Scientific Research Publishing

Advances in Remote Sensing, 2022, 11, 167-181
https://www.scirp.org/journal/ars
ISSN Online: 2169-2688
ISSN Print: 2169-267X

Assessment of Land Degradation in Dambatta Local Government Area Using Remote Sensing Techniques

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How to cite this paper: Jibril, M.S., Aule D.S. and Idris, A.H. (2022) Assessment of Land Degradation in Dambatta Local Government Area Using Remote Sensing Techniques. *Advances in Remote Sensing*, **11**, 167-181.
https://doi.org/10.4236/ars.2022.114010

Received: June 20, 2022
Accepted: December 26, 2022
Published: December 29, 2022

Abstract

Kano State is one of the frontline states in northern Nigeria that have suffered land degradation. This degradation results from urbanization and anthropogenic influence. In Danbatta Local Government Area (LGA), persistent degradation of the land has adversely affected the environment and the economy and there is lack of studies on land degradation in the area. Therefore, this study assessed land degradation in Dambatta Local Government Area (LGA) of Kano State paying special attention to the causes and effects of the reduction in the lands' actual or potential uses. The images used for the research analysis were obtained from National Space Research and Development Agency (NASRDA), Abuja. The data sets were captured by Landsat Multispectral Scanner/Thematic Mapper (MSS/TM) 1997, Landsat Enhanced Thematic Mapper Plus (ETM+) 2007 and Operational Land Imager (OLI) 2017. Post classification change detection technique was conducted in ILWIS 5.2, and later converted to shape files where it was imported to Arc Map 10.2 GIS software. The results showed Normalized Difference Vegetation Index (NDVI) ranges from −0.056 to 0.18 in 1997, −0.07 to 0.11 in 2007 and −0.128 to 0.217 in 2017. This depicts that there has been a progressive loss in vegetation cover in Dambatta LGA over a period of 20 years with corresponding acceleration in bare lands and developed areas. The Land Surface Temperature (LST) results generally show a continuous and constant increase in surface temperature from the developed and urban areas to the undeveloped and rural areas. The LST results also show that no area under consideration in the study area experienced an extreme temperature (≥44˚C) during the period of study. In 2017, a large part of the study area fell within the higher temperature zones (≥40˚C) and other areas fell into mid-temperature zones (35˚C - 40˚C). This high surface temperature resulted from increase in bare land, high insolation, urbanization, anthropogenic influences and large distribution of imperviousness or geographical relief of the area. It was suggested that afforestation and sustainable development should be encouraged and strengthened in the area. In addition, studies should be carried out on the appropriate solution to the land degradation problem in Dambatta LGA, Kano State. Furthermore, Local Government Areas neighboring Dambatta LGA should also be analyzed on the issue of land degradation.

Keywords

ILWIS, GIS, Satellite Imagery, Land Degradation, Danbatta, LST and NDVI

1. Introduction

Land degradation is defined as the long-term loss of ecosystem function and productivity caused by disturbances from which the land cannot recover unaided. It is the decline in soil quality caused through misuse by humans and results in deterioration of soil's life support processes and decline in its capacity to produce food, feed, fiber and fuel. It is the decline in the biological productivity or usefulness of land resources in their predominant intended use, stemming from human activity and encompasses soil degradation and changes in the traditional landscape and vegetation due to human interference [1] [2] [3]. According to Gretton and Salma, "land degradation is the diminution of the soil's current and/or potential capability to produce quantitative or qualitative goods or services as a result of one or more degradative processes" [4].

Land degradation occurs slowly and cumulatively and has long-lasting impacts on rural people who become increasingly vulnerable [5]. The United Nation (UN) Convention to Combat Desertification (CCD), of which Nigeria is a signatory, recognizes land degradation as a global development and environment issue. This study will adopt Gretton and Salma's definition of land degradation because it studies the rate of land degradation in Dambatta Local Government Area of Kano State through desertification and change in vegetation cover using the NDVI technique.

Land degradation manifests itself in many forms; among them are soil erosion, increased sediment loading of water bodies, loss of soil fertility, salinity, reduced ground cover, and the reduced carrying capacity of pastures [6] [7] [8] [9] [10]. Desertification is the most severe form of land degradation. The CCD defines desertification as land degradation in arid, semi-arid, and dry sub-humid areas (also referred to as dry lands) resulting from various factors, including climatic variations and human activities [5]. The impacts of land degradation include a reduction in crop and pasture productivity and fuel wood and non-timber forest products, which are closely linked to poverty and food insecurity. The damage to soil, loss of habitat, water shortages, and siltation reduce biodiversity and ecosystem services and have economic consequences [6].

