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Analysis of Land Use Land Cover changes in Ruma-Kukar Jangarai Forest Reserve Nigeria.

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Abstract

This study examined the vegetation changed in Ruma-Kukar Jangarai Forest Reserve for the purpose of analysing the extent and the rate of change in the area. This was achieved through Land use land cover (LULC) mapping of the study area for the year 1972, 1992 and 2015. The images were classified using supervised maximum likelihood classifier algorithm. The outcome of the study were the classified images of the study area at 1972, 1992 and 2015. The accuracy achieved were 84, 86 and 76% for the 1972, 1992 and 2015 images respectively. The LULC with major changes are settlement, dense vegetation, farmlands and water body. Settlement increased by 176%, dense vegetation decreased by 99.4%, farmland increased by 136%, water body decrease by 97.5%, The study recommended modelling the dynamic of the forest by including socio-economic activities among the parameters

Keywords: *Forest Reserve, Geo-information, Remote-sensing Ruma-Kukar Jangarai and Vegetation.*

Introduction

Vegetation is assemblages of plant species in an area. It is a general term, encompassing life, forms, structure, spatial extent, or any other specific botanical or geographic characteristics. It is broader than the term flora which refers to species composition. Perhaps the closest synonym is plant community, but vegetation can, and often does, refer to a wider range of spatial scales than that term does, including scales as large as the global (Farlex, 2014).

The reservation of land for forestry purposes started in Nigeria during colonial time in 1899.

The emphasis is on reservation by Local Communities who held and lay claim on local lands

(Na'iya 2017). At least 20% of the Nigerian total land area was planned to be forest reserve, but up to now the target has not been met (Adamu in Na'iya (2017)).

It is estimated that the total area of forest reserves in Nigeria is 10 million ha, which is about 10% of the total land area of Nigeria (Na'iya, 2017). It should be noted that forest reserves vary according to ecological classification. Hence, forest reserves in the Savannah and Sahel regions may not necessarily dense like those in the lowland rain forest areas of southern Nigeria. Such forest reserves are owned by the State Governments who managed the State Forestry Departments (SFDS). Efforts to increase the size of the reserves (forestry estate) since then have not been too successful. Hence, only about 10% of the land area of the country is currently under forest reserves (Na'iya, 2017).

