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Impact of Human Activities on Land Use/ Land Cover Changes in Jalingo, Nigeria

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Abstract

The study was aimed at assessing the impact of human activities on land use/ land cover changes in Jalingo, Taraba State, Nigeria between 1990 and 2020. In identifying human activities affecting land use land cover change, Kobo collect toolbox digital data collection was adopted. The integration of Geospatial data; Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM+) with Thermal Infrared Sensor (TIRS) and Satellite Imageries were used to derive land use and land cover maps of Jalingo. NDVI, NDWI and LST were generated to assess their relationship with the land use land cover trends. The results show that out of the human activities impacting land use land cover change 16.67% is Deforestation, 16.67% is Dumping of non-biodegradable trash, 33.33% is Exposure to bare soil, 16.67% is Mis-management of agricultural lands while 16.67% are Quarrying activities. The land use and land cover change analysis of Jalingo from 1990 to 2005 and 2020 revealed that there was an increase in the area coverage of the bare surface from 40.8% in 1990 to 43.9% in 2005 and 45% in 2020; an increase in the area coverage of built-up area from 3.3% in 1990 to 14% in 2005 and 32.4% in 2020; a decrease in the area coverage of vegetative land from 53.9% in 1990 to 40.7% in 2005 and 20.5% in 2020. The trend reveals a gradual reduction in vegetative cover and of surface moisture levels in Jalingo. The research recommends Irrigation, Afforestation, Clean Biomass system among others.

Keywords: GIS, RS, Land use, Landcover Change, Human Activities, Impact Jalingo, Taraba State

Introduction

Human activities in recent times have accelerated the changes in Land Use and Land Cover. Accelerated conversion of forest land due to rapid urbanization and other allied activities like intensive agricultural practices, over-exploitation of resources, and other anthropogenic activities have resulted in land-use and land cover patterns, especially in the Jalingo metropolis. Significant land use and land cover changes have been reported on a spatial and temporal scale during the last century, mainly due to economic development and population growth [1,2].

According to Fabiyi, human use of land resources leads to "land use," which varies based on the aims it serves, such as food production, shelter, recreation, material extraction and processing, as well as the land's biophysical features [3]. As a result, land use is affected by two sets of forces: human requirements and environmental characteristics and processes. Thus, land-use change has become a critical and important component in monitoring environmental changes and managing resources, according to Oluseyi et al., and Lavorel and Steffen [4,5]. Moreover, human actions tend to leave indelible traces on the landscape [6-8].

Jalingo metropolis, a savanna region, covers the semi-arid Sudan zone in the north. The metropolis over the years has been subjected to land degradation through human pressure. There is a widespread concern that the potential of the savanna may not be realized in the presence of human pressure and that the civilization that has built up through the ages in the Sudan and Sahel zones may be threatened [9]. Human actions have impacted the natural ecology since civilization because of the aggressive drive for development [7]. According to estimates, more than 1200 million hectares of forests and woodlands have been removed over the last three centuries. Grassland and pastures have shrunk by around 560 million hectares, while farmland has grown by about 1200 million hectares [3]. In Nigeria, about 350,000 to 400,000 ha of forest are lost per annum [10,11].

According to Hooper and Vetousek and Iwara and Deco , The existence of vegetation in a given area supports ecosystem sustainability and services such as soil erosion prevention, soil and nutrient loss reduction, and hydrological cycle maintenance [12,13]. As a result, according to Verburg , land-use change has become one of the most important predictors of environmental vulnerability within the human-environment system, aside from the direct influence on ecosystem spatial extent through deforestation, fragmentation, and other means [14].

Land-use change modifies the spatial configuration of different land-use types. Similarly, the unprecedented changes inland, its use, and cover characteristics affect the structure and floristic pattern and composition of a region and have been acknowledged to decrease species richness and diversity worldwide [12,13]. More specifically, because the canopy's interception role is lost, evapotranspiration is changed or reduced, runoff may be increased, and the radiation budget may be upset by prescribing new surface geometry and albedo, the removal of vegetation cover frequently leads to an adjustment in local water balance [5,16]. These and other effects highlighted the fact that man has very likely removed vegetative cover across huge areas for diverse purposes during the last few decades, resulting in climate change due to unfavourable energy and mass balances, permitting soil destruction and desertification to set in most places [17].

In this sense, remote sensing (RS) and geographic information systems (GIS) have provided new tools for sophisticated ecosystem management. At the local, regional, and global scales, remote sensing data allows for more comprehensive analyses of the earth's system function, patterning, and change over time; these data also serve as a vital link between intensive, localized ecological study and biological diversity conservation and management at the regional, national, and worldwide levels [18].

The primary vegetation of the Jalingo metropolis is fast changing to secondary and derived vegetation due to the aggressive incursion of human activities into the seemingly undisturbed ecosystem that characterized the area about a century ago. Human activities, including farming, urban development, are causing imbalances in the ecosystems of the metropolis with resultant negative consequences on the environmental quality and livability of the metropolis. The extent of these environmental alterations has prompted different concerns concerning the social, economic and cultural consequences of the changes that are taking place.

For many people, the impact of these human activities directly leads to poverty, as natural resources have traditionally been primary sources of sustenance in most communities in developing countries. Therefore, one of the prime prerequisites for land degradation is information on the existing land use patterns and land-use changes through time. Legislators, state and local government officers need to know about human impacts on land uses like agriculture and recreation, as well as information on their changing proportions, to develop better land-use policy, identify future development pressure points and areas, and implement effective metropolis development plans, which is why this study is needed.