Land is increasingly becoming under pressure from excess clearing for developmental programs, thereby leading to desertification and land degradation. Land degradation will remain an important global issue for the 21st century because of its adverse impact on agronomic productivity, the environment, and its effect on food security and the quality of life. Productivity impacts of land degradation are due to a decline in land quality on site where degradation has occurred. Desert encroachment and desertification are amongst the major causes of land degradation for agricultural purposes. Nigeria's agricultural production is without doubt vulnerable to many adverse effects of desertification. Generally, land degradation presently affects eleven (11) northern states of Nigeria referred to as the frontline states, these include: Adamawa, Borno, Yobe, Jigawa, Kano, Katsina, Zamfara, Sokoto, Kebbi, Bauchi and Gombe States [11]. These states are agricultural producing areas that are affected by desert encroachment which is fast moving southwards [11].

It was in line with this that the former Minister of Environment, Mrs. Amina Mohammed announced the plan of the Federal Government of Nigeria to move the Desertification Control (DC) national headquarters to Kano State for effective desertification management and evaluation [12]. She expressed the Government's concern about how desertification is destroying livelihood, fuel crisis, and conflict, creating abject poverty. It described the development as very alarming and a lethal threat which need urgent action to save the future of the country's young generation [2].

Dauda studied the effect of desertification in Dambatta LGA of Kano State in 1997. The temporal scope of his study covers a period of 10 yrs (1986-1996). This period is too short for a noticeable conspicuous change in the environment as a result of desertification. Dauda's research was conducted about 20 yrs ago and since then no research has been conducted in the study area to assess the effect of desertification or land degradation, an area where agriculture is the main occupation. Hence, the need to conduct new research that will cover a wider temporal scope in order to detect a noticeable change and for comprehensive analysis and also to provide recent analysis and information about land degradation in Dambatta LGA between 1997 and 2017.

The productivity of lands in Dambata LGA has declined by about 12% due to land degradation which may have translated to an economic loss of about N18 million [13]. The continuous loss of arable land and reduction in productivity with a consequential economic loss in Dambatta LGA has necessitated such research work that will apply contemporary methods to detect and also analyze the environmental causes of land degradation in Dambatta LGA.

Thus, this research made use of Land Cover (LC) data of Dambatta LGA as it checked integrally, the spatial and temporal rate of land degradation by analyzing Normalized Differential Vegetation Index (NDVI) of different localities within the LGA, analyzing the Land Surface Temperature (LST), and checking the vegetation dynamics within the study area to identify the environmental causes and the spatial extent of land degradation in Dambatta LGA.

2. Materials and Methods

2.1. Study Area

Dambatta Local Government Area is located in the Northern fringe of Kano State. It lies approximately between latitude 12˚25'59"N and 12˚30'00"N of the equator and longitude 8˚30'00"E and 8˚50'00"E of the Greenwich Meridian (Figure 1). Dambatta LGA falls within the tropics and has a tropical climate with well-defined wet and dry seasons, according to Koppen's classification scheme. In drought years, mean annual rainfall could be lower than 450 mm as in the case of 1972/73 drought [14].

Relative humidity ranges between 10% and 30% in dry season, and 70% and 90% in the wet season respectively [15]. The relative relief here falls within the average of about 15 to 20 meters. The landform found here is of sandy plains

