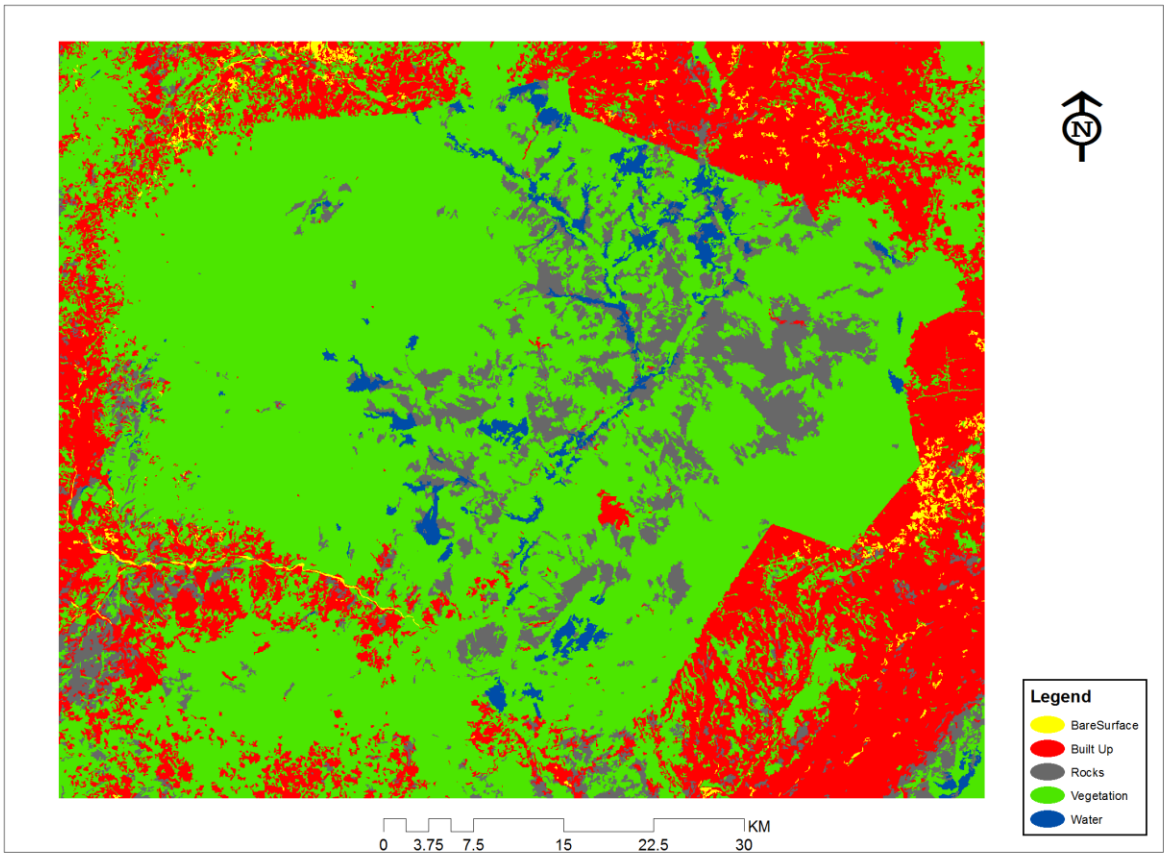

Figure 5: Landuse Landcover of Yankari Game Reserve for the Year 2016
Source: GloVis 2018

Change Detetion Analysis

Figure 6 is the Change Detection Map of Yankari Game Reserve between 2003 to 2016. It shows the gains and loss of different landuses. Based on the analysis, the LULC conversion from vegetation to build up, vegetation to rock outcrops and rock outcrops to vegetation accounted for the highest proportion of landuse landcover chnages between 2003 and 2016. That shows that increased in built up due to urbanisation at the fringes of the Yankari Game Reserve led to decease in vegetation of about 439.7 km of vegetal cover. Also about 51.4 Km^2 of vegetation has been exposed in the reserve as a results of human activities. For Bare surface, it was 0.98% in 2003 but later rose to 1.54% in 2010 and decreased to 0.99% in 2016. For Rock outcrops, it was 13.94% in 2003 but increased to 27.86% in 2010 and decreased to 9.81% in 2016. For Water, it was 2.09% in 2003 but reduced to 0.38% in 2010 and later rose to 2.16 in the year 2016. These

conversion of landuse landcover are the major changes that occur during the period of the study. Table 4 shows the detailed statistics of all landuse conversion.