Legislators, state and local government officers require information on human impacts on land uses such as agriculture and recreation, as well as information on their changing proportions, to develop better land-use policy, identify future development pressure points and areas, and develop better land-use policy, and to implement effective plans for the metropolis development hence the need for this study. As a result, in this study, an attempt was made to map out the classes of land use and land cover of the Jalingo metropolis between 1990 and 2020 to detect the land consumption rate and changes that have occurred in these classes, particularly in built-up areas, to predict possible changes that will occur in these classes over a period of years using Remote Sensing data. Subsequently, this study assessed accurately at appropriate scales the impact of human activities on land use/land and provided an improved understanding of other environmental implications.

Some of the questions that served as a guide to the study include: Are there any human activity effects on Land use and land cover change in Jalingo? What are the trends, rates, nature, location and magnitudes of land-use and land cover changes in Jalingo? and what is the relationship between Normalized Difference Vegetation Index, Normalized Difference Water Index, and Land Surface Temperature with Land Use and Land Cover Change?

An Empirical Review of Previous Studies on

Land Use and Land Cover

To highlight the importance of Remote Sensing and Geographical Information systems in urban studies, an overview of previous studies was examined from the global, continental and regional perspectives to assess the impact of human activities on land use /land cover changes over the years 1990, 2005 and 2020 in Jalingo LGA, Taraba state. For instance, Zemba investigates the nature, extent and rate of urbanization and its implications on land use - land cover (LULC) change in Jalingo city for 1973, 1991 and 2009 [19]. Results from the study indicate that rapid urbanization has occurred resulting in significant conversion in land cover types of the city. Four out of the five land cover types identified and mapped have witnessed a substantial increase, the highest being the build-up lands followed by farmlands and bare surface. Water bodies were found to occupy almost the same land area over the years with a relatively slight difference. Natural vegetation suffered a loss of about 95% due to the high demand for agricultural and residential lands. Oruonye in a similar study assessed the impact of land-use changes along the floodplains of River Lamurde, Jalingo LGA, Nigeria observed that land use along the floodplain of River Lamurde has undergone a substantial level of change from open fields and fallow lands to intensively cultivated irrigation and residential areas [20]. The dominant land-use types in the basins presently are rain-fed agriculture and irrigation farming, grazing, development of residential, commercial and institutional buildings as well as indiscriminate waste disposal. The observed land-use activities include excessive water extraction, deforestation for fuelwood and other domestic uses, excessive use of chemical fertilizers and land degradation due to improper agricultural practices. These land-use activities have impacted negatively the river ecosystem. The study concludes that there is a need to streamline land-use activities, conserve vital ecosystems like watershed areas and maintain buffers along stream channels as a matter of policy to ensure adequate protection of aquatic fauna and sustainable water supply. Chigbu, analysed land use and land cover changes in Aba urban area between 1991, 2000 and 2005 using medium resolution satellite imageries (Landsat ETM+ of 2000 and Nigeria Sat-

1 of 2005) [21]. The results reveal that from 1991 to 2005, water bodies increased from 15.1% to 22.1% and 22.4% due partly to increasing activities within and around the waterways, the built-up area increased from 21.7% to 26.8% to 36.5%. Unlike river and built-up areas, there is a significant disparity and trend in vegetation cover due to rapid urbanization and socio-economic activities. Thus, vegetation cover decreased from 63.2% to 51.1% in 2000 and 2005, it further decreased to 41.1%.

Similarly, Zubair, analysed Land use /Land cover change in Ilorin between 1972 and 2001 using Landsat imageries [22]. The result of the work shows rapid growth in built-up land between 1972 and 1986 while periods between 1986 and 2001 witnessed a reduction in this class. It was also observed that change by 2015 may likely follow the trend in 1986/2001. Many projects were embarked upon after the creation of the state and falls during the oil boom era of the 1970s. But reduction between 1986-2001 was attributed to what the researcher called austerity measures known as SAP introduced into the country in the period to restore the country's economy.

Akpu and Tanko studied the rate and pattern of the Spatio-Temporal Growth of Kaduna Metropolis between 1973 and 2009 using GIS and the Remote Sensing technique [23]. They used Landsat MSS imagery obtained in 1973; Landsat TM captured in 1990; Landsat ETM+ acquired in 2001 and Nigeriasat-1 image of 2009. The visual interpretation method was used to sort the various datasets into land use/cover classes. The built-up area was extracted and the rates of growth between the periods (1973-1990; 1990-2001 and 2001-2009) were ascertained. The built-up area for the four-time period was overlaid to derive the urban growth. The Shanoon's entropy technique was adopted to determine the extent of landscape disorganization or pattern of growth. The results revealed that the built-up area increased from 6,410.4ha in 1973 to 19,611.5ha in 2009. The city was growing at the rate of 5.72% per annum within the period studied. The result also showed that the area towards the southern part of the River Kaduna was growing at a higher rate 11.24% compared with the northern part, however, the difference in entropy was higher for the northern zone.

Ramachandra, Bharath and Sreekantha used an integrated approach of remote sensing and spatial metrics with gradient analysis to identify the trends of urban land changes in Indian metropolis using the Remote Sensing and Geographic Information System technique [24]. The results indicated a significant increase in the urban built-up area during the last four decades. Landscape metrics indicate the coalescence of urban areas that occurred during the rapid urban growth from 2000 to 2009 indicating the clumped growth at the boundary region with convoluted shapes.

