ASSESSMENT FOR THE INFLUENCE OF LAND USE AND LAND COVER CHANGES ON FLOOD IN LAVUN LOCAL GOVERNMENT AREA, NIGER STATE, NIGERIA

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ABSTRACT

Flood disaster is a common phenomenum in the study which frequently occur and need to be investigated. The study aimed at identification and Map out of flood vulnerable areas in Lavun Local Government Area for effective mitigation strategy. Field measurement, GIS and RS were also used in obtaining the data. Land use and land cover of the study area between 1990 to 2020 Image processing was carried out to manipulate and interpret digital data which involves some basic operations namely; image enhancement to increase the interpretability of features by increasing apparent contrast among various features, image classification on the other hand is assigning each pixel to a given class. The data were analyzed using supervised classification. The result shows that, built-up areas have been on increase from 163.85 km^2 (5.77%) in 1990 to 433.34 km^2 (15.24%) in 2020. The work concluded that, settlements are on the increase towards the floodplain which implies an increasing vulnerability of the built-up areas to flooding. It was recommended that, the communities that are discovered to be highly vulnerable to flood should be relocated and discouragements of future settlements in flood prone areas.

Keywords: Flooding, Land Degradation, Vulnerability, Flood Prone, Land Use, Land Cover, Supervised Classification.

INTRODUCTION

The past two decades have seen a significant upsurge in the frequency of flooding on a global scale (Najibi & Devineni, 2017; Njoku, Efiong and Ayara, 2020). Flood is known to cause devastating livelihood impacts, suffering and economic damages, it is a natural hydrological extreme event affecting the flow regime of all rivers, particularly during the rainy season (Eze, Vogel and Ibrahim, 2018). Flood is considered to be one of the most devastating and frequently occurring natural hazards globally. Impacts of flood disaster on the society and its effect on sustainable development are overwhelming in recent years (Komolafe, Adegboyega, & Akinluyi, 2015).

In Nigeria, flooding is a recurrent phenomenon which could be coastal, fluvial or pluvial (Ogato, Bantider, Abebe and Geneletti, 2020). Coastal and fluvial flooding in Nigeria affects coastal and riverine environments and are due to seasonal water upsurge from large rivers such as the Niger, Benue, Cross River and Kaduna. Recent flood occurrences in Nigeria have been particularly, among other factors, geared by the release of water from the Dams and the high intensity of rainfall in some regions and the haphazard development of land on flood prone areas (Atufu & Holt, 2018).

The current trend of flood occurrences and impacts in Nigeria calls for more studies and accurate spatial information on the potential flood hazards. Thus, presenting the need for an effective and a reliable analytical approach to understand the nature of the vulnerability for appropriate decision-making aimed at mitigating the associated impacts (Tarekegn *et al.*, 2010; Njoku *et al.,* 2020).

Floods are among the most dramatic forms interaction between man and its environment. They occur both in the developed or developing are always associated with heavy loses of life and property, misery hardship disease and at times famine. The type of flooding predominant in the study area is perennial flooding caused by heavy rainfall and overflow of river banks (Eni *et al.*, 2011). Floods are major disasters affecting many countries of the world annually especially in most flood plain areas. Floods do not only damage properties and endanger the lives of human and animals but also produce other secondary effects like outbreak of diseases such as cholera and malaria as well. Flooding is commonly caused by heavy downpours of rains on flat ground, reservoir failure, volcano, melting of snow and or glaciers etc. Flood risk is not just based on history, but on a number of factors: rainfall, river flow and tidal-surge data, topography, flood control measures, and changes due to construction of building and development on flood plain areas (Tiepolo *et al.,* 2019).