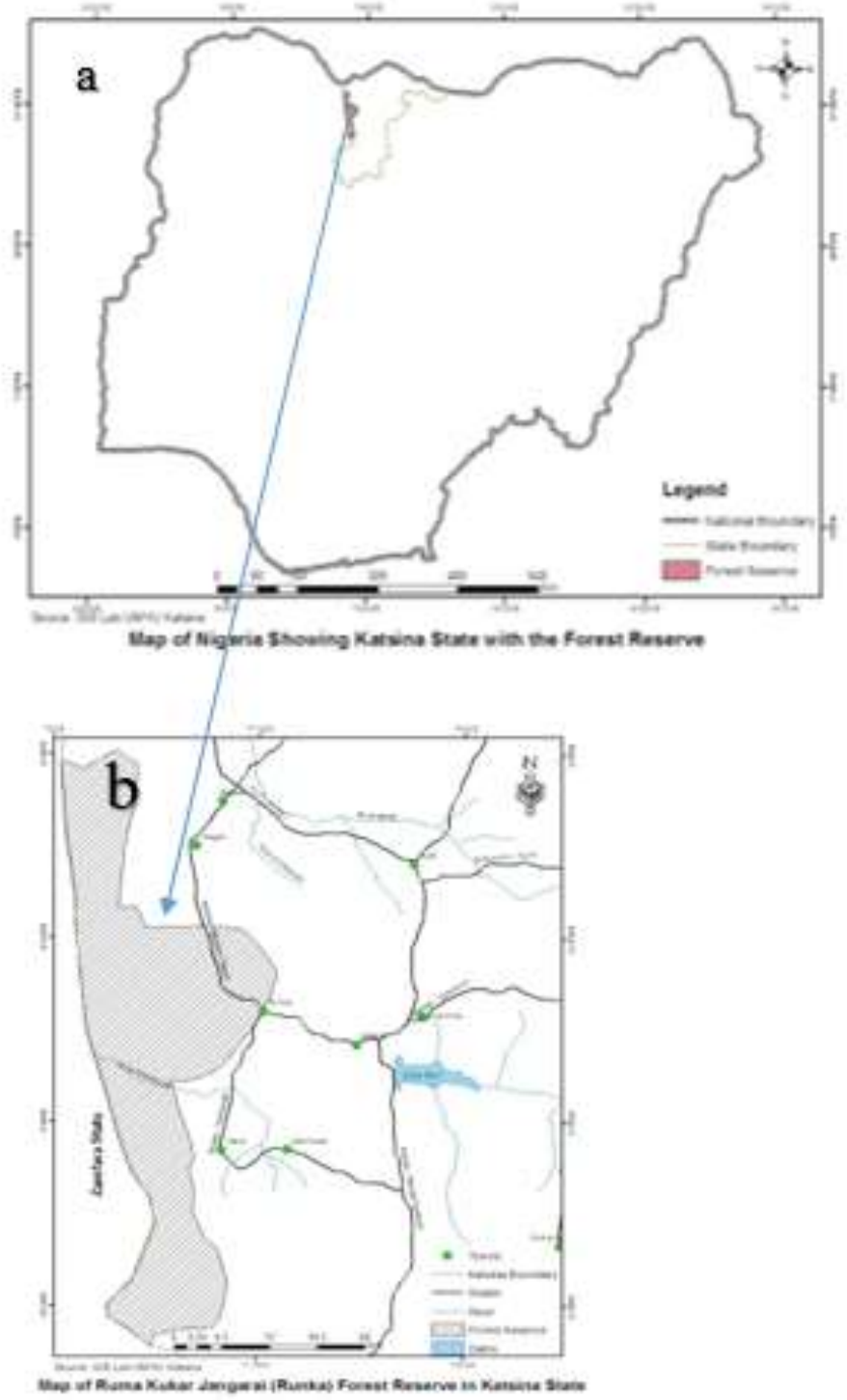
Forest reserves are portions of state lands where commercial harvesting of forest products is excluded in order to capture elements of biodiversity that can be missing from sustainably harvested sites. Small position of the reserves will conserve sensitive, localized resources such as steep slopes, fragile soils, and habitat for certain rare species that benefit from intact forest canopies. Matrix reserves will ultimately support a wider diversity of tree sizes and ages than typically occurs on sustainably harvested sites, and will also support structures and processes associated with extensive accumulations of large woody debris that are typically absent from harvested sites (Anderson and Bernstein, 2003).

Nigeria's natural ecosystems are highly vulnerable to many adverse influences, deliberate or highly inadvertent. They are increasingly

coming under pressure from excessive hunting, overgrazing, logging, slash and burn for agriculture, shifting cultivation. Some of which are the problems facing Ruma Kukar Jangarai Forest Reserve in Katsina state. Development around the forest reserve has created large human concentrations with high demand for natural resources. Increased reliance on floral diversity services for energy, medicine, food, and other product for human sustainability constitute a growing threat to the physical integrity, richness, biodiversity productivity of reserve. All of these should not be underrated as their devastation of the natural environment can be costly, socially, ecologically and financially. Ruma Kukar Jangarai forest reserve, despite its legal status as protected areas, does not in itself guarantee the protection of the ecosystem it contains. According to Clark and Bolton (2008), protected areas generally reduce deforestation relative to unprotected areas, however, they do not entirely eliminate land use change within them. This study analysed the of changes of land use land cover within the Ruma Kukar Jangarai forest reserve. This can be achieved through Land use land cover mapping, analysis of mapping accuracy, change detection and the analysis of rate of changes.