Abbas and Arigbede also conducted a study in Zaria to determine the changes in land use/land cover between 1985 and 2005 to provide a database for future planning [25]. Landsat, Spot and digital globe imageries for 1985, 1995, and 2005 respectively were used for the analysis. The results showed that built-up areas increased from 2.3% in 1985 to 36.4% in 2005, water body decreased from 22.5% in 1985 to 6.5% in 2005 while cultivation decreased from 44% in 1995 to 40% sending a bad signal of imminent food crisis if not checked Goetzke, et al., analysed Landsat images between 1975 and 2005 over the North Rhine-Westphalia in Germany, the need for the analysis being the result of urban sprawl and growing human population, which had induced land consumption in the area [26]. They used unsupervised classification to group the classes. The result showed that grassland and agricultural land had been used up. Nathawat and Pandy mapped the Land use/ Land cover (LULC) of Panchkula, Ambala and Yamunanger districts in India [27]. They observed that the heterogeneous climate and physiographic conditions in these districts have resulted in the development of different LULC. The digital analysis of satellite data indicates that the majority of areas in these districts are used for agricultural purposes. The hilly regions exhibit fair development of the reserved forest. The implication is that the LULC pattern in the area is generally controlled by agro-climate conditions, groundwater potentials and a host of other factors.

Njungbwen and Njungbwen studied urban expansion and loss of agricultural land in Uyo, Akwa Ibom state using Geographic Information System (GIS) and Remote Sensing techniques. Aerial photographs of 1969-2001 and Quick Bird satellite imagery of 2004 were used. Their results showed that the average annual rate of urban growth rose from 4.48% between 1978 and 1988 to 8.57% between 1988 and 2001 and rose to 5% between 2001 and 2004, The results also indicate that the loss in agricultural land increased from 0.4% between 1978-1988 to 0.46% between 2001-2004. Therefore, agricultural lands continually dropped during the period while the built-up land increased. They finally concluded that the loss of agricultural land brought hunger and poverty to the area [28]. In like manner, Odeh, conducted research using GIS and Remote Sensing techniques to study the impact of urban expansion on agricultural lands in urban Zaria and its environs between 1970-2009 [29]. The author used Landsat Multi-Spectral Scanner (MSS) images in 1973, LandSat Thematic Mapper (TM) in 1990, Landsat Enhanced Thematic Mapper (ETM) in 1999 and NigeriaSat-1 Image in 2009. The results showed that built-up areas have grown considerably from 14.51km^2 in 1973 to 37.13km2 in 2009 and agricultural lands have reduced significantly from 442.58km^2 in 1973 to 204.21km^2 in 2009. This indicates an increase in the built-up areas and a decrease in agricultural land.

Materials and Methods

Study Area

Location

Jalingo LGA is roughly located between latitudes 8^{o}47' to 9^{o}01'N and longitudes 11o09' to 11^{o}30'E (figure 1). It is bounded to the North by Lau LGA, to the East by Yorro LGA, to the South and West by Ardo Kola LGA. Jalingo town was founded in 1893, as a convenient and suitable site for the relocation of the administrative capital of the Muri emirate. The town developed as a war camp established eight miles south of Kona village [30]. It was a military base for the operation of the Emir of Muri. Hamman observed that since its establishment in 1895, Jalingo has continued to witness phenomenal growth as a result of its being the seat of the new Muri Emirate government and a trading centre [31]. Following the creation of Taraba State in 1991, it was made the state capital. It has a total land area of about 195km^2.

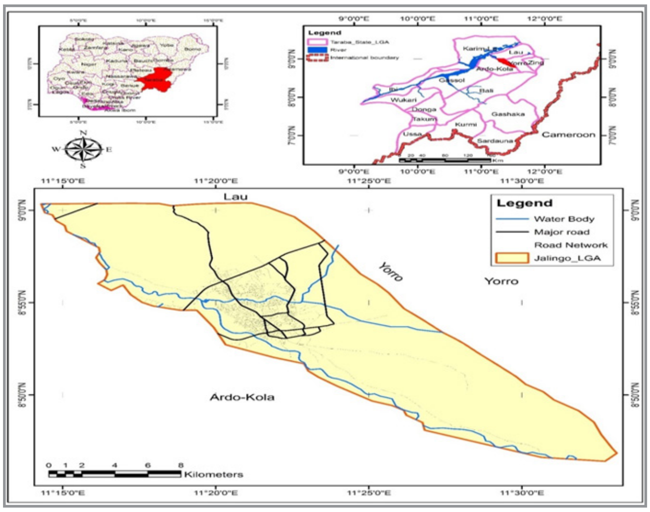

Figure 1: Map of Jalingo: the study area with Nigeria and Taraba State Insert

The People of the Area

The major ethnic groups in Jalingo are Fulani, Kona and Mumuye. Other ethnic groups include Hausa, Jenjo, Wurkum and Nyandang. The Hausa language is widely spoken as a medium of communication for social and economic interactions [32]. Jalingo metropolis was developed as a war camp established eight miles south of Kona village [30].

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Topography

Jalingo metropolis lies on gently sloping land that leads to the great Muri plains. The metropolis lies between 305m to 610m above sea level. The ground level rises to a peak of about 914 meters above sea level in the southeast [34]. The Lamurde River and its tributaries drain the town into the Benue River, forming a watershed from this peak. There are some hills and rock outcrops as high as 323meters in the northern part of the metropolis. These hills include the Jauro Shadi Hill, Jalingo Hill, Jauro Ashe Hill, Hosere Waligo and Danbature Hills.