Adeaga (2009) used GIS techniques to produce flood probability map and land use/land cover pattern information of part of Lagos NE region, which was used to estimate flood risk and probable peak discharge of the different land use/land cover classes. The study integrated this information into a GIS decision support system to provide a detailed flood pre-disaster and lead time geo-information services within the city. Aderoju *et al.* (2014) used remote sensing and GIS to assess, map and analyze the 2012 flood disaster in Kogi state, Nigeria for an effective flood disaster risk management and proper planning. Satellites imageries [MODIS of 20th October, 2008 (before) and 13th October 2012 (during) and provided by NASA; Nigeria Sat-X of 2012 and SPOT 5 of 2002], Base map of Kogi State, SRTM DEM, GPS coordinates; and flood pictorial evidence acquired during field survey were integrated to map flood plain, analyze the spatial extent of inundation and disaster risk areas.

MATERIALS AND METHODS

Study Area

Lavun is a Local Government Area in Niger State, Nigeria. Its headquarters is in the town of Kutigi, the study area is located between latitude 9°1′50″ N - 9°46′45″ N and longitude 5°18′ 55″E - 5°51′ 35″E. The Kaduna River forms the eastern border of the LGA. It has an area of 2,835 km² and a population of 209,917 at the 2006 census (FGN, 2007). The local government area is situated in the southern part of Niger state and bordered by Kaduna River and Gbako local government in the east, Wushishi and Mashegu local government areas in the north, Edati local government area in the south and Mokwa local government area in the west (figure 1). The majority of the population are Nupe. The working population of Lavun Local Government are Farmers, livestock/poultry farmers, marketers and also some administrative workers in the local government with rich cultural values.