The Study area

The study area (Figure 1) which is the forest reserve is located between Latitude 7º0’22"E and 12º0’25" N, and longitude 7º0º00" 7º0º20" E of the Greenwich Meridian. It covers the surface area of about 155325.823 Hectares. It is located about 80km south west of Katsina City, the capital of Katsina State. The western part of the reserve forms border with Zamfara State where it joins Zamfara forest. According to 1991 population census the population of settlements of Wagini, Runka, and Mara were 6,175; 5,730 and 9,599 respectively. However, based on 4.38% annual growth rate Runka has a population of 13,358 in 2011. While Mara town records 49,476 people in 2011 to base on NPC’s annual 8.82% annual growth rate computed in 2015. (NPC data 1991, obtained 2015) The prominent towns and villages surrounding the forest reserve are; Wagini, Mara, Runka, Gora, Awa, Marina and Illela-rubo amongst others. These settlements can best be described as growing rural settlements getting more compacted at the edge of reserve. Larger proportion of the inhabitants earns their living from farming activities, hunting and grazing, most of which is in traditional form(Na’iya, 2017).



Map of Nigeria Showing Katsina State with the Forest Reserve

Map of Ruma Kukar Jangarai (Runka) Forest Reserve in Katsina State

Source: Na'iya, 2017

Figure 1.a Map of Nigeria showing forest reserve b Map of Ruma Kukar Jangarai forest reserve

Materials and Method

The data used in this study Landsat imageries obtained from the USGS www.earthexplorer. usgs.gov with WGS84 UTM zone 32 N origin. Considerable effort was put into selecting cloud-free data sets and to get data near the same date and the same season in order to reduce seasonal difference effects on the images for classification and change detection. The selected images were acquired between January and February which is considered as dry season in the study area because there are no available imageries to maintain consistency in day but seasonal consistency was maintained. Table 1 is a summary of the data.

Table 1: Details of Landsat Data utilized for the Study

Platform (sensor)	Row/ path	Date Acquired	Spatial resolution meters	Cloud Cover
Landsat 4	189/51	08/01/1972	30	0.00
Landsat 5	189/51	12/02/1992	30	0.0
Landsat 7	19/51	1/1/2015	30	0.00
Landsat 4	189/52	08/01/1972	30	0.00
Landsat 5	189/52	12/02/1992	30	0.00
Landsat 7	189/52	1/1/2015	30	3.33

Source: www.earthexplorer. usgs.gov

A handheld GPS receiver Garmin 75x was used for capturing the position of reference points in the study area during ground-truthing for the analysis of mapping accuracy. Google map was used also for acquiring the positions of land-use land-cover that are inaccessible during groundthruthing. Erdas Imagine version 2014 was used for image pre-and-post processing analysis. ArcGIS version 10.4.1 was used for mapping, data integration and further analysis of relationships, patterns and trends in a multi-temporal approach.

Method

In order to achieve the major objective which is the mapping and analysis of land use land cover changes in this research, the Landsat images obtained

were layer stacked, clipped, and visually corrected to make the imageries ready for analysis. The training samples of level one classification scheme were generated and averaged. Then, the farmland, waterbody, settlement, bare land, dense-and-less dense vegetation were classified using supervised maximum likelihood classifier. About 400 reference points were captured during ground-truthing and were used for the analysis of the mapping accuracy. The size of each land cover class was quantified. Change detection was conducted to analyse changes in the land-use land cover using equation 1

Determination of the Rate of change

In order to determine the extent and rate of change in the land cover dynamics in the region, the following variables were computed. These variables can be described by the following formula:

(Yesserie, 2009)

$$\text{Ca} = a(t_2) - Ta(t_2) \quad 1$$

$$Ce = \frac{Ca}{\text{Ta}(t_1)} \times 100\% \quad 2$$

$$Cr = \frac{Ce}{(t_1) - (t_2)} \times 100\% \quad 3$$

where t_1 and t_2 is the beginning and ending time of the land cover.
Ta, Ca, Ce and Cr is the total area, changed area, change in extend, and annual rate of change respectively

Result and Analysis

Figure 3,4 and 5 are the classified images of the study area at 1972, 1992 and 2015, respectively. Table 2, is the statistics of the quantification of the area classified images, percentage change and loss/gain of areas of the land use land cover. The overall accuracy and kappa achieved after the classification of the images at 1972, 1992 and 2015 were 84.28% 0.8886, 86.23% 0.7764 and 78.65% 0.7261 respectively. This shows that, there is strong agreement between the land use land cover and the reference data. This quality test of the classification prove that, the results obtained can be used for application like Monitoring of land use land cover change and analysis etc.