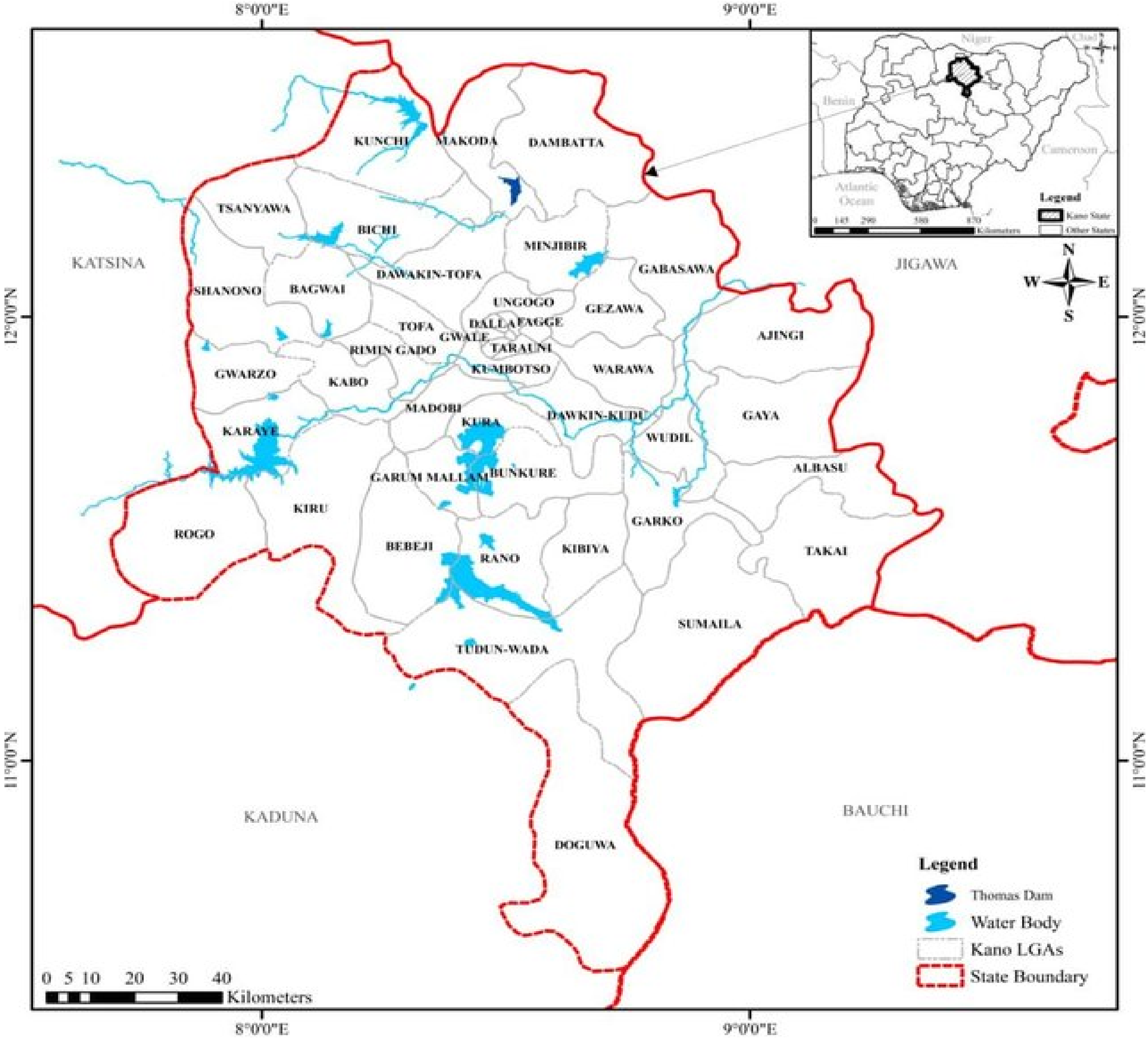

Figure 1. Nigeria and Kano Stae Showing Dambatta and other LGAs. Source: Niramart Technologies [14].

where sand sheets occupy the area [16]. The soil normally consists mostly of unconsolidated sediments which are predominantly sandy, silt to sandy loam. The vegetation type in the area is that of the Sudan Savannah.

About 75% of the land in the area is put to agriculture through rain-fed cultivation. The system of farming practiced by the farmers is mostly mixed cropping; few farmers practice mono-cropping. Animal rearing is one of the important agricultural activities in the area even though there is scarcity of grazing land and one of the prominent landmarks in the area is the Kurma Forest Reserve located at the west side of the area.

2.2. Materials

Materials used for the study are categorized into three, which are hardware, software and data. The hardware comprise both computer hardware and instrument such as GPS. The software comprises of computer applications used for data processing, storage and analysis. While the data used comprises of satellite imageries, coordinates of control points and remotely sensed data. The hardware used for this study are:

1) Computer system for data storage, processing, analysis and output.

2) Global Positioning System (GPS) for collecting coordinates of the control points, which was used for sampling site and for accuracy assessment.

While the software used for this study are:

1) ILWIS 5.2 Version;

2) Arc Map 10.2 Version;

3) Microsoft Excel 2010.

2.2.1. Types and Sources of Data

The types of data used for this study are from two sources. They are:

1) Primary source of data: The primary source of data for this study includes field survey. Coordinates of the control points were used for sampling set and for accuracy assessment via hand held Global Positioning System (GPS) device (Garmin GPSMap 76 CSx).

2) Secondary source of data: Secondary source of data includes satellite imagery which was sourced from National Space Research and Development Agency (NARSDA). Information was also obtained from past literatures, journals, internet resource, published and unpublished relevant works and topographical map on scale 1:50,000 acquired from Niramart Technologies, Kaduna.

The temporal interval is a ten (10) years period, with the justification that there would be obvious significant changes in the land use and land cover. The images for this study were captured during the dry season so as to show vividly the changes that have taken place.