Table 4: LULC Conversion of Yankari Game Reserve between 2003 to 2016 in Km^2

LULC Conversion (from 2003 – 2016)	km^2
Built Up to Bare Surface	23.7132
Rock Outcrops to Bare Surface	1.1601
Vegetation to Bare Surface	4.0878
Water to Bare Surface	0.0045
Bare Surface to Built Up	24.5511
Rock Outcrops to Built Up	30.7359
Vegetation to Built Up	439.6842
Water to Built Up	3.1248
Bare Surface to Rock Outcrops	0.2034
Built Up to Rock Outcrops	21.9158
Vegetation to Rock Outcrops	51.4496
Water to Rock Outcrops	10.9008
Bare Surface to Vegetation	3.9348
Water to Vegetation	58.9975
Built Up to Water	0.9657
Rock Outcrops to Water	17.5167
Vegetation to Water	78.1974

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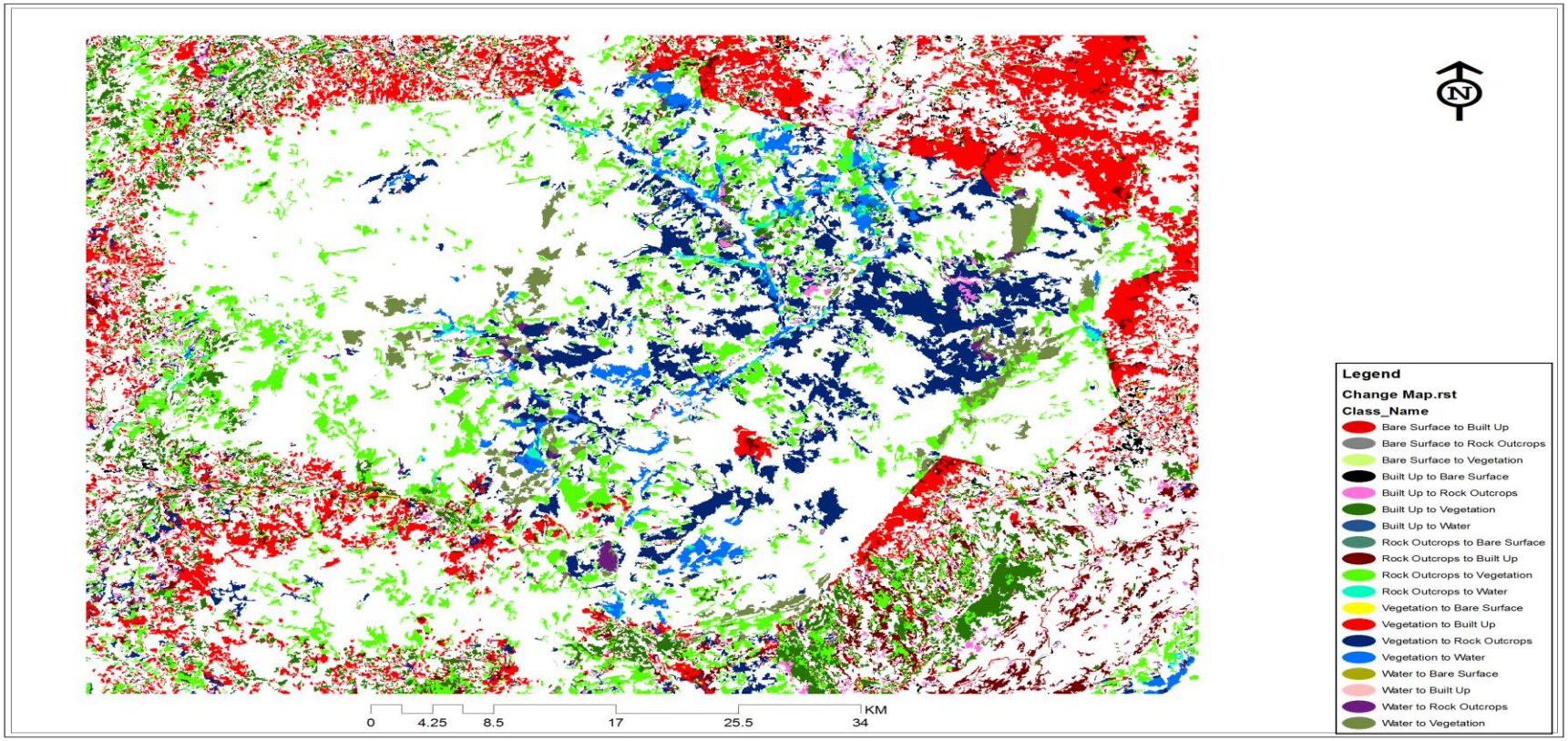
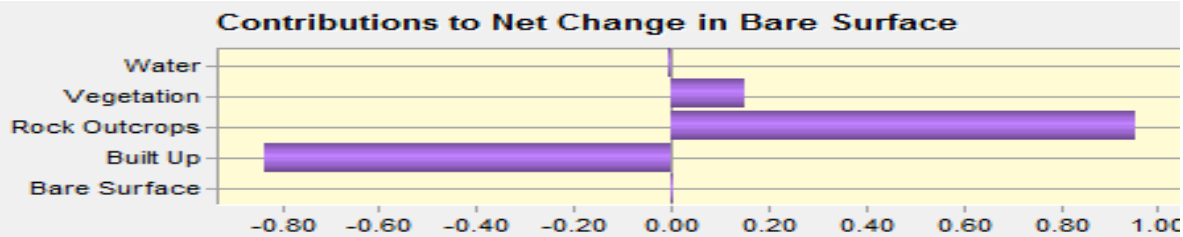