The topographical characteristics of Jalingo are well suited for adequate stormwater drainage. The southern part of the metropolis slopes southward and drains into River Lamurde. The northern part of the town drains into River Mayogwoi, the tributary to River Lamurde and is intersected by many other natural drainage water causes. Jalingo hill is an essential feature in the town and influences the surface runoff and stormwater discharge carried by the drainage system within the areas around the hill [34].

Methods

This research was achieved through, a reconnaissance survey, which was used to be familiar and acquire activities within the study area. Remote sensing was used for the survey. Coordinates of various land use and land cover of the study area were ascertained and validated which improved the accuracy of the classification that was adapted to the imageries.

Data and Software Needed

The sources of data for this study was acquired from a time series of landsat Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM+) plus with Thermal Infrared Sensor (TIRS) and Satellite Imageries were used to derive land use and land cover maps of the Jalingo. The data set include a notable period of three years for, 1990, 2005, and 2020. The raw satellite data were obtained from the archive of the United States Geological Survey and Earth Explorer. The maps are projected using Universal Transverse Mercator (UTM) and datum WGS 84 of zone 32.

Data and Software Acquired and used

The following softwares were used in this study: ERDAS Imagine [35]: This was used in displaying processing, enhancement and classification of the imageries. It was also used for the delineation of the study area imagery. The ArcGIS 10.1 was used in developing, displaying and processing of the locational maps. The Microsoft Word Office 2010 was used for the presentation of the research work and Microsoft Excel was used in producing the Histogram and chart. It was also used in converting the coordinates into x and y degree of decimals

Image Enhancement

Enhancement operations are normally applied to image data after the appropriate restoration procedures have been performed. Noise removal is an important precursor to most enhancements without it; the image interpreter is left with the prospect of analyzing enhanced noise. Basically, there are three techniques for digital enhancement such as: Contrast Manipulation for Grey – level threshold, level slicing and contrast stretching; Spatial Feature Manipulation for Spatial filtering, image enhancement. Multi-Image Manipulation for multi-spectral band rationing and differencing, principal components, canonical components, vegetation components, intensity – hue saturation (HIS) colour space transformations and de-correlation stretching.

Image Classification

Image classification procedure is to automatically categorize all pixels in an image into land use and land cover classes. Multi spectral data were used to perform the classification and the spectral pattern present within the data for each pixel is used as the numerical basis for categorization, i.e. the different combinations of DNs based on their inherent spectral reflectance and remittance properties. Others include classification Smoothing.

Table 1: Land Use and Land Cover Classification

	LEVEL 1, LAND USE AND LAND COVERCATEGORIES	LAND USE AND LAND COVERDESCRIPTION
1	BARE SURFACE	This includes farmland, sparse vegetation and thick vegetation
2	BUILT UP AREA	Urban area, industrial layout, bare soil, residential, commercial, educational, infrastructure, road network, pipeline, flow station, oil and gas facilities, flow lines, open and cleaned areas.
3	WATERBODY	Exposed water bodies within the study area including river, stream, rivulet creek

Source: Adopted from Anderson et al., [36]

Method of Data Analysis/Processing

Data processing is regarded as the various procedure and steps involved in the production of maps, using remote sensing and geographical information system. During the course of this research, the following processes were adopted; these involved the use of spatial analytical tool for the analysis; Determine the boundary was the first stage after data sorting and editing, the local government area of study (Jalingo). The study area regional shape file was used to clip the data that was used for the region. It was closely followed by digital image processing largely concerned with four basic operations: image restoration, image enhancement, image classification, image transformation. Lastly, to achieve the purpose of a map, image processing listed above were achieved through Image Clipping in Arc GIS environment.

The following computations were carried out using the stated algorithms on Raster Calculator on ArcGIS.

1. Normalized Difference Water Index (NDWI)

Normalized Difference Water Index (NDWI) may refer to one of at least two remote sensing-derived indexes related to liquid water: One is used to monitor changes in water content of leaves, using near-infrared (NIR) and short-wave infrared (SWIR) wavelengths. NDWI is computed using the algorithm below:

$$\text{NDWI} = \frac{(Xnir - Xswir)}{(Xnir + Xswir)}$$

NDWI = (Band 3 – Band 5) / (Band 3 + Band 5) following the formula for TM and ETM+ bands.

2. TOA (Top of Atmospheric) spectral radiance.

TOA (L) = M_L * Q_{cal} + A_L

Where:

M_L = Band-specific multiplicative rescaling factor from the metadata (RADIANCE_MULT_BAND_x, where x is the band number).

Q_{cal} = corresponds to band 10.

A_L = Band-specific additive rescaling factor from the metadata (RADIANCE_ADD_BAND_x, where x is the band number).

TOA = 0.0003342 * "Band 10" + 0.1

3. Brightness Temperature

BT = (K_2 / (ln (K_1 / L) + 1)) − 273.15

Where:

K_1 = Band-specific thermal conversion constant from the metadata (K1_CONSTANT_BAND_x, where x is the thermal band number).

K_2 = Band-specific thermal conversion constant from the metadata (K2_CONSTANT_BAND_x, where x is the thermal band number).

L = TOA

Therefore, to obtain the results in Celsius, the radiant temperature will be adjusted by adding the absolute zero (approx. -273.15°C).