2.2.2. Remote Sensing Data

The data used for this study includes six historical Landsat images covering the study area for the period of 20 years (1997-2017). The images of 1997, 2007 and

2017 with spatial resolution of 30 m were obtained from National Space Research and Development Agency (NARSDA), Abuja. These data sets were captured by Landsat MSS/TM (Multispectral Scanner/Thematic Mapper) on 21st December 1997, while the other Landsat ETM+ (Enhanced Thematic Mapper Plus) was captured on 4th January 2007. The OLI (Operational Land Imager) Landsat of 2017 was captured on 24th of January 2017 as already shown in Table 1. A Landsat track is 185 km wide. At the equator there is a 7.6 percent overlap between adjacent tracks, which gradually increases as the satellites approach the poles, reaching 54 percent at 60˚ latitudes. The Landsat image scenes were selected because of reduced spectral reparability and phonological stability as was noted by Ayuba, that for any meaningful change detection, summer and winter are the best seasons because of their phonological stability. Also, selecting the summer or the driest period of the year enhances spectral reparability [7] [8].

It should be noted that Dambatta LGA crosscuts two Landsat footprints and therefore, both footprints of Landsat scenes for the three selected years within the study period were acquired for this study. That is why there are two paths and two rows in the Path/Row column.

2.3. Methods

The methods used for data collection, processing and analysis include reconnaissance survey, data georeferencing, projection, enhancement, supervised image classification, Normalized Difference Vegetation Index and Land Surface Temperature analysis.

2.3.1. Pre-Field, Preparation and Interpretation of Satellite Imageries

The base map and the satellite imageries were used accordingly to extract the needed information such as the administrative boundaries, roads and administrative patterns. Reconnaissance survey was required for familiarization with the study area. During the exercise, it was observed that the area has both healthy and stressed vegetation, which necessitated the generation of NOIO of the area.

Table 1. Landsat imageries used for this study.

LANDSAT IMAGERIES					
Sensor	**Date**	**Resolution**	**Source**	**Path/Row**	**Satellite**
MSS/TM	21st December, 1997	30 m	NARSDA	188/050 188/051	Landsat 5
ETM+	4th November, 2007	30 m	NARSDA	188/050 188/051	Landsat 7
OLI	24th November, 2017	30 m	NARSDA	188/050 188/051	Landsat 8

Source: Authors' field work (2018).

2.3.2. Digital Image Manipulation and Data Analysis

The data processing and manipulation was conducted using post classification change detection technique in Integrated Land and Water Information System ILWIS 5.2, and later converted to shape files where it was imported to Arc Map 10.2 GIS software. Landsat image of 30 metres resolution covering the study area in 1997, 2007, and 2017 was used for land cover classification to identify the changes in land cover (LC) of Dambatta LGA between 1997 and 2017. Normalized Difference Vegetation Index was used to establish the rate and spatial extent of desertification in Dambatta LGA between 1997 to 2017. Land Surface Temperature was used to identify the amount of temperature increase brought about by each land cover change in the study area.

3. Results and Discussion

3.1. Land Degradation in Dambatta Local Government Area, Kano State

In order to establish evidence of land degradation in Danbatta LGA, the Normalized Difference Vegetation Indices (NDVI) and Land Surface Temperature (LST) geospatial analysis were carried out in Dambatta LGA using Landsat MMS, ETM+ and OLI imageries of 1997, 2007, and 2017 respectively. The NDVI analysis was performed to identify the rate of vegetal cover degradation (healthy and stressed vegetation) from 1997 to 2017 and also compare the NDVI result with the LC results in order to establish areas and extent of land degradation in Dambatta LGA.

3.2. Normalized Difference Vegetation Indices (NDVI)

Normalized difference vegetation index (NDVI) is a simple graphical indicator that can be used to analyze remote sensing measurements, often from a space platform, assessing whether or not the target being observed contains live green vegetation. Using bands 3 and 4 of Landsat MMS and ETM+ of 1997 and 2007, and bands 4 and 5 of Landsat OLI of 2017, the NDVI analysis was carried out on Dambatta LGA satellite imageries. NDVI result typically yield values ranging from −1 to +1, negative values (−0.2 to −0.8) typically depict cloud or snow cover, negative and positive values tending towards zero (−0.1 to 0.1) typically depict water bodies or bare land. While values ranging from 0.1 to 0.2 usually depict stressed or unhealthy vegetation. Values ranging from 0.2 to 0.8 typically depict dense and healthy vegetation. Although these are general classification for NDVI values around the world, there exist some slight variations in some parts of the world depending on the prevailing climatic conditions. Dambatta LGA lies in the Sahel savanna region of Nigeria where vegetation is usually sparce and less healthy, hence the NDVI value categorizations are expected to differ slightly. The NDVI analysis was performed using ArcGIS NDVI algorithm to produce NDVI images for the years under study. The NDVI images were achieved and illustrated in **Figure 2**.