Figure 6: Change Detection map of Yankari Game reserve between 2003 to 2016
Source: Authors' work (2019)

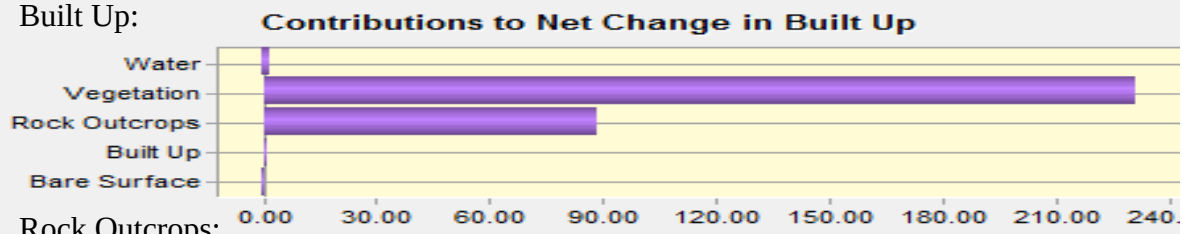
Contributors to changes of Landuse Landcover between 2003 to 2016

Figure 7 illustrates the contributions to changes experienced by each land use landcover (bare surface, built up, rock outcrops, vegetation and water), selected by the user from the drop-down list of landcover categories.

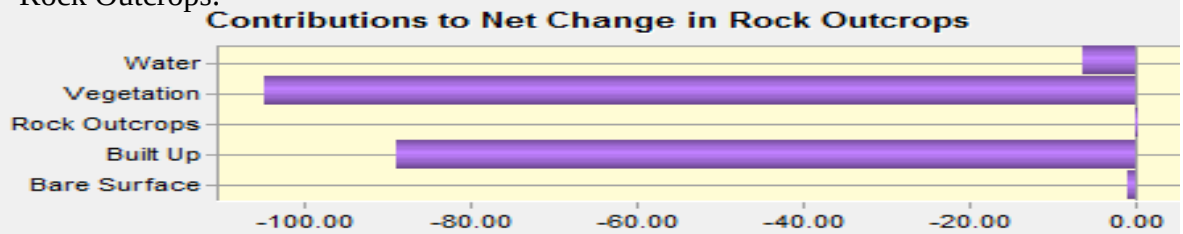
Bare surface:



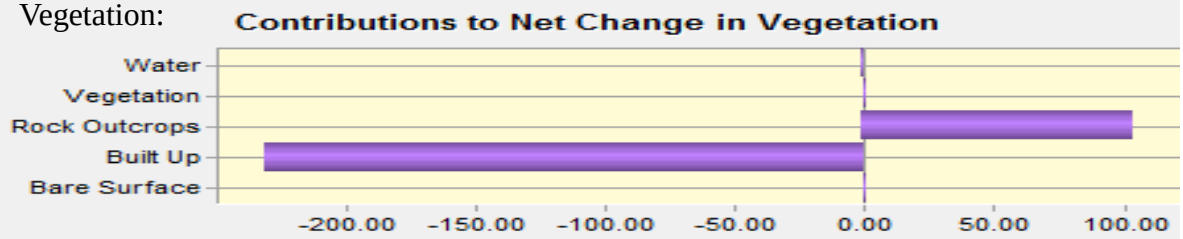
Built Up:



