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THE CURRENT PLANT SPECIES COMPOSITION AND ABUNDANCE IN RELATION TO LAND USE PATTERN AT TSONJE KAGORO KADUNA STATE, NIGERIA BY

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Abstract

The study aimed to examine plants biodiversity status in Tsonje riparian forest in Kagoro Kaura Local Government Area of Kaduna state. The extinction of some plants species has become a major concern of the day, which triggers this research. The current composition and abundance of plants species, the level of degradation of the forest using satellite imagery for three decades and seasonal variation and composition of plants population whereas determined. Using Modified Whittaker techniques, (1/10th of a hectare) which involved two plots sizes of 100 by 100 metres. The satellite imagery for three decades whereas taken to determine the level of changes that occurred over time due to land use pressure. The result showed that there were seventeen (17) species of plants. However, the family fabaceae had the highest number of species of four (4) followed by the family Verbecnacenae with three numbers of species. Family Asteraceae had the least species of one in the study area. The changes in plants that have taken place in each decades from 19902000-2020 showed a decrease in vegetation cover in the order 83.5%, > 72.5% > 53.4% for the first(2000), second(2010) and third (2020) decades respectively. This revealed the level of degradation caused as a result of anthropogenic activities in the forest. These activities if not managed may lead to total loss of vegetation in the area.
This can be managed through conservation practices and public education.

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INTRODUCTION

Riparian zones (the fringes of rivers or streams) are the interface between aquatic and terrestrial ecosystems. Riparian zones are significant, environmental management and civil engineering due to their role in soil conservation, biodiversity and the influence they have on aquatic ecosystem (Abagai and Tanko, 2015). They occur in many forms including grassland, woodland, wetland or even areas of the sparse vegetation. Riparian area as provide critical habitats for many types of wildlife because of their diverse productive and complex structure of their plant communities as well as proximity to water. The wildlife may be permanent residents or the riparian area or occasional visitors that used the area for food, water or temporary shelter from extreme weathers. Riparian forest provides sheltered environment for animal to feed, rest and reproduce (Abagai and Tanko, 2015). It also helps the animals to escape from predators and human activities. Decrease in in the quality and quantity of riparian ecosystems have therefore contributed to the widespread and elimination of several animal species (Provide this Ref). The Kagoro Tsonje riparian habitat was reported as a breeding site for *Vanellus supercilliosus* with their nest recorded in 1987 and 1997 (Ezealor, 2002, Abagai and Tanko, 2015). The Hhabitat was also one of the areas where *Chrysococys flavigularis* has been reported (Birdlife 2008; Abagai and Tanko, 2015).

Habitat quality is said to be a function of species specific demands on different resources. Tanko (2015) opined that alarming rate of species extinction is a direct consequence of human activities. Habitat fragmentation may shrink the habitat of a species leading to local extinction of the species because of disruption of food chain. (Tanko *et.al.*, 2013). Kagoro forest as was popularly called was named one of the important Bird Areas in Nigeria by Ezealror, 2002). With the on-goingd destruction of frorfest resources, Abagai and Tanko, (2015) doubted if the site still retains its status as Important Birds Area in Nigeria. Abagai and Tanko, (2015) investigated the status of the site and reported that some bird's species with unique records that qualified the site as

Important Bird Area in Nigeria were not seen. They recorded 52 plant species and 69 bird species that were still utilizing the site despite the degradation. They attributed the degradation of the site to human activities, majorly, over-exploitation for timber, fuelwood extraction, over-grazing, explosion in population leading to slash-and-burnt system of farming. The consequences of these human-induced activities includes: desert encroachment, depletion of soil and water resources, destruction of the earth's web of life, loss of biodiversity, extinction of endemic species and globally, the global warming (Tanko *et al.*, 2013). The greatest problem with degraded environment is its inability to recover fully when it is excessively logged or cleared for farming (Tanko *et al.*, 2013). Prolonged loggings, cultivation with shortening periods of fallow and frequent bush burning were shown to have consequences of converting an existing forest to a derived savanna (Tanko, *et al.*, 2010). Forest plants and birds species were not seen in their study. Absence of forest species in their study was an indication that the site was shifting from the forest outlier it was known to be and was becoming woodland that characterized the region (Abagai and Tanko, 2015). This claim necessitated this study to establish the current status of the site and also observed the ecological succession that would have taken place within the period. Are there still plants and animals at the site? is there a shift from forest species to woodland species?