BT = (1321.0789 / Ln ((774.8853 / "%TOA%") + 1)) – 273.15

Where:

BT = Brightness Temperature

Ln = Natural Logarithm

TOA = Top of Atmospheric

4. NDVI = (Band 5 – Band 4) / (Band 5 + Band 4)

The normalized difference vegetation index NDVI is a sensitive indicator of the amount and state of green vegetation [37]. Values for NDVI range between −1 and +1.

Note that the calculation of the NDVI is important because, subsequently, the proportion of vegetation (Pv), which is highly related to the NDVI, and emissivity (ε), which is related to the Pv, must be calculated.

NDVI = Float (Band 5 – Band 4) / Float (Band 5 + Band 4)

7. **Proportion of vegetation Pv**

Pv = Square ((NDVI – NDVImin) / (NDVImax – NDVImin))

5. Calculate Emissivity ε

Emissivity is the emitting ability of the bitumen in comparison to that black body. Surface emissivity will be estimated using NDVI and an empirically-derived method [38]:

ε = 0.004 * Pv + 0.986

Where:

ε = Emissivity

Pv = Proportion of Vegetation

Simply apply the formula in the raster calculator in arcGIS, the value of 0.986 corresponds to a correction value of the equation.

6. Calculate the Land Surface Temperature

Surface temperature is the temperature of the body or surface and is a measure of the amount of heat energy contained in it

LST = (BT / (1 + (0.00115 * BT / 1.4388) * Ln(ε)))

Where

BT = Brightness Temperature

Ln = Natural Logarithm

ε = Emissivity

- To identify the main human activities effects on Land use/ Land cover Change in Jalingo. This involved the review of literatures on human activities, interviews from both old and young and reconnaissance survey was done in Jalingo using kobocollect app. Results are presented in tables and figures.
- To determine the trends, rates, nature, location and magni-

tudes of landuse and landcover changes between 1990 to 2020. Using ArcGIS 10.1, Band combination was carried out using Band 6,5 and 4 (False colour band combination) for landsat 8 and Band 5,4 and 3 (False colour band combination) for landsat 1 to 7, training samples were created for Vegetation, built-up areas, water body and bare surface and the maximum likelihood Image classification analysis was done to create the land use and land cover of the study area. Using the field calculator areas and percentages were generated, computed and analyzed using Ms Excel.

- To assess the relationship between Normalized Difference Vegetation Index, Normalized Difference Water Index and Land Surface Temperature with Land use Land cover Change: Using the raster calculator of the ArcGIS 10.1 software, Normalized Difference Vegetation Index, Normalized Difference Water Index and Land Surface Temperature were calculated for year 1990, 2005, and 2020 respectively. Zonal statistics analysis was used to extraction values Normalized Difference Vegetation Index, Normalized Difference Water Index and Land Surface Temperature relationship with their respective year land use land cover. Results are presented using Tables and figures.

Results and Discussions

Human Activities Effects on Land use and land cover change in Jalingo.

The Table 2 shows the human activities effects on land use and land cover change in Jalingo. The result shows that a number of human activities out of which 33.33% are caused by Deforestation, 16.67% each are caused by Exposure of naked soil, Dumping of Non-biodegradable trash, Mismanagement of agriculture land and Quarrying. The paper found that the rate of deforestation and erosion in the study area is linked to the methods of farming practices as well as the removal of the catchment vegetation as part of land preparation. Uncontrolled human settlement and demand for fuel wood etc. Tree planting and protection of existing vegetation from fire and land clearing should be encouraged, as the restoration of degraded lands.

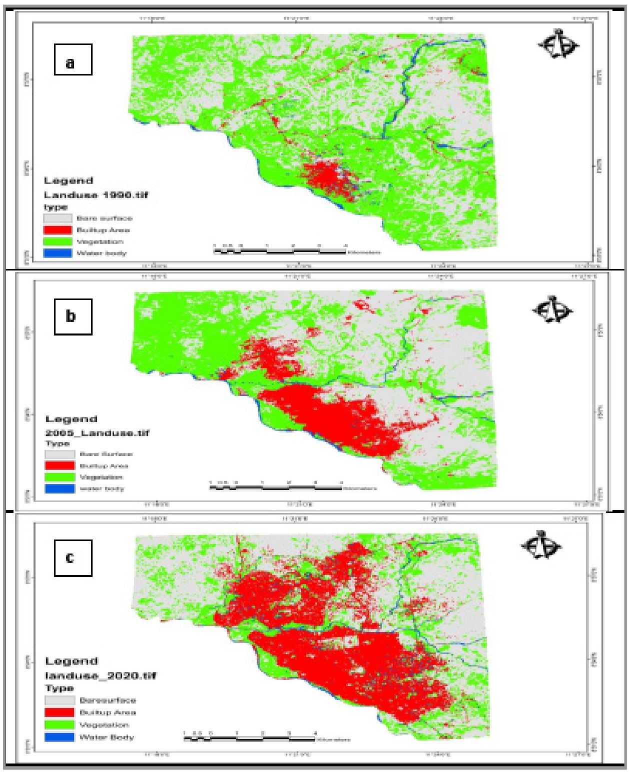
Table 2: Activities effects on land use/land cover

Activities	Percentage
Dumping of non-biodegradable trash	16.67%
Exposure of naked soil	16.67%
Deforestation	33.33%
Mismanagement of agricultural land	16.67%
Quarrying	16.67%
	100.00%