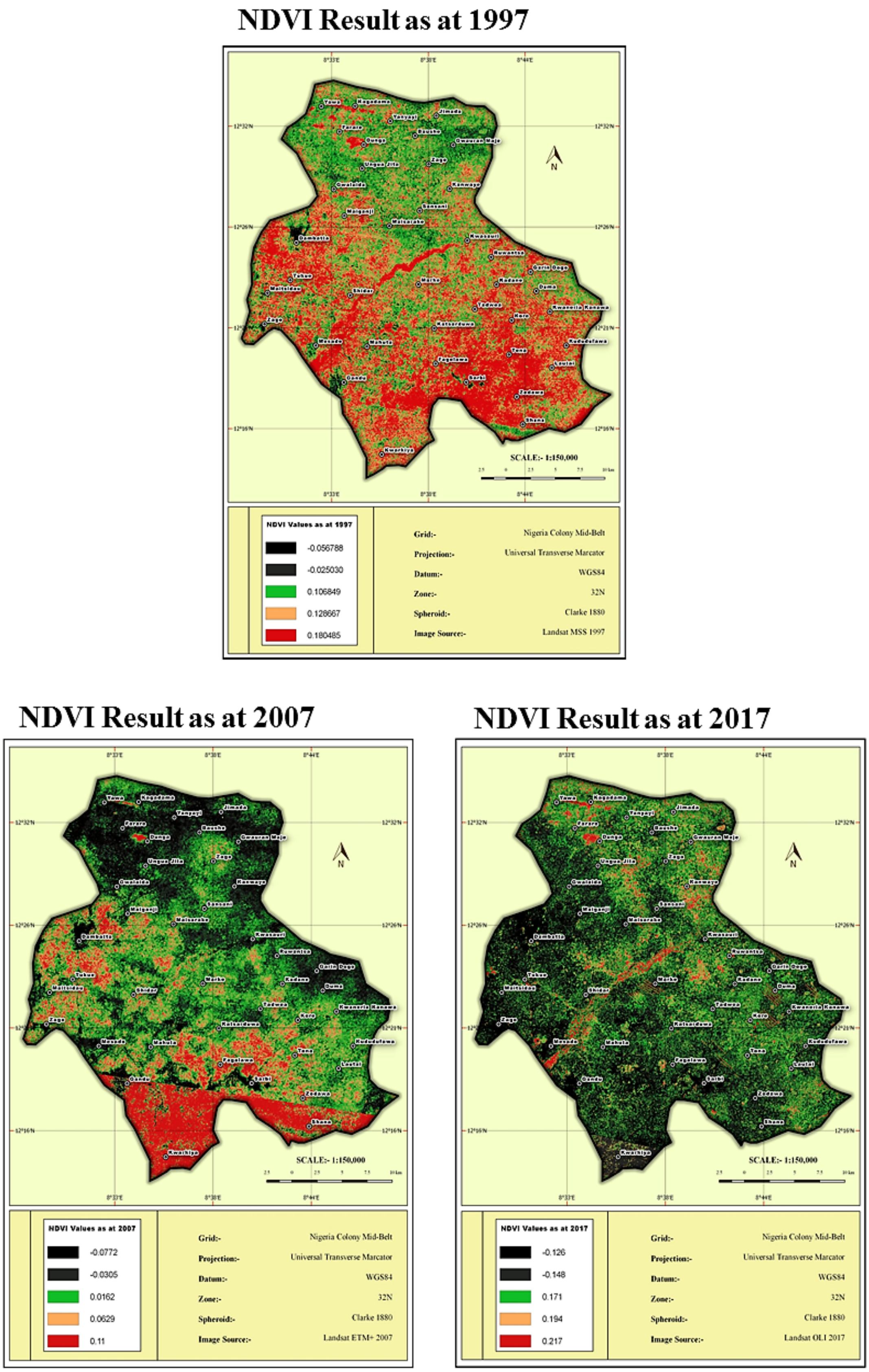

Figure 2. NDVI results of Dambatta LGA From 1997-2017. Source: Authors' field Work (2018).

The NDVI result of Dambatta LGA as at 1997 was computed by creating a composite of only two bands in the 1997 Landsat datasets. The bands selected were the red band (Band 3) and the near infrared band (Band 4). The NDVI for a pixel in 1997 is calculated from the following formula:

$$NDVI = (NIR - R)/(NIR + R)$$

NIR = Near Infrared

R = Red (Visible band)

The NDVI values in 1997 MMS Landsat image range from −0.056788 to 0.180485. The black color on the image indicates water body, the deep green colors indicate bare land and developed area, the light greenish colorations indicate unhealthy vegetation, while the red color indicates dense and healthy vegetation. As of 1997, Dambatta LGA had significantly dense and healthy vegetation especially in the southern, eastern, western regions and in the northern fringes. This is because Dambatta LGA is the last LGA in Kano that boarders with Katsina, which is of course, part of Sahel Savanna regions of Nigeria. Settlements in Dambatta LGA with high NDVI showning dense and healthy vegetation as at 1997 include: Shidar, Mesado, Fagolawa, Sarbi, Katsarduwa, Marke, Sarbi, Zedawa, Shana, Duma, Tona, Kudufawa and Kore.