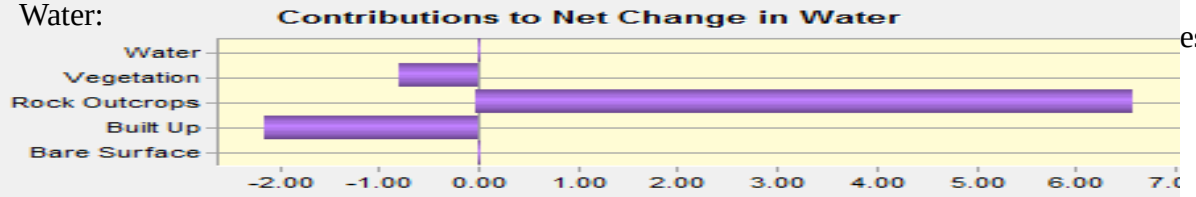
Rock Outcrops:



Vegetation:



Water:



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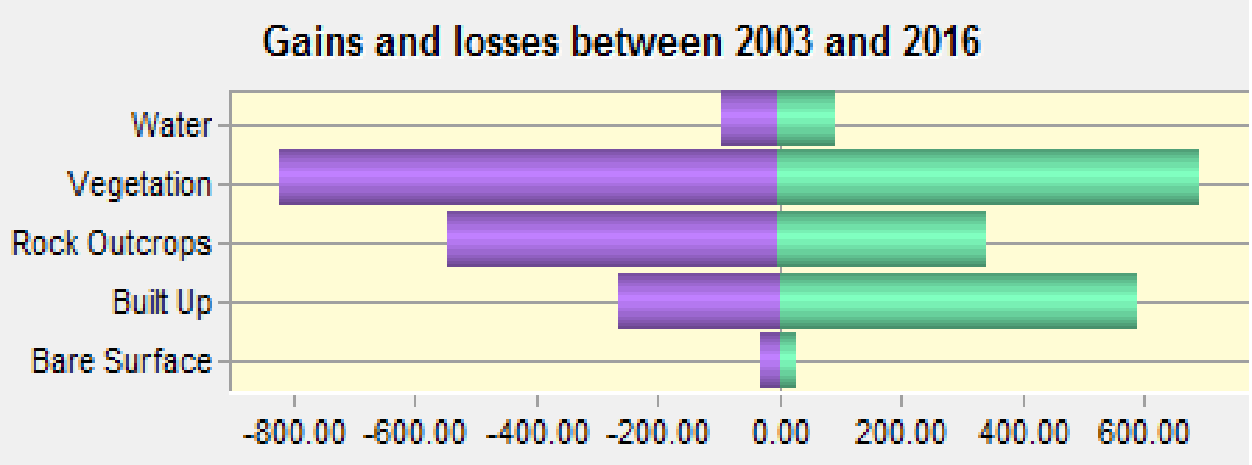

Figure 8: Showing Gains and Loss of LULC in Yankari Game Reserve in km^2 between 2003 - 2016
Source: Authors' work (2019)

DISCUSSION

This study examined the impact of Boko Haram activities in Yankari Game Reserve especially vegetation biomass. In 2003, the activities of Boko Haram were not known or better still have not manifested. There was high patronage which in turn led to massive construction of infrastructures to meet the demands of the high patronage level. This could be well explained looking at the landuse landcover change of the Game Reserve. For Bare surface, it was 0.98% in 2003 but later rose to 1.54% in 2010 and decreased to 0.99% in 2016. For Built up, it was 18.63% in 2003 but decreased to 10.35% in 2010 and later increased to 25.26% in 2016. This can be attributed to the activities of Boko Haram which manifested in full force in the year 2010 leading to poor infrastructural development in this period.

For Vegetation, it was 64.36% in 2003 but later decreased to 48.35% in 2010 and later increased to 61.78% in 2016. The decrease in vegetation cover from 64.36% in 2003 to 48.35% in 2010 can be attributed to massive infrastructural development during this era (2003) and the indirect effect of Boko Haram activities in 2010. It is noteworthy that in the year 2003, Boko Haram insurgency was not in existence neither was it active but the sharp and noticeable decrease in the year 2010 was as a result of anthropogenic activities caused by Boko Haram insurgency. Vegetation was being cleared for infrastructures such as roads, buildings, among others to be erected as well as anthropogenic activities. While the increase from 48.35% in 2010 to 61.78% in 2016 can be attributed to regeneration as the fight against Boko Haram is being won by the government. In a simple term, the vegetation of Yankari Game Reserve is regenerating. Natural regeneration is seriously taking place as activities in the Game Reserve are gradually coming