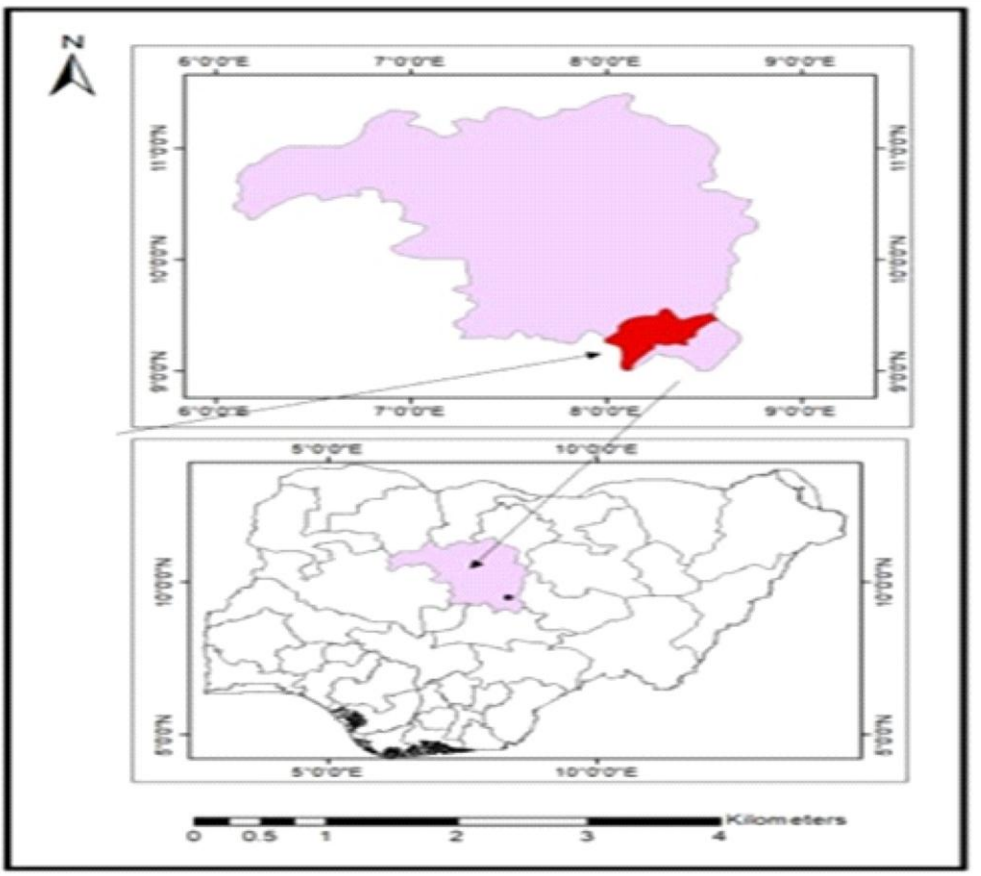
MATERIAL AND METHODS

Study area

Study area: The study was carried out in Kagoro/Tsonje which in the past was described as Kagoro forest lies between latitude $9^{0}31^{'}$ 542" and $9^{0}33^{'}$ 509" N and longitude $8^{0}22^{'}$ .244" and $8^{0}22^{'}$ 262" E.