The NDVI result of 2007 in **Figure 2** ranges from −0.0772 to 0.11. The NDVI values of 2007 are low compared to those of 1997. As of 2007, the northern fringes down to the north central area were covered with bare lands and patches of unhealthy vegetation. So also, other areas which were covered with dense and healthy vegetation in 1997 have been reduced to bare lands and patches of unhealthy vegetation. While some areas have been converted to built-up areas, some of which are areas like Mesado, Shidar, Sarbi, and Duma. Settlements in the extreme southern region of Dambatta LGA are the only areas that have not undergone significant changes. Settlements like Kwarkiya, Shana, Fagolawa, and Gandu have remained largely unchanged.

The values of 2017 Landsat OLI NDVI result as shown in **Figure 2** range from −0.126 to 0.217. The image shows that there are just little patches of dense and healthy vegetation cover left in Dambatta LGA as at 2017. These areas are in the northern region, patches of healthy vegetation were found in the eastern area and western fringes of Dambatta LGA. The regions with clustered dense vegetation are areas along the river, such as Mesado, Shidar, Marke; and some settlements in the northern fringes such as Yawa, Dunga, and Kanwaye as at 2017.

The Normalized Difference Vegetation Index (NDVI) is a calculation, based on several spectral bands, of the photosynthetic output (amount of green stuff) in a pixel in a satellite image. It measures, in effect, the amount of green vegetation in an area. In this research, MultiSpecs was used to create new channels in an image to display the NDVI for an image. The results obtained from the NDVI analysis of the three satellite images of 1997, 2007 and 2017 when compared as shown in **Figure 2** depict that, there was less vegetal degradation in 1997 with an NDVI range between −0.056 and 0.18 and healthier vegetal cover occupies larger spatial extent. In 2007, the NDVI result ranges from −0.07 to 0.11, this shows a low vegetation index depicting unhealthy vegetation and areas covered by vegetation are less compared to 1997. The image of 2017 has an NDVI ranging from −0.128 to 0.217 which reveals a high vegetation index depicting healthy vegetation. But, the areas covered by this vegetation have drastically reduced compared to the spatial extent occupied in 2007 and subsequently in 1997. The areas having this high vegetation index in 2017 are areas around water bodies, which explains the high vegetation index result. There is a significant vegetation loss in all parts of the study area which is more pronounced at the extreme western side of the study area as in 2017 (*i.e.* Along Dambatta Town). This depicts that there has been a progressive loss in vegetation cover in Dambatta LGA over a period of 20 years with corresponding acceleration in bare lands and developed areas.

3.3. Land Surface Temperature (LST)

The result further reinforces the earlier assertion that; the unprecedented increase in developed area in Dambatta LGA over the 20 years period may have led to urban heat island, which has had a consequential effect on vegetation cover. This phenomenon may have led to significant decrease in vegetation cover experienced in the last 20 years, leading to an increase in bare lands. The bare lands were exposed to direct sunlight and lack of replenishment of soil nutrient as a result of absence of vegetation cover leading to land degradation, with a consequential reduction in agricultural land as experienced over the 20 years of the study. Campbell's study on impact of urbanization on the thermal environment of Bangkok Metropolitan Area also indicated that built-up areas expanded drastically and agricultural land declined, while temperature differences between the urban/built-up areas and the surrounding rural areas significantly widened [7]. To further compliment these findings, Land Surface Temperature (LST) analysis was carried out on the satellite imageries.

Spatial distribution of land surface temperature (LST) was analyzed in this study in order to detect the extent of temporal pattern and comparative analysis of urban heat island (UHI) in the study area. The LST distribution was derived from the Landsat MMS, ETM+ and OLI thermal bands. Spatial pattern of the LST of each landsat data was mapped and observed. The LST was categorized into five (5) classes as shown in **Figure 3**.

The LST analysis carried out on the three satellite images (1997, 2007 and 2017) of Dambatta LGA reveals that surface temperature in Dambatta LGA was having less spatial outspread in 1997 when compared with the LST result of 2007 and the spatial spread of LST considerably increased in 2017 as shown in **Figure 3**. The LST results generally show a continuous and constant decrease in surface temperature from the developed areas and rural areas to the undeveloped areas. The LST results also show that no area under consideration in the study area experienced an extreme temperature (≥44˚C) as at the time satellite overpassed in all the periods.