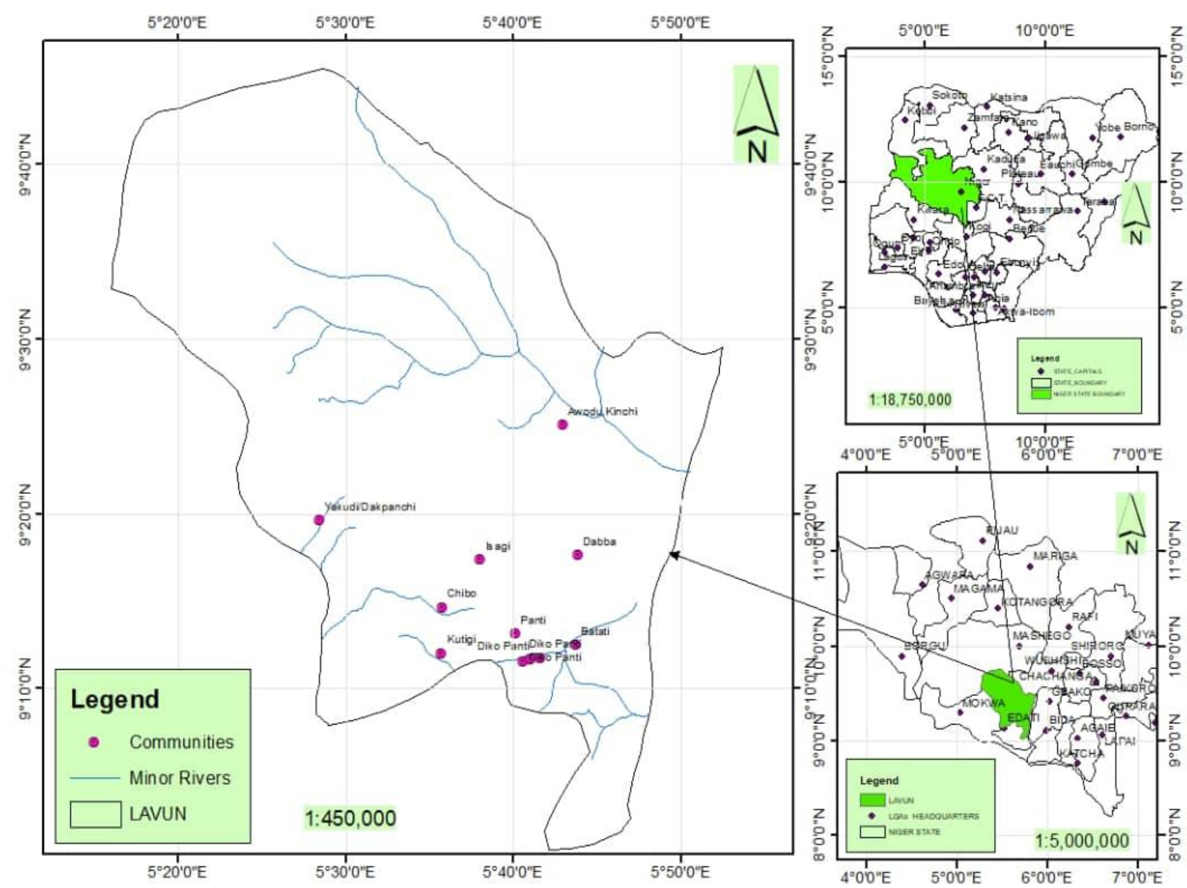


Figure 1: Map of the Study Area
Source: Geography Department, Federal University of Technology Minna.

Methods of Data Collection

A reconnaissance survey was carried out for familiarization of the study area, to see the extent of flood vulnerability and the affected areas. It also helped in identifying the economic activities of the communities, to see the flooded farmland, structures (Residential houses, clinics, and schools). It was discovered that there is variation between the communities in terms of vulnerability to flooding. For change detection, Land use/Land cover images of the study area from 1990 to 2020 was downloads from United State Geological Survey (USGS) website. The characteristics of the satellite data used is presented in table 1.

Table 1: Remote Sensing data used in the study

Date of Acquisition	Sensor	Path	Row	Multispectral Band	Thermal Band	Spectral Range (micrometers)	Spatial Resolution (pixel spacing)	Source
1990	TM	190	053/054	1to5 and 7	6	10.45-12.45	30	
2010	ETM+	189	053/054	1to5 and 7	6	10.45-12.45	30	USGS
2020	OLI and TIRS	189	053/054	1to7 and 9	10 and 11	10.60-12.51	30	

Source: Authors Analysis 2021

Methods of data Analysis

For the Examination of land use and land cover of the study area between 1990 to 2020 Image processing was carried out to manipulate and interpret digital data which involves some basic operations namely; image enhancement to increase the interpretability of features by increasing apparent contrast among various features, image classification on the other hand is assigning each pixel to a given class.

Supervised classification was used on the processed image to classify the land cover based on spectral signature in the training set. These include built up areas, forest cover, cultivated land and Grassland and water bodies. The Classification System was based on Anderson, Hardy, Roach and Witmer (1976) land-use/land-cover classification scheme. The various land-use/land-cover types is modified into five classes within the study area. The supervised classification image of each year involves pixel categorizations by taking training area for each class of LU/LC. After the training area is assigned for each class, classification activity was performed for each LU/LC types (Coppin *et al.*, 1996) as cited by Nwobodo (2018).

Supervised classification technique using maximum likelihood algorithm is the most commonly and widely used method for land cover classification (Jia *et al.*, 2006). A Band combination of 2, 3 & 4 was used for Landsat TM 1990 and ETM+ 2010, while band 3, 4, & 5 was used for OLI 2020 for preprocessing of the images. The LU/LC pattern was mapped using supervised classification with the likelihood classification algorithm of ArcGIS 10.3 software.

Table 2: Land use land covers Classification Scheme

S/N	Class	Description
1	Built-up	Areas under urban and rural built-up including homestead area, residential, commercial, mixed use and industrial areas, villages, settlements, road network, pavements, and man-made structures
2	Forest cover	Trees, natural vegetation, mixed forest, gardens, parks and playgrounds, grassland, vegetated lands, agricultural lands, and crop fields.
3	Farmland	This category involves land under crops, fallow, plantations and aquaculture
4	Grassland	This are areas dominated by grass.
5	Water bodies	Body of water like rivers, streams, oceans etc.

Source: Authors Analysis 2021

RESULTS AND DISCUSSION

1990 Satellite imagery LULC classification for the Study area

Result of the classified land use/land cover for the year 1990 is presented in figure 2. The map shows five (5) categories of land use/land covers; built-ups areas, forest cover, grassland, cultivated land and water bodies.