The forest is located in Kagoro, Kaura Local Government area of Kaduna State, Nigeria. It is about 2km from the Kagoro town along Kafanchan –Jos road. The study covered a period of one year spanning both dry and wet seasons. The vegetation of the reserve is a mosaic of savanna and forest. The forest occurs mainly in river and stream valleys but also elsewhere from the rivers, as a

consequence of the relatively high annual rainfall of about 1550mm. (Ezealor, 2002, Birdlife International, 2008). Figure 1 is the map of Kaduna state with the Kagoro forest where to the study was conducted.



Source: Geographical Information System (GIS, 2020)

Figure 1: Showing The map of the study area

Vegetation Study

The vegetation was investigated after a reconnaissance survey. The method of investigation of the woody vegetation was 1/10th of a Hectare Technique/ Modified Whittaker Technique used by Abagai (2011). Two plots sizes of 100

by 100 metres-each were mapped out in the encroached uncultivated reserved and farmed segments of the site.

The following evaluations were done: The species compositions of all woody and non- woody plants in the plot were identified and total number of each species occurrence enumerated. The following materials were used, transect, rope and pecks.

Data Sources and Data Collection for Satellite Imagery:

The secondary data includes the use of spatial data such as topographical map, LAND SAT TM (1991) Imagery, LAND SAT TM (2001) Imagery and LAND SAT TM (2009) of the study area, obtained of path 189, Row 53 from the archives of National Remote Sensing Centre Jos, Plateau state. These were used because they were readily available as at the time of the research. The data collected was mapped by ground trotting and ground survey methods. This involves moving along defined traverse and line transect while observing surface samples which were decided based on the heterogeneity of classes mapped from the field samples and this was aided by the use of a Global Positioning System (GPS) to locate the ground verification points on the satellite image for further incorporation of details. The GPS points were collected along trafficable roads intersections and edges of defined boundaries. Sixty percent of collected ground truth (training samples) was used in image classification.

Topographical map is the map of the study area; this was generated using the GPS points of the area (Latitudinal and Longitudinal points) which served as reference point for acquiring the image and to retrieve on the image the position of the study area. These were taken to Jos Remote Sensing Center where the satellite images of the study area were generated. Based on the image processing analysis, the software generated the values for each land cover in each year.

Satellite Image Analysis

The data used in this research were for the years 2000, 2010 and 2020. These years were selected because information were more complete and comprehensive as compared to the other years. The study adopted imageries of different multi-temporal data acquired in the dry season with cloud free conditions as described by (Michael, 2013). An important advantage of LAND SAT imageries is the availability of older images to establish a baseline for determining medium-term rates of change. The entire satellite images were processed using Ilwis 3.3a processing software. Using this approach, fourseven broad land use classes (Settlements, Rock outcrop, Secondary forest and Water body) were identified using the maximum likelihood algorithm in supervised classification procedure.

Furthermore, the different land cover maps were produced.

Land Use Classification Scheme Description

The land use information for the study was based on field observation by the researchers, with focus on the four major land cover classes, which were the classification scheme adopted for the purpose of the research:

i. **Settlements:** These were man-made areas covered with buildings and other artificial structures with intensive human developmental in-print. In this category the built-up are composed of areas with most of the land covered with structures such as villages, commercial, strip development along highways, and an institutional complex. On the images they are represented by a regular and clustered pattern.

ii. **Secondary Forest:** These were areas covered by tree cover mosaics of different species distinguished by their height, with presence of little or no human activities. It refers to areas dominated with scattered bushes of woody plants or a light forest with trees. These were represented by its deep red colour on the satellite imagery.

iii. **Rock Outcrops:** These were uncultivated lands and areas dominated by inselbergs and bare rock outcrops. These are depicted by very light tone with occasional white color and are represented by their irregular pattern.

iv. **Water body:** These were open water bodies and/or areas covered mainly with water: dams, rivers and streams. These are depicted by a bluish to black color recognized by clustering.