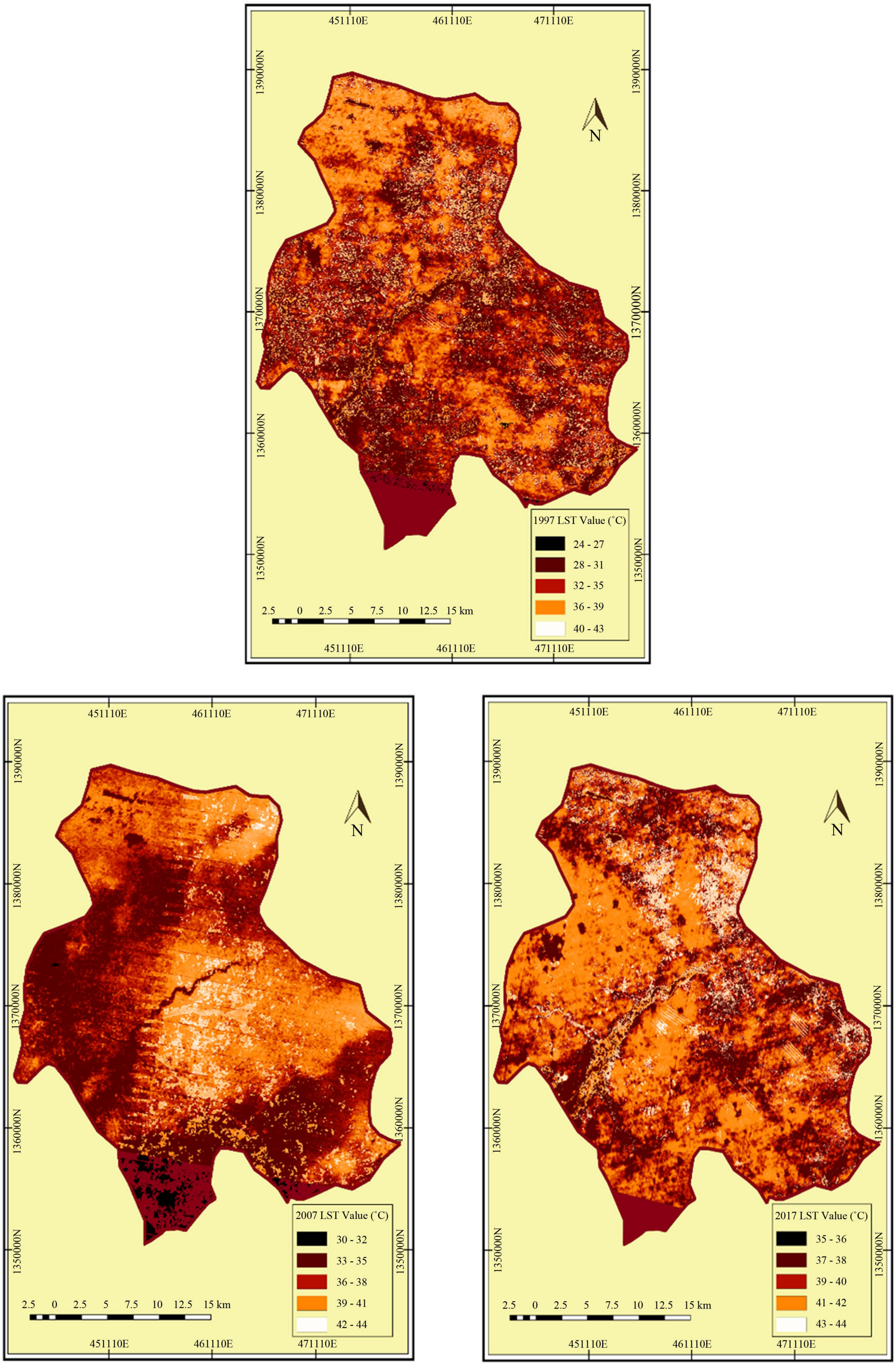

Figure 3. LST result of Dambatta LGA as at 1997, 2007 and 2017 respectively. Source: Authors' field work (2018).

In 2017, a large part of the study area fell within the higher temperature zones (≥40˚C) and other areas fell into mid-temperature zones (35˚C - 40˚C). This high surface temperature was as a result of increase in bare land, high insolation, urbanization, anthropogenic influences and large distribution of imperviousness or geographical relief of the area. But in 2007, large proportions of the study area were dominated by mid-surface temperature zones ranging from 35˚C - 40˚C except in the southern fringes of the area where LST values were below 35˚C. However, a higher LST zone (≥35˚C) was observed in fewer areas, precisely in the northern fringes of the area in 1997. A larger portion of the study area was found in the lower temperature zone (<28˚C) and mid (28˚C - 35˚C) temperature zones in 1997, most especially in the southern, western and eastern areas of the map (**Figure 3**). This is as a result of the presence of more vegetated areas and fewer occurrences of bare land and built-up areas during the period.