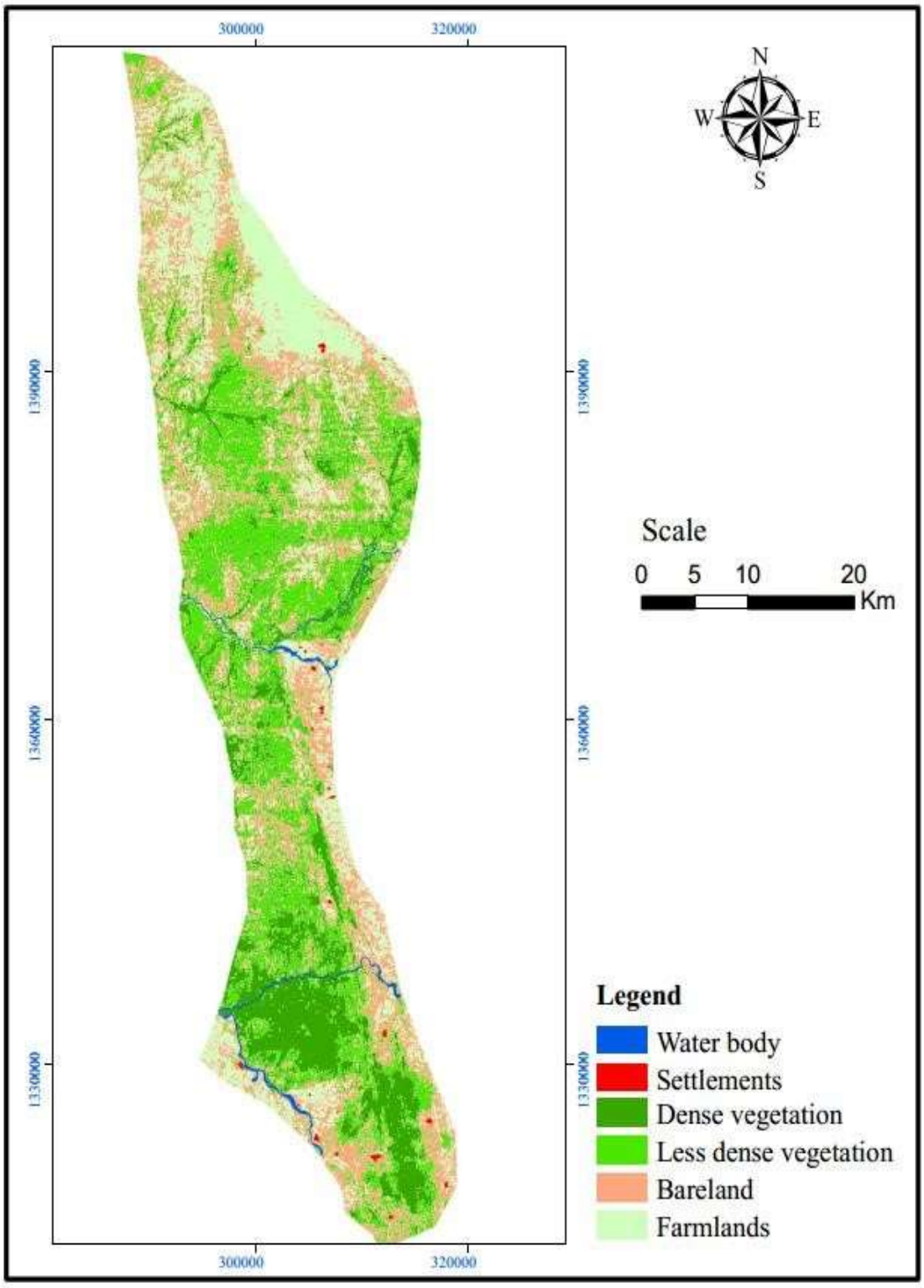


Figure 2 Classified image of 1972
Source: Author's work

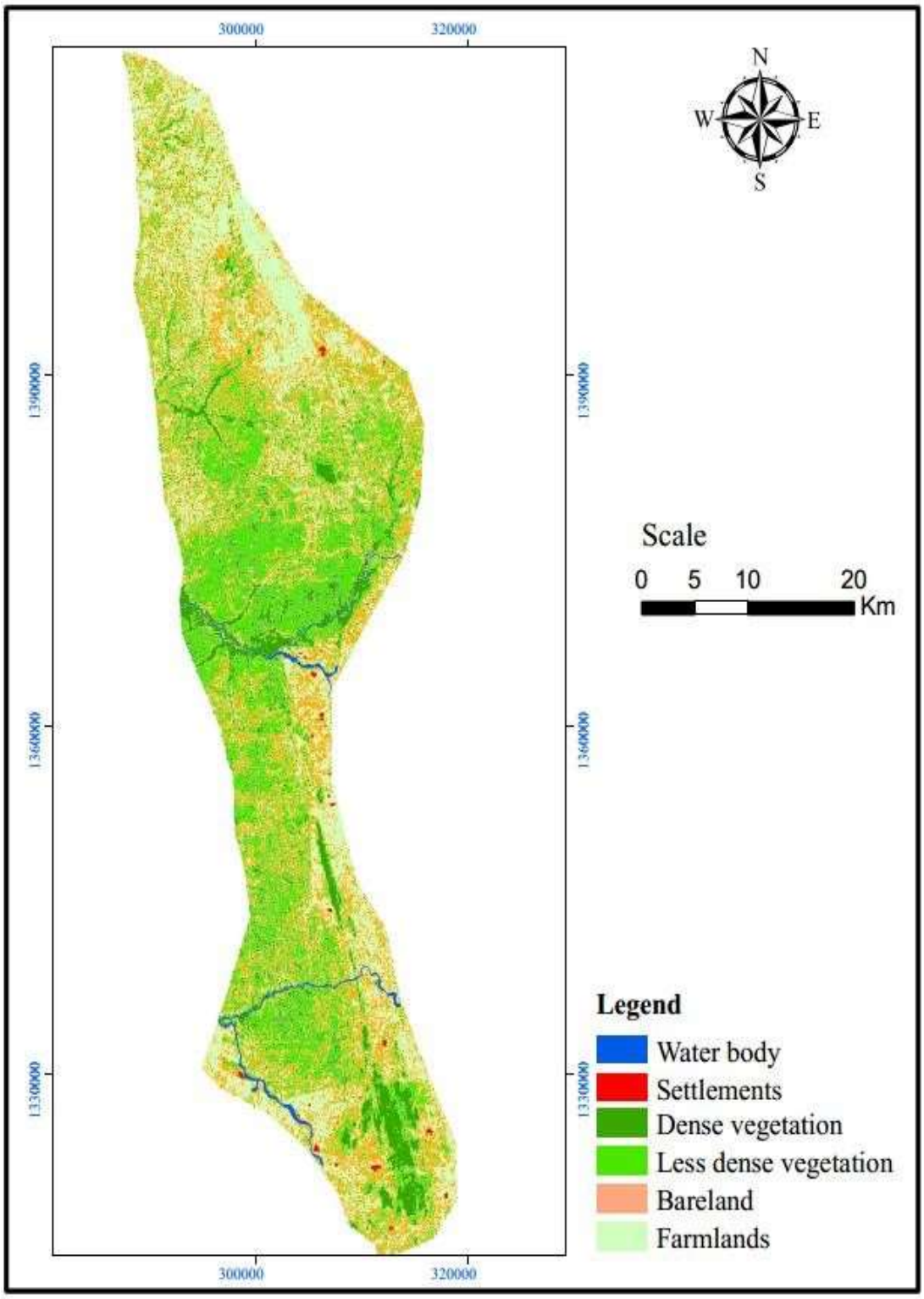


Figure 3 Classified image of 1992
Source: Author's work

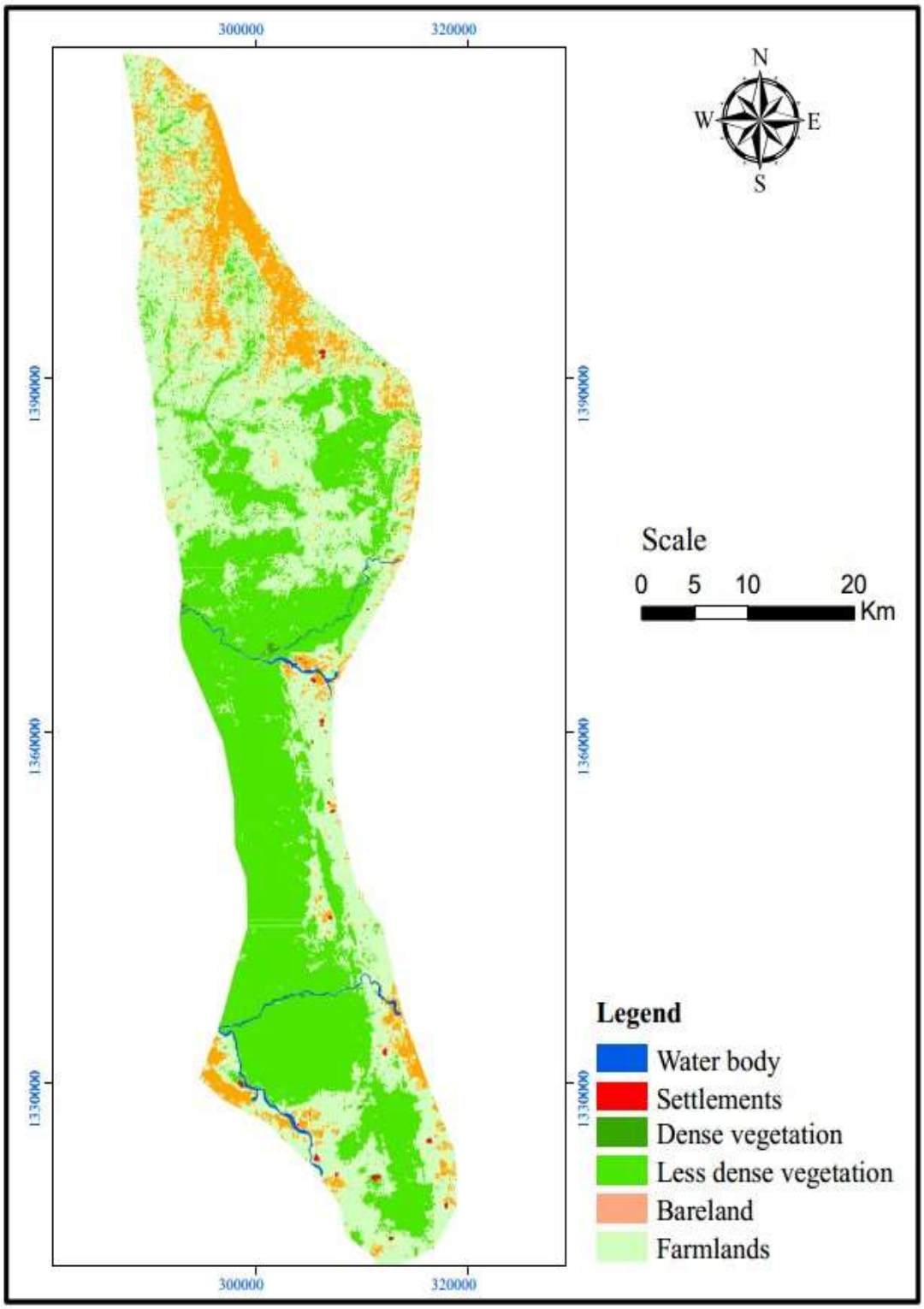


Figure 4 Classified image of 2015
Source: Author's work

Table 2 Quantification of LULC Classes in the study area

LULC Classes	1972(Ha)	1992(Ha)	2015(Ha)	Change (%) 1972-2015			Remark
				72-92	**92-15**	**72-15**	
Dense Vegetation	27100.112	18127.564	162.588	-33.11	-99.1	-99.4	Loss
Less-dense Vegetation	52315.654	51851.898	70617.27	-0.89	36.2	34.9	Gain
Bare land	47050.578	50434.389	17734.23	7.19	-64.83	-62.3	Loss
Farmland	27537.489	33474.342	65242.68	21.5	94.9	136.9	Gain
Water body	1204.389	1239.711	1245.234	2.93	0.44	3.39	Loss
Settlement	117.601	198.192	323.189	69.4	62.96	176	Gain
Total	155325.823	155325.396	155325.192				

Source: Author's work

Table 3 Percentage of Change Extent and Rate of Change of LULC