Analysis of Data

i. Geo-spatial analysis:

This process helped to show the extent of temporal and spatial change in land use pattern. Geo-spatial techniques utilized are used to explain variation in change patterns occurring in the study area. Two change detection methods were used in the study. These are: 35 this is not complete.

ii. *Area analysis*: This analysis highlights the trend and rate of the land cover change

1. Percentage Change was calculated using the equation:

Percentage Change = MC/BY X 100, where MC=magnitude of change i.e Reference Year(2000); BY= Base Year (1990) Where *OC* is the observed change; and *ASC* is the absolute sum of change.

2. Annual Rate of Change was calculated using the equation:

Annual Rate of Change = MC/BY, where MC=magnitude of change i.e Reference Year(2000); BY= Base Year (1990)Where OC is the observed change; *Y 1* is the starting year; and *Y 2* is the ending year.

iii. Overlay analysis

The Overlay analysis involves the actual topological overlay of different data layers. This overlay, or spatial join, integrates data on built up, bare soil, farmland, secondary forest, and shrub land, roads water bodyies and river to produce a land cover map.

The means variables of plants species for three decades using satellite imagery were compared for similarity or differences by using the one way analysis of variance (1-ANOVA).

RESULTS

Table 1 provides a checklist of plant species composition and abundance of the study area. There were seventeen species belonging to ten families. Family *Fabaceae* had the highest number of species of 4, followed by the family *Verbecnacenae* with three numbers of species. Family *Asteraceae* had the least species of one in the study area. Furthermore, *solanum dasyphyllum* had the highest occurrence with seventy plants (70) followed by

Gmelina arborea 44 standsplants, then *Chlorophora excelta* with 4 individualsplants while *Senna sieberiana, Parkia biglobossa* and *vitex doniana sw* have two individuals each, whereas others occurred once in the forest.

Table 1: Plants species composition and abundance of Kagoro riparian forest.

Botanical Name	Family	Common Name	Hausa Name	Occurrences
	Verbenaceae	Black plum	Dinya (H)	2
Khaya ivorensis		Vitex doniana sw	Madacin kurmi (H)	1
Chlorophora excelsa	Moraceae	Mabule	Iroko (Y)	4
Gmelina arborea	Verbenaceae	White teak	Dinyar Bature (H)	44
Tectona grandis	Verbenaceae	Teak	Ichen Takarda (H)	1
Diospyros mespiliformis	Ebenaceae	Ebony Tree	Kanya (H)	1
Hollorhena floribunda	Apocynaceae	Hollorhena	Bakin Mayu (H)	1
Chromolaena odorata	Asteraceae	Siam Weed	Agatu (H)	1
Parkia biglobossa	Fabaceae: Mimosoideae	Lucust Bean Tree	Dorawa (H)	2
Tamarindus indica	Fabaceae:Caesalpinioideae	Tamarind	Tsamiya (H)	1
Ficus exasperate	Moraceae	Sand Paper Tree	Sanfefa (H)	1
Cola gigantea	Sterculiaceae	Giant cola	Bokoko (H)	1
Vernonia colorata	Asteraceae	Wild Bitter Leaf	Bagashi (H)	1
Afzelia africana	Fabaceae:Caesalpinioideae	African Afzelia	Kano (H)	1
Senna sieberiana	Fabaceae:Caesalpinioideae	Senna	Farar Kaya	2
Solanum dasyphyllum	Solanaceae	Hoary Solanum	Gautan Kura (H)	70
Psidium guajava	Myrtaceae	Guava	Gwaiba (H)	1
Total 17	10			135

Land Cover Distributions (Identifying and Mapping): The land cover and land cover changes for the study area is presented in Table 2. The land covered by built up was 6.18km^2 in the year 2000, increased to 12.96km^2 in year 2010 and 20.39km^2 in 2020.

Exposed rock out crops covered 0.38km^2 in 2000, 0.78km^2 in 2010 and then increased to 1.22km^2 in 2020. Secondary forest decreased from 68.40km^2 in 2000 to 61.07km^2 in 2010 and further decline to 52.84km^2 in 2020. On the other hand, water bodiesbodies' exposure increases from 1.24km^2 in 2000 to 1.39km^2 2010 and 1.75 km^2. Detail of the land cover distribution is shown in (Table 2).