back to normal and anthropogenic activities have been checkmated. Similarly, the decrease in the vegetation cover in the year 2010 could also be attributed to human activities such as farming, poaching, lumbering, rearing, as the major economic activity of the host community is farming/rearing. So many factors can be attributed to that. It is noteworthy that Boko Haram rampage was at its peak during this period and as such tourists' patronage (especially foreigners) to the Game Reserve reduced drastically for fear of being bombed, kidnapped, among others. The locals that patronize it then only go there for personal reasons such as fetching of firewood, farming, lumbering, etc. which are the agents of vegetal degradation. According to Cunningham and Cunningham (2004), an estimated 12.5 million km^2 of tropical land were covered with closed canopy forest a century ago and 9.2 million hectares or about 0.6 percent of the remaining tropical forest is cleared each year. This situation occurs as a result of over exploitation due to high demand for food, energy and fodder and also through illegal logging and non-replacement of natural vegetation; people have decided to use firewood as an alternative means of energy for domestic purpose. Another dimension is added by felling and burning of wood to produce charcoal and this is causing serious depletion of the forest resources (Okonkwo et al. 2002). In a nutshell, human activities are recognized worldwide as the major cause of deforestation, with the agricultural and urban-industrial activity complex which are considered important factors.

Ifatimehin and Ufuah (2006) and Rimal (2001) asserts that, the change in land cover occurs even in the absence of human activities through natural processes whereas land use change is the manipulation of land cover by humans for multiple purposes; food, shelter, fuel wood, timber, fodder, medicine, raw materials and recreation. So many socioeconomic and environmental factors inter play in land use and land cover dynamics, major consequences of the globally recognized rapid land use and land cover changes are; land degradation, agricultural yield depletion, loss of biodiversity and ecosystem functioning (as cited by Ejaro and Abdullahi 2013). The work of Arome and Ejaro (2012) opined that land use is shaped under the influence of two broad sets of forces; they are human needs and the environmental features and process, neither one of these forces stays still; they are in constant state of flux as change is the quintessence of life. Socioeconomically, the land cover change of Yankari Game Reserve can be attributed to human activities as noted by Ukah and Ejaro (2019) that the most important occupation of the host community of Yankari Game Reserve was farming/rearing and farming/hunting. It was observed that after the emergence of Boko Haram activities, the locals do sneak into the Game Reserve to fetch fuelwood and to graze their animals while during the emergence of Boko Haram activities, movement was restricted.

Implication to Research and Practice

This study has been able to evaluate the effect of Boko Haram activities on LULC at Yankari Game Reserve, Bauchi State, Nigeria. The nature of the vegetation of Yankari Game Reserve before the emergence of Boko Haram was assessed and compared with the nature of the

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vegetation after the emergence of Boko Haram. The result showed that truly, Boko Haram activities have seriously impacted on the LULC of the study area. This implies that Boko Haram activities should be stopped and Boko Haram eliminated to avoid further deterioration of the environment of Yankari Game Reserve. In practice, government at all levels, NGOs, in fact, all hands should be on desk in proffering a lasting solution to the menace of Boko Haram.

CONCLUSION

The nature of vegetation cover before and after the emergence of Boko Haram changed. For example, Vegetation in 2003 was 64.36% but later decreased to 48.35% in 2010 and recently increased to 61.78% in 2016. The decrease in vegetation cover from 64.36% in 2003 to 48.35% in 2010 can be attributed to massive infrastructural development during this era. Similarly, the decrease in 2010 (48.35%) could be attributed to human interference but the increase between 2010 and 2016 was due to considerable reduction in human activities consequent on patronage by tourist and time for vegetation regeneration. In addition, human interference should not be neglected in this case because it is a major contributing factor. The study examined the effect of Boko Haram activities on Land Use Land Cover (LULC) change at Yankari Game Reserve, Bauchi State, Nigeria. It is deduced that Boko Haram activities have effect on the Land Use Land Cover change at Yankari Game Reserve as can be seen from the Land Use Land Cover change detection map. Recommendations are proffered to address the observed LULC changes and attendant challenges. These include; Enforcing the protection of forest at Yankari Game Reserve. Cutting down of trees, grazing and illegal burning in the Reserve should be prohibited. Sustainable forest management, reforestation efforts and maintaining the integrity of protected areas should be the watch word. This is not only possible, but necessary if we intend to preserve our most precious wildlife, respect and empower the local community as well as maintaining critical ecosystem services. The people of the host community of Yankari Game Reserve should be educated through enlightenment campaigns on the consequences of indiscriminate felling of trees. In addition to that, alternative sources of cooking energy should be provided to the local inhabitants. The management of Yankari Game Reserve should adopt Remote Sensing and Geographic Information System (GIS) techniques which have proven to be effective and efficient in the monitoring of vegetation cover. This would help to control encroachment and illegal logging in the area.

Future Research

There is need for future research to evaluate the effect of Boko Haram activities on land use and land cover (LULC) of Bauchi State of Nigeria as a whole.

ULR:https://doi.org/10.37745/bjes.2013

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