4. Discussion of Findings

The combination of acceleration in bare lands which has increased tremendously by 113 km^2 from 1997 to 2017 and reduction in vegetated land by 92 km^2 between 1997 and 2017 has resulted in the reduction of fertile land for agricultural purposes. This was also corroborated by a drastic reduction in agricultural land by 249 km^2 within the period under review. The increasing urbanization with replacement of the natural soil and vegetation cover of the area by artificial features like roads, and buildings, is also another significant factor contributing to increase of heat pockets. It has also been observed that micro heat islands have a significant impact on the land cover characteristics of an area. The heat islands are mostly formed because of the reduced landscape, lack of vegetation, dark coloured surfaces, bare lands, heat generating vehicles and mini-companies/Industries. **Table 2** shows the distribution of surface emissivity and land surface temperature in 2017.

Table 2. Derived surface emissivity and LST for different LC types.

S/No	LAND COVER	SURFACE EMISSIVITY			SURFACE TEMPERATURE (˚C)		
		MIN	MAX	AVG	MIN	MAX	AVG
1	Bare-Land	0.90	0.95	0.93	36	42.9	39.45
2	Developed Area	0.91	0.96	0.94	38	44.7	41.35
3	Vegetation	0.97	0.98	0.98	25	27.9	26.5
4	Water-Body	0.96	0.97	0.97	28	31.9	30.0
5	Agricultural Land	0.91	0.95	0.93	29	33.2	31.1
Maximum LST Value		44.7˚C (Developed Area)					

Source: Landsat imagery, (2017).

The distribution of LST of various LC features as shown in **Table 2** depicts that bare land and built-up areas have the highest temperature range and largest land coverage in Dambatta LGA as of 2017. This result indicates that acceleration of bare land, high land surface temperature and desertification in Dambatta LGA of Kano State has contributed immensely to land degradation in the study area which has led to reduction in vegetation and agricultural land over the period under review. As temperature variation is an established climatic factor, which has contributed immensely to the land degradation in Dambatta LGA, this indicates that the environmental cause of land degradation in Dambatta LGA is climatic deterioration as evidenced in the LST result of the 3-satellite imagery analysis. According to Dong *et al.*, "Climate Change has had noticeable role in vegetation degradation, for its characteristics are not suitable for the growth of vegetation" [8]. The increase in average temperatures of the regions makes them less suitable for vegetation to grow due to the more rapid evaporation of water that was formerly utilized by vegetation. This is evidenced in the LST analysis where surface temperature has risen above 40˚C in areas like Zedawa, Baushe, Gwalaida, Maiganji and others in 2017. Abit *et al.* also noticed the effect of climatic deterioration on plains and plateaux of alpine meadows or grasslands, most notably in the Philippines and in the Tibetan and Inner Mongolian region of China where 2460 km^2 of grassland is degraded each year [9]. Across the globe, it is estimated that 23% of the land is degraded [8]. Furthermore, neither periods of much rain nor stretches of drought, both of which become more prevalent with climate change, encourage the growth of vegetation [10]. The above-mentioned researchers have extensively emphasized the effect of climatic deterioration on vegetation degradation as also evidenced in Dambatta LGA of Kano State.

5. Conclusions

The NDVI results show that there is a very high rate of vegetation loss across Dambatta Local Government area between 1997 and 2017 with the degree of imbalance varying and increasing as one moves from south to north-eastern parts of the area. Dambatta LGA lies in the Sahel savanna region of Nigeria where vegetations are usually sparse and less healthy; hence the NDVI value categorizations differ slightly from the general classification of NDVI around the world. However, the NDVI values clearly indicate a deficiency. The regions with clustered dense vegetation are areas along the river. This depicts that there has been a progressive loss in vegetation cover in Dambatta LGA over a period of 20 years with corresponding acceleration in bare lands and developed areas.

The distribution of LST of various LC features indicates that acceleration of bare land, high land surface temperature and desertification has contributed immensely to land degradation in the study area which has led to reduction in vegetation and agricultural land over the period under review. Evidently, temperature variation is an established climatic factor, which has contributed immensely to the land degradation in Dambatta LGA. The LST result of the 3-satellite imagery analysis indicates that the environmental cause of land degradation in Dambatta LGA is climatic deterioration.

The effects of insolation and retarded replenishing on the bare lands may result in degradation and consequent loss of agricultural land which threaten food security. While the developed areas are likely to result in Urban Heat Islands (UHI) and consequent global warming and climate change. This conforms to findings of the global researchers community generally.

6. Recommendations

In order to reduce the effects of Land Degradation, the study hereby offers the following recommendations:

1) Studies should be carried out on the appropriate solution to the land degradation problem in Dambatta LGA, Kano State.

2) Local Government Areas neighbouring Dambatta LGA should also be analyzed on the issue of land degradation.

3) There is a need to encourage and strengthen afforestation and sustainable development in the area.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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