Figures 2, 3 and 4 are the satellite images for the period 2000, 2010 and 2020 respectively.

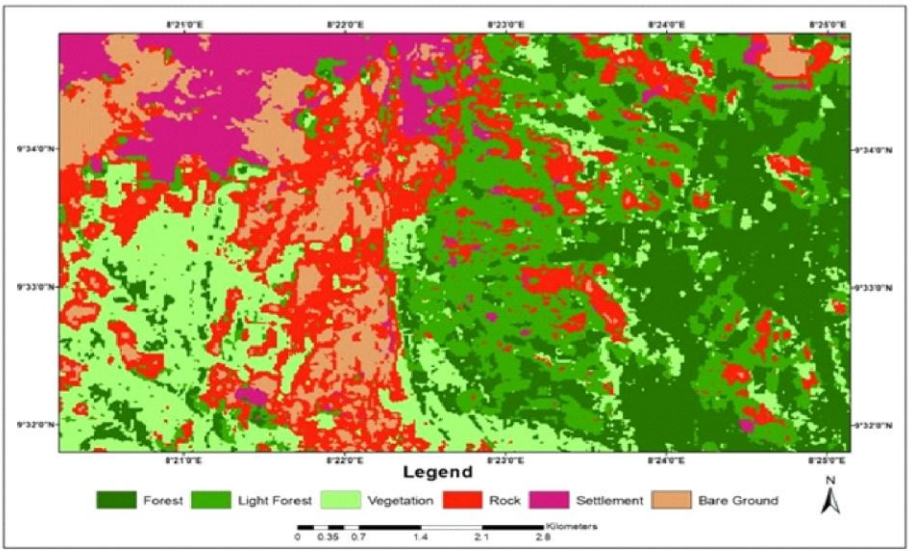
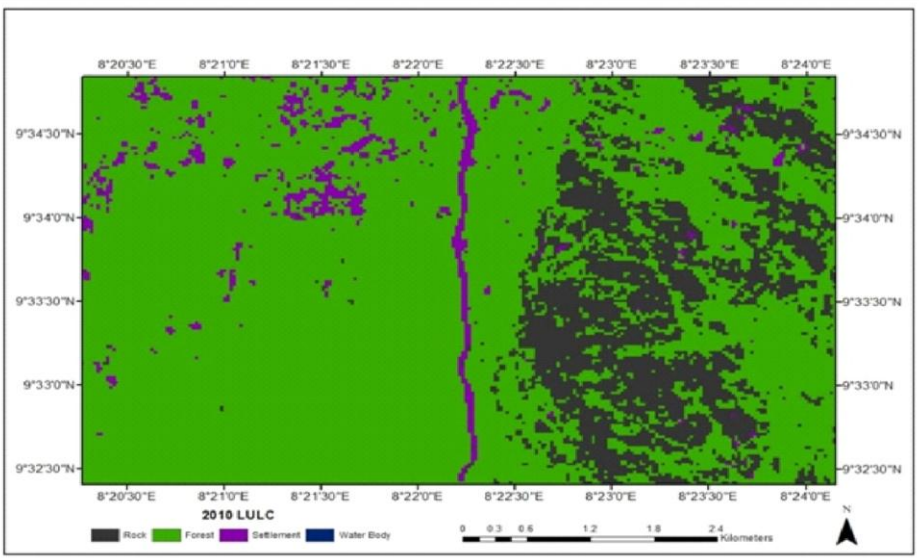