Source: Authors Fieldwork, 2021

3.1 Land use and land cover analysis

In figure 2 (a), the ash portion represents bare surface, red portion represent the built-up area, green portion represent Vegetative area while the Blue portion represent water bodies. The shows a large concentration of built-up area in Jalingo in 1990 at the south with new development along road networks, large portion of vegetative cover around central and towards the Northern part of the study area with patches of bare surfaces. In In figure 2 (b), the ash portion represents bare surface, the red portion represent the built up area, green portion represent Vegetative area while the Blue portion represent water bodies. The map shows a large concentration of built-up area in Jalingo in 2005 at the southeast and Northeast, large portion of vegetative cover around Northeastern part of the study area with large patches of bare surfaces around the western part of Jalingo. Furthermore, in figure 2 (c), the ash portion represents bare surface, red portion represent the built up area, green portion represent Vegetative area while the Blue portion represent water bodies. The map shows a large concentration of built up area in Jalingo in 2020 around the central part of the study area, patches of vegetative cover and bare surfaces around the study area. Table 3 shows the Land use/Land covers Calculation for Jalingo between 1990 and 2020.



Source: Authors Analysis, 2021

Figure 2: Land use and Land cover change of Jalingo in (a) 1990, (b) 2005 and (c) 2020

Table 3: Land use/Land covers Calculation

Land use Type	Area (Hectares) in 1990	Percentage in 1990	Area (Hectares) in 2005	Percentage in 2005	Area (Hectares) in 2020	Percentage in 2020
Bare surface	5415.17	40.8	5826.62	43.9	5977.17	45.0
Built-up Area	437.99	3.3	1858.15	14	4170.51	32.4
Vegetation	7153.87	53.9	5401.90	40.7	2725.38	20.5
Water body	265.45	2	185.81	1.4	399.42	2.0

Source: Authors Analysis, 2021

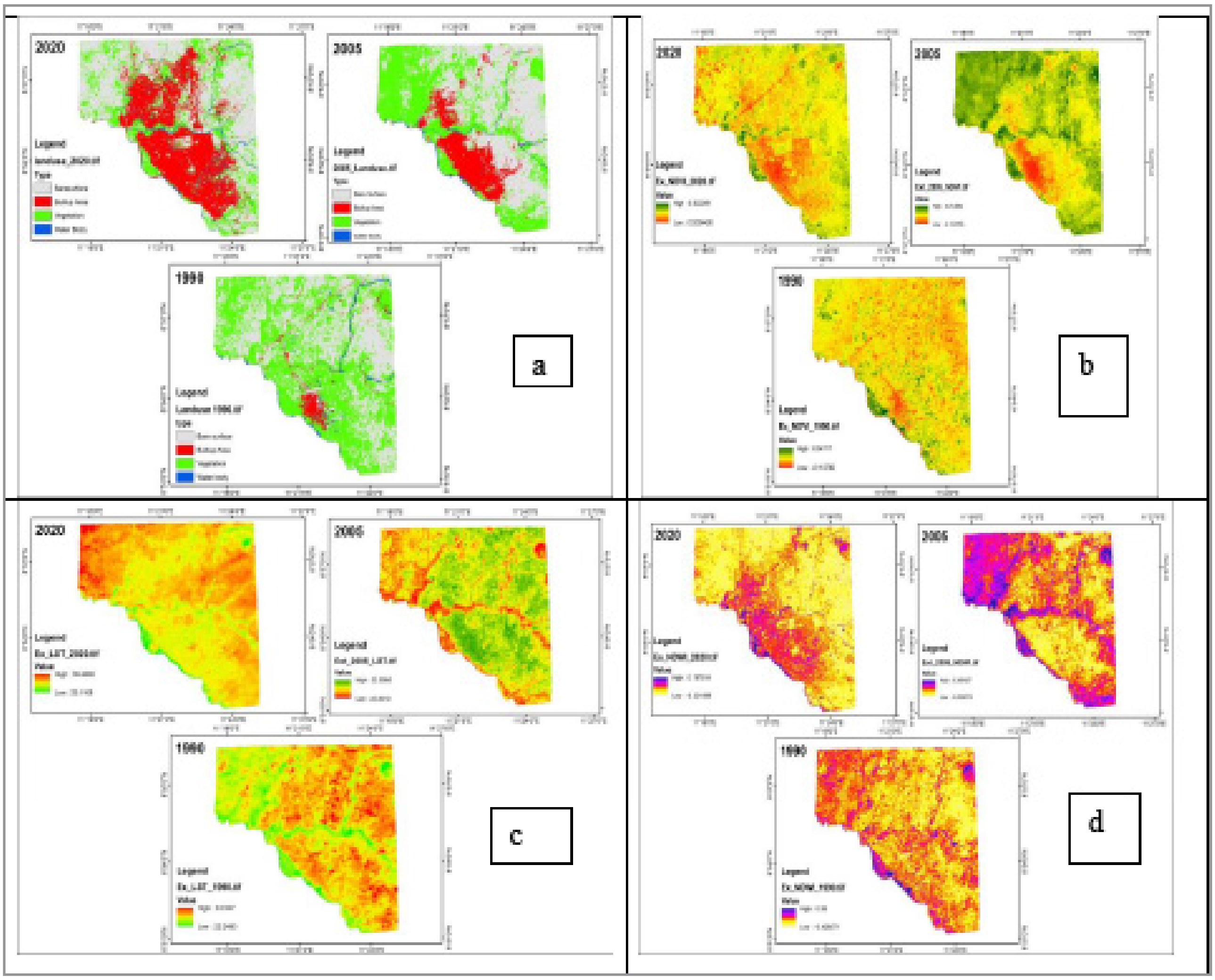
The table 3 shows that in 1990, the bare surface covered an area of 5415.17 hectares which is 40.8% of the total area. However, the built-up area covered an area of 437.99 hectares which is 3.3 % of the total area. Furthermore, while vegetation covered an area of 7153.87 hectares which is 53.9 % of the total area, Water body covered an area of 265.45 hectares which is 2.0% of the total area. This reveals that the vegetative area covered a larger area of Jalingo in the year 1990 followed by the bare surface, the built-up area and the water body. In 2005 (Table 3), bare surface covered an area of 5826.62 hectares which is 43.9% of the total area as the built up area covered an area of 1858.15 hectares which is 14% of the total area. Vegetation covered an area of 5401.90 hectares which is 40.7% of the total area while water body covered an area of 185.81 hectares which is 1.4% of the total area. This reveals that the bare surface area now covered a larger area of Jalingo in the year 2005 as against vegetation in 1990 as vegetation, and the built up area and water body followed respectively. In 2020 however, Table 3 shows that the bare surface covered an area of 5977.17 hectares which is 45% of the total area, and the built up area covered an area of 4170.51 hectare which is 32.4% of the total area. Similarly, vegetation covered an area of 2725.38 hectares which is 20.5% of the total area while water body covered an area of 399.42 hectares which is 2.0 % of the total area. This reveals that the bare surface area again covered a larger area of Jalingo in the year 2020 followed by the built up area, vegetation and water body respectively. It can be inferred that while the change in water body was not very significant in the 30 years period, as the water area has a dwindling change from 2% in 1990 to 1.4% in 2005 and back to 2.0% in 2020 but bare surfaces increased by almost 5% while the built up area increased by over 29% and the vegetation reduced by 33%. This is a huge loss considering the role of vegetal cover in providing shades, calming wind storms, carbon sequestration and provision of better air quality. This is in conformity with the findings of Ullah et al. , Fabiyi revealing that over time there is an increase in the built up area and bare surface having a surge on the vegetative area leading to its reduction [3, 39].