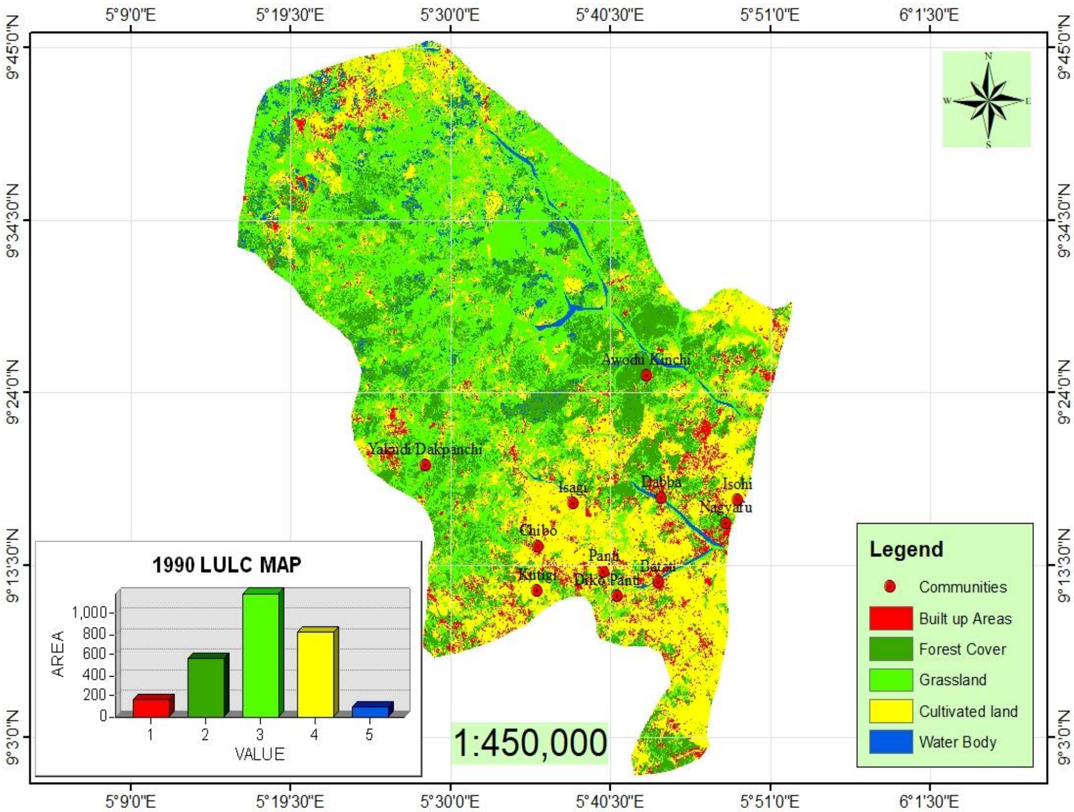


Figure 2: 1990 Land use and land cover map of the study area
Source: Author's Analysis, 2020.

The area extent of these classes reveal that the dominant class is grassland which covers 1189.85 km^2 (41.89%), this is followed by cultivated land with 819.65 km^2 (28.86%), built up areas covers 163.85 km^2 (5.77%). This is seen more at the eastern and other parts of the study area, forest cover on the other hand occupies an area of 564.80 km^2 (19.88%) and water bodies with 102.43 km^2 representing (3.61%) of the total area as the less dominant land use and land cover class.

This result shows that there is low vegetation cover in the study area as results of cultivation of agricultural lands. This contribute to high run-off that may causes flood in the study area. Also when flood occurs, it affect mostly farmlands because from the LULC classification, cultivated lands are higher compare to build up areas. In the event of floods, vegetation helps to reduce the direct impacts of running water on the floodable areas. Therefore, low vegetation defines high impacts of the flood effects. This agrees with the work of Awoniran (2012) observes that land use changes or land conversion occur at the periphery of large urban concentration where urbanization and industrialization pressures frequently result in loss of prime agricultural lands and tree cover. Which implies that the conversion of agricultural lands and tree covers to urbanisation will lead to high runoff and flooding.