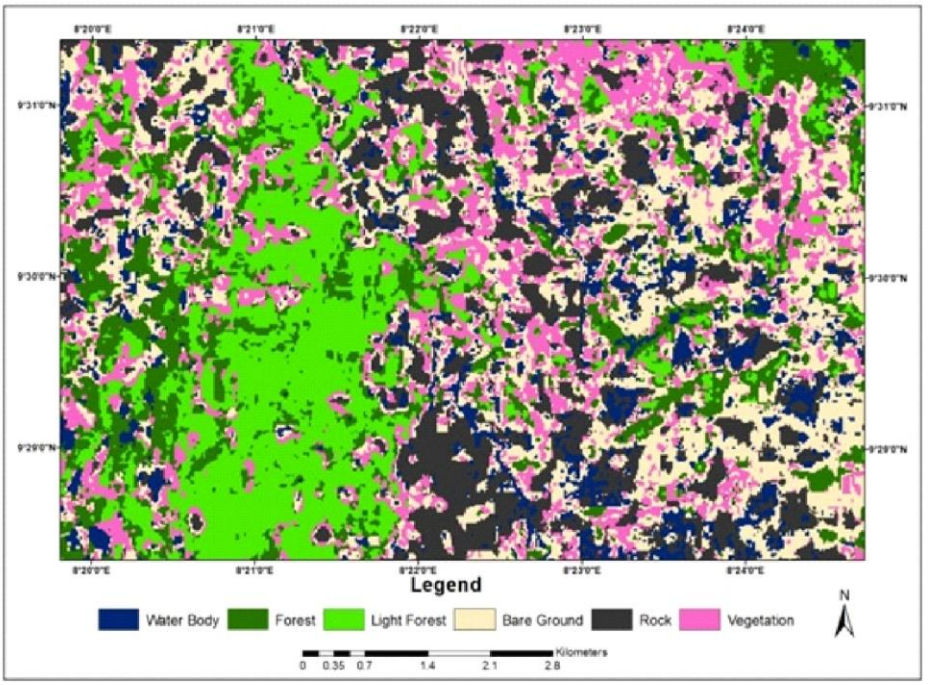
Figure 2: Satellite Imagery of Land Cover Categories of 2000



Source: National Remote Sensing Center Jos, Plateau State

Figure 3: Satellite Imagery of Land Cover Categories of 2010

Source: National Remote Sensing Center Jos, Plateau State



Source: GIS 2020

Figure 3: Degradation status of the forest in the year 2020

Static land covers distribution for the year 2000

The static land use distribution of the study area as derived from the maps is presented in Table 2 for each study year. The analysis of 200 revealed that rock outcrops constituted the lowest proportion of the land use form in the study area minimally occupying only 0.38 km^2 representing 0.50% of the study area.

The development of built up, road network, and infrastructure was moderate and it constituted 6.18 km^2, which represents 8.12 % of the total land cover class. Thus, these are exhibited as farm settlements and villages concentrated as points which are irregularly spaced in a linear pattern occurring within short distances. A notable feature of this period was the absence of any bare soil surfaces. Also, secondary forest and shrub land occupied the largest proportion with 68.40 km^2 of the total

categories representing 89.80 %. Exposed streams covered 1.24 km^2 representing 1.63% respectively. The study area at the time had a low spatial aggregation.

Static land cover distributions for the year 2010

In the year 2010, secondary forest and shrub land had reduced. Hence, it can be seen in Table 2 that secondary forest has deincreased significantly and are the major land cover class covering 61.07 km^2 representing 80.18 %.

The visibility of Rock outcrop has increased significantly occupying 0.78 km^2 representing 1.02%. Similarly, built up/road infrastructure have increased to 12.96 km2 representing 17.02 %.

During the period the direction of built up was gradually expanding forming a cluster and regular pattern of development that were linearly connected compared with the earlier period. The exposed water bodies occupying 1.39 km^2 represented 1.83% which is recognized by their linear/irregular patterns. The study area at the time had a low spatial aggregation with more settlement development.

Static Land Cover Distributions 2020

In 2020 Table 2 indicates that secondary forest and shrub land have the highest proportion in land cover categories covering 52.84 km^2 representing 69.34 %. However, the secondary forest land and shrub land areas recorded decreased from 80.18 % to 69.34% in 2020. Rock outcrop visibilities have increased from 1.02 % to 1.60% in 2020 covering an area of 1.22 km^2. Built up and road infrastructures have significantly increased from 17.02 % to 26.76 % in 2020 covering about 20.39 km^2.This indicates that built up and road infrastructure recorded significant gains. . The study area at the time had a high spatial aggregation with a geographic characteristic of a linear and clustered pattern of settlements development.