The result agrees with the studies of Usman study which examined the impacts of fuel wood harvesting activities on forest degradation in Mutum-Biyu area of Gassol LGA area of Taraba State and reported that there is a decline in the numbers of tree species and may be related to increasing demand generated by the growing human population and national need for charcoal [40]. The study also revealed that, provision of other sources of fuel, provision of more job opportunities; people enlightenment, law enforcement and reforestation remain the most potential ways of controlling the impacts of fuel wood harvesting activities on forest degradation. He further reiterated that environment of these source regions has been experiencing a negative impact such as deforestation, soil erosion, loss of biodiversity, `decrease in tree population, wind storm, social conflicts, decline of water source, decrease in food production, soil fertility and leaching. It also aligns with Ujoh et al., which shows increasing population and expansion in the Federal Capital City (FCC), Abuja resulted in land degradation including loss of vegetal cover, indiscriminate waste disposal, contamination of surface water, etc [37]. now clearly visible in the FCC. Thus, in view of the important role that vegetation plays as a carbon sink, policy-makers are requested to strictly enforce the existing laws on afforestation and parks establishment and other measures, within and around the FCC in order to achieve a sustainable urban growth and development.

It further corroborates with Yabo and Jacob showed that the built-up area increased from 15.65% in 1990 to 17.88% in 2001 while in 2014 built-up accounted for 23.87% of the total land area in Kaduna metropolis [42]. This study has clearly shown evidence of rapid urban expansion in Kaduna metropolis. In an earlier study on the pattern of land use and land cover dynamics in Jalingo region from 1973 to 2009, Zemba & Yusuf observed that considerable land cover change has been recorded in the study area with arable lands declining by about 85% from the initial value of 200, 771.2 hectares in 1973 to 29, 675 hectares in 2009 [43]. They further stressed that approximately 5, 423 hectares of arable lands is lost annually to other uses, which suggests that the whole of natural vegetation could be entirely wiped out in the next 30 years, if no direct and urgent intervention measure is put in place [43]. The study also agrees with Mbaya et al., study in Gombe metropolis which showed a rapid decrease on the vegetation and a gradual increase in settlements between 1976 and 2016 due to the fact that Gombe metropolis became the capital of Gombe state in 1996 [44]. Also only few tree species were found within the study area, as most trees are cut down for various developmental purposes. The result is also congruent with Ojeh et al and Koko et al., both carried out in Lagos and revealed three phases of growth in Lagos and a substantial increase in the city's built-up area from 496 km^2 in 1990 to approximately 860 km^2 in 2000 [45,46]. This area increased further to 1113 km2 in 2010, and presently over 1256 km^2. The result also revealed a substantial decrease in the city's vegetation, water bodies, and bare soil by approximately 398 km^2, 246 km^2, and 115 km^2, respectively, between 1990 and 2020 [46].

The relationship between Normalized Difference Vegetation Index, Normalized Difference Water Index and Land Surface Temperature with Land use Land cover Change

Figure 3 present maps of land cover, LST, NDVI and NDVI from 1990 to 2020 in Jalingo. The progressive increase in the built-up areas and the decrease in vegetation cover are evident in Figure 3 (a). The LST map in figure 3 (c) shows a progressive rise in temperatures emanating from the centre of the Jalingo metropolis. Juxtaposing the three maps, it can be deduced that the surrounding areas of Jalingo has varied vegetation where vegetation decline over the 30 years follows a pattern of increasing disappearance from the North to the South. This also indicates that urban development endeavours is very high at the centre of the metropolis, and it increases yearly towards the north-western and eastern regions of the Jalingo. Generally, the vegetation-covered areas have the highest NDVI and NDWI values as indicated in figure 3 (b & d). Areas with abundant vegetation cover display low LST values and collaborates the study of Guha et al. [47]. The trend of overall LST ranging from higher to lower for built-up areas, bare land and vegetation conforms to the findings of Ullah et al. [39].