Classes	**1972-1992**			**1992-2015**			**1972-2015**		
	t2-tl(Ha)	change %	Rate %	t3-t2(Ha)	change %	Rate %	t3-tl(Ta)	changes %	Rate %
Settlement	80.59	69.4	86.11	124.997	62.96	50.45	205.588	176	85.44
Dense Vegetation	-8972.54	-33.11	0.37	-17964.97	-99.1	0.55	-26937.52	-99.4	0.37
Less-dense Vegetation	-463.756	-0.89	0.19	18765.372	36.2	0.19	18301.616	34.9	0.19
Water body	35.322	2.93	8.29	5.52	0.44	7.97	40.845	3.39	8.30
Farmland	5936.853	21.5	0.36	31768.338	94.9	0.3	37705.191	136.9	0.36
Bare land	3383.811	7.19	0.21	-32700.15	-64.83	0.2	-29316.35	-62.3	0.21

Source: Author's work

Vegetation Dynamics between 1972 and 2015

From Table 2 bare land, water body and dense vegetation reduced in size. Between 1972 and 2015 dense vegetation decreased from -33.11% to -99.1% in the first and second epochs (1972-1992 and 1992-2015) respectively. These changes occurred at the rate of 0.30, and 0.36% (19721992 and 1992-2015

respectively) due to population growth and corresponding increase in demand for heat energy. The deforestation was rapid in the second epoch. Water bodies decreased from 2.93 to 0.44% respectively (between 1972-1992 and 1992-2015). This may be as a result of construction of zobe dam on the major river draining in the forest, siltation, sedimentation and lack of regular evacuation of impounded reservoirs. The rate of change in water body was 8.29 and 7.97%, respectively for the two epochs. The change was rapid between 1972-1992. About 64.8% and 62.3% of bare land also loss to settlement and farmland within two epochs under review (1972 to 2015). Farmland within the period under review increase by 136% between 1972 and 2015. The gain was rapid (0.36%) mainly due to the rapid conversion to vegetation to farmlands. In addition, less-dense vegetation increased by 34% as a result of deforestation. Settlements is the class with the highest gain. It increases by 176% between 1972 and 2015 at the rate of 86.11%. the change of this land cover was rapid between 1992-2015 in the second epoch.

Conclusion and Recommendation

The study mapped, analyses changes in land use land cover and the rate at which the changes occurred. The outcome of the study were the classified images and the changes that occured. The study identified dynamics of land covers within Ruma Kukar Jangarai Forest Reserve area in parts of Batsari, Danmusa and Safana LGA of Katsina State. The LULC with major changes are settlement, dense vegetation, farmlands and water body. Settlement increased by 176% at the rate of 0.67%, Dense vegetation decreased by 99.4% at the rate of 0.46%. Farmland increased by 136% at the rate of 0.33%. Water body also suffered losses of about 97.5% with highest rate of loss in the second epoch. Based on the results of this study, it was recommended that, further research should be focused toward modelling the dynamic of the forest by including socio-economic activities data among the parameters

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