Effect of Spatial Trend Iin Land Cover Change

Table 3 represent the details of rate of changes in land cover class, the comparisons for the trend for periods 2000 to 2020 Between the years 2000 to 2010, built up areas has reduced the floral cover by -1.40 %. The rate of decreased in floral cover as a result of built up between 2010-to2020 was 7.00% . between the year 2000 to 2020 built up had replaced 7.01 5km^2 that was floral cover as at year 2000. Secondary forest witnessed a decreased of 11.01% between the period of 2000-2010 and a remarkable decrease in 2010-2020 by 19.06% .

Total landcover change for 20 years (2000-2020) showed increaswed of streams exposure buy 4.65 km^2, 6.41Km^2 rock exposure and a decreased in forest cover by 18.08km^2. Ssettlements took over 7. 01km^2 of the initial floral cover. The project landcover replacement for the next

two decades (2040) was estimated to be 36.16 km^2 of the the initial 68.40 km^2 , leaving

32.24km^2 with floral cover.

Table 2: Changes of plants that have taken place at every ten years interval between 2000-2020

Land use pattern	Year 2000		Y ear 2010		Year 2020	
Class nam e	Area (m^2)	Percentag e	Area (m^2)	Percentag e	Area (m^2)	Percentag e
Forest	68.3961430 6	89.79678	61.06934	80.17748	52.83743	69.342
Rock	0.37937868 3	0.498083	0.778378	1.021927	1.221459	1.603
Settlemen t	6.18383503 6	8.118711	12.96032	17.01551	20.38686	26.755
Water Bod y	1.23895473 4	1.626614	1.390193	1.825174	1.752561	2.3
Total	76.1983115 1	100	76.19824	100	76.19831	100

Table 3: Rates of changes between years in percentage

Years	Total land cover change from 2000-2020	2010-2020	2000-2010	Projected land cover change in the next 20j years (2040)%2000-%2010
Forest	-18.07891836	-11.46Km (19.06%)	-6.62km^2(11.01%)	11.00713
Rock	6.41411056	5.90km^2 (-9.82%)	0.51 km^2(-0.85%)	-0.84796
Settlement	7.010046515	4.21km^2 (-7.00%)	2.80 km^2 (-1.39%)	-1.39319
Water Body	4.65476129	1.36km^2(-2.25%)	3.30 km^2 (-3.29%)	-3.29379

DISCUSSION

The rapid declined of plant population in the Kagoro Tsonje forest may be attributed to human activities such as lumbering, farming, mining and increase in the human population which in turn caused increase in settlement (Amundson, 2015). From the study, seventeen species of different plants recorded belonging to 10 families is very low when compared to 52 species recorded by Abagai and Tanko, (20135) ion the same site. The implication of this result is change in name of the site from the Kagoro forest to Kagoro savanna grassland since the site no longer hold the forest species composition and diversity that qualified it as a forest then

The highest occurrence of *Solanum dasyphyllum* may due to the facts that it is not economic shrub and therefore cannot be used for any purpose by man. Its abundance in the site may indicate high grazing activities. The weed produces large number of fruits which are often eaten by cattle as they graze on the leaves. This aid in dispersal of the species from one location to another. This finding is synonymous to the work of Bardgett, (2014) who also carried out a research and discovered the same species of plant with highest occurrence.

Gmaelina arborea was second in occurrence with 44 plants stands. This may be due to its economic value such as major sources of timber lumbering purpose which was observed at the siteit to be preserved in the forest. This Herdsmen cut the leaves to feed their animals therefore may not want to cut down the main trunk for this reason. *Gmaelina* also has the ability to regenerate through coppices which made total extirpation of the species difficult despite grazing pressure. Tanko *et al*. (2013) observed *Piliostigma thonningii* as the only species thriving to sprout in a study site despite grazing presuure and attribute this to the growth habit of the species which has the ability to regenerate itself. The composition and abundance of plant species in the site has shown a steady decline in the last three decades.