Furthermore, the mean LST for the three periods are 28.53°C (1990), 28.88 °C (2005) and 33.88°C (2020), respectively. The trend reveals a gradual rise in surface temperatures and warmness within the environment surrounding the Jalingo over the years. The lowest temperature recorded was 22.24°C in 1990 whereas the highest temperature was 39.50°C in 2020. The NDVI values ranged from -0.11 to 0.54 (1990), −0.13 to 0.31 (2005), and 0.02 to 0.32 (2020). The trend reveals a gradual reduction in vegetative cover in Jalingo. For the NDWI, the ranges are as follows: from -0.42 to 0.36 (1990), −0.20 to 0.35 (2005), and −0.33 to 0.19 (2020). These reveal drastic reduction of surface moisture level in Jalingo over the years and these are exacerbated by climate change with its attendant effects on the health of humans, animals and plants [48]. The effects become very evident during the DJFM months (dry season) where Jalingo residents experiences excessive heat during the day and night to the level that majority of the people sleep outside the house mostly between February and March. Some, citizens migrate temporary from Jalingo to the cooler Mambilla Plateau region in Sardauna LGA during this period for the fear of heat exhaustion, a condition characterized by heavy sweating, and rapid pulse as a result of overheating of the body. This put the lives of the more vulnerable populations such as children below 5 years and older adults of above 65 years in danger [45].

Conclusion and Recommendation

The study explore and identified activities in Jalingo, it was found out that 16.67% are Deforestation, 16.67% are dumping of non-biogradable trash, 33.33% are exposure of naked soil, 16.67% are mismanagement of agricultural land while 16.67% are quarrying activities. The study furthermore performed land use and land cover change analysis of Jalingo from 1990 to 2005 and to 2020 the results shows that there is an increase in the area coverage of bare surface from 40.8% in 1990 to 43.9% in 2005 and to 45% in 2020.it reveals that there is an increase in the area coverage of the built-up area from 3.3% in 1990 to 14% in 2005 and to 32.4% in 2020. It also shows that there is a decrease in the area coverage of vegetative land from 53.9% in 1990 to

40.7% in 2005 and to 20.5% in 2020. While the water area has a dwindling change from 2% in 1990 to 1.4% in 2005 and back to 2.0% in 2020 this is in conformity with the findings of Ullah et al., Fabiyi revealing that over time there is an increase in the buit-up area and bare surface having a surge on the vegetative area leading to its reduction [3, 39].

Furthermore, the exposure of bare soil amounts to the largest human activity leading to land degradation in Jalingo. And over time with increase in urbanization and growth in the built-up area results to decrease in vegetative cover and that land use land cover change occurs most in the city periphery.

The trend reveals a gradual rise in surface temperatures and warmness within the environment surrounding the Jalingo over the years. The trend reveals a gradual reduction in vegetative cover in Jalingo. This reveals drastic reduction of Surface moisture Level in Jalingo over the years.
Based on the results, the following recommendations are made

Irrigation
Irrigation, through increased evaporation, cools the earth's surface and provides a counterbalance to global warming, high surface temperatures, and loss of land cover, according to research, particularly in higher latitudes like Jalingo [49].

Trading plants for carbon
It has been suggested that there is a complex trade-off between expanding agriculture and keeping carbon locked up on the land recommended that farmers, particularly those in the tropics like Taraba state, focus on increasing crop yields on already cleared land to avoid carbon emissions [49, 50]. This is due to the fact that farmers in the tropics engage in bushfires and other farming practices that increase carbon dioxide emissions. Paul West and colleagues from the University of Wisconsin-Madison used soil and agricultural data from around the world to calculate how much carbon would be lost if natural ecosystems were cleared for food or biofuel crops.

Afforestation
It has been suggested by Zeraatpisheh, M., et. al.[51]. that deforestation causes land degradation more compared to other human activities and this research has identified deforestation as a major cause of Land Degradation and suggested afforestation as a major solution with the protection of existing vegetation from fire and land clearing should be also encouraged, as the restoration of degraded lands.

Clean biomass systems
Clean biomass systems have a lot of potential for lowering greenhouse gas (GHG) emissions. When biomass is burned inefficiently, as in conventional cooking stoves, some carbon that was previously considered carbon-neutral is released into the atmosphere in the form of methane and carbon monoxide – greenhouse gases that are even more powerful than carbon dioxide – but when these conventional stoves were replaced by cleaner-burning types, a reduction in carbon was observed [49,52].

Government policies on adaptation
Climate change is clearly a threat to humanity, and better and more effective policy options for overcoming obstacles and barriers are critical for climate adaptation and mitigation. Several frameworks have been developed to assist policymakers and scientists in identifying barriers to climate change adaptation [53 54-59]. This focuses on identifying where some of the most difficult barriers to climate adaptation are located, as well as the appropriate framework for determining which barriers are the most difficult to overcome, providing policymakers with the opportunity to better allocate resources and strategically design processes to overcome the obstacles [55, 58, 59].

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