The implication is that either through farming or fuel wood extraction , over exploitation of once upon a time flourishing forest has reached a catastrophic state This work agreed with the work of Koch, (2013) who state that development infrastructure such as roads and markets are major factors of deforestation. It appears that fuel wood and timber exploitation pave way for farming. Whereas the exploitation is in line with the general devastation of similar such ecologies area in Nigeria (Ezealor, 2002).

Decline in forest cover in 2000 from 68.40Km^2 to 52.84Km^2 in 2020 Wwas an indication of continuous decline as a result of continually anthropogenic activities going on in the forest. These activities if not checked may turn the site to a bare ground in the next decade. Ever since, the activities of man have been distorting the natural setting of natural resources such as forest. This has been a challenge in preserving the wild fauna as this caused the wild life to migrate to other places where there is still existence of thick forest. The increase of human activities in the forest may be due to the fertility of the soil and search to earn a living.

During the early stage of encroachment (2000), most of the land cover were relatively stable with secondary forest experiencing the little negative change. Similarly, the reductions in shrub land shows that built up and road expansion have continued to encroach as a result of anthropogenic activities taking place at the expense of vegetal cover loss. The positive changes observed in settlements areas indicating that encroachment into the site for buildt-up started even before other anthropogenic activities. This is not unconnected with global population explosion and search for livelihood. The buildt-up areas have a link with the roads constructions since the settlers will have access roads to their homes and also transport their goods to the market. The settlers were probably engaged in other activities like wood logging, fishing and grazing with farming being a secondary activityies. Rock outcrops showed a positive increased probably because the

ongoing anthropogenic activities further exposed them making them more visible than they were when the site was densely forested.

The post encroachment period (2000-2020): During this period most of the land cover experienced significant changes with river and water body experiencing the most positive change (gain).

The increasing shares in the built up areas have intensified and have accelerated urban encroachment into the natural vegetation, leading to increase in changes observed .These activities have negative impacts on the vegetation. The reduction in secondary forest and shrub land indicates that built up and road expansion have continue to encroach as a result of anthropogenic activities taking place due to rapid expansion occurring at the expense of vegetal cover loss. Therefore, the period presents secondary forest and shrub land with a decline compared with the previous period. This therefore, demonstrates that expansion activities have placed more pressure on the bio-diversity of the study area.

Vegetation degradation/depletion arising from agricultural extension, increased demand for fuel wood, vegetal clearance at exposing bare soil surfaces were encroached upon for construction activities. This findings support the work of Boakye *et al.,* (2008), which explain that vegetation changes are often the result of anthropogenic pressure (e.g. population growth) and natural factors such as variability in climate.

Conclusion

The vegetation of the forest has greatly reduced and loss of native vegetation had resulted in loss of habitat for many animals. This has been shown in the disappearance of plants that in recent years made the Kagoro/Tsonje forest to be of ornithological importance. The loss of the forest has also removed plant communities in many parts and the forest is replaced by open fields, shrubs or grass savannah of much less ecological value. The ecological consequences are serious both at local and regional levels. The damaged that occurred in the forest has made several natural species of plants which are of economic value to

get extinct and also the loss of this vegetation contributed to the loss of many species of wild animal.

Recommendation

From the finding, it is recommended that awareness, supervision, monitoring should be done at all levels in order to safe guard the natural resources to avoid so that it will not be completely get extinction for futures use.

We also recommend the promotion of alternative energy source for fuel wood in order to reduce the pressure on the forest. Development and promotion of trade in non-timber forest product to reduce the pressure on timber resources and to enhance rural livelihood is also recommended. The available vegetation area and the farmland must be properly utilized to encourage sustainable management between the rural dwellers and the government.

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