Land use/land cover Classification of 2010 for the study area.

The land use and cover map of the study area for 2010 (Figure 3), reveals that there was a drastic increase in built up areas. Result shows that built up area increase from 163.85 km^2 (5.77%) in 1990 to 330.64 km^2 (11.63%) in 2010. This increase is attributed to inflow of people in study area which engage in farming, fishing and lumbering activities. Because the soil is fertile and suitable for agriculture.

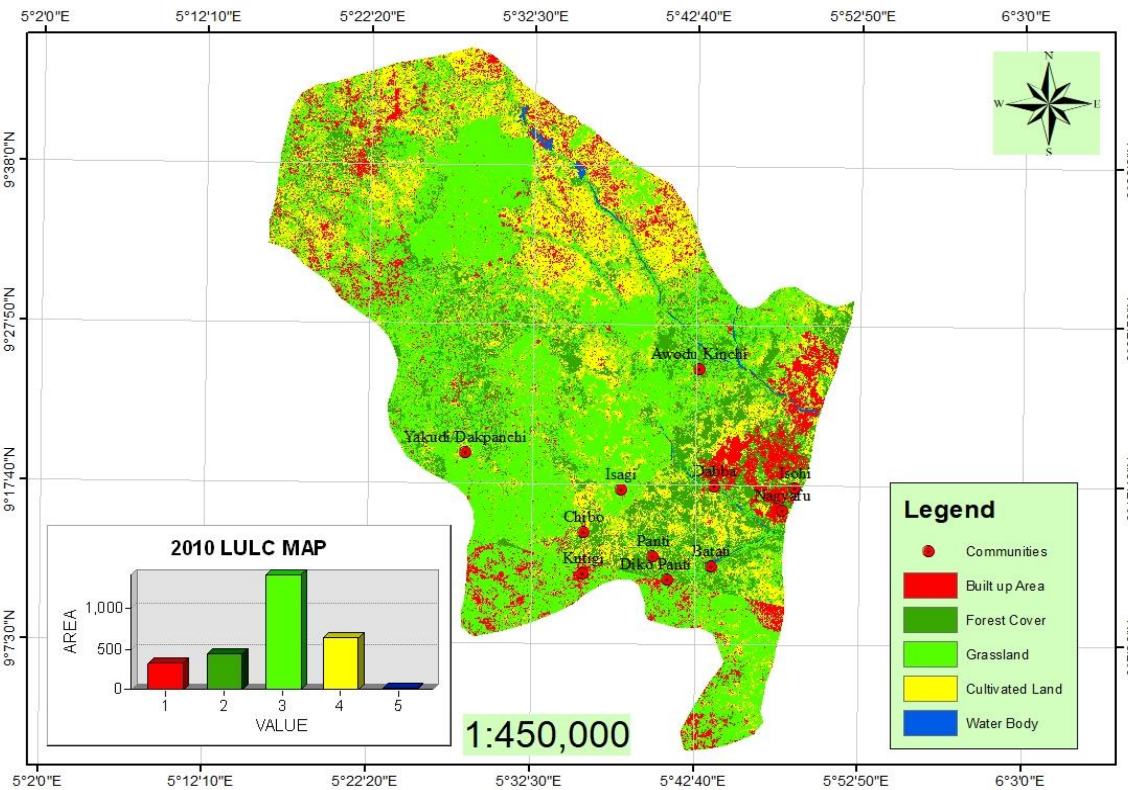


Figure 3: classified 2010 land use and land cover map of the study area
Source: Author’s Analysis, 2020.

The built up expands towards the eastern and northern section of the map due to continuous influx of people to the area who engage in fishing, farming and other activities, this increase is attributed to increase in population growth. Findings reveal that cultivated land also decrease from 819.65 km^2 (28.86%) in 1990 to 648.0324 km^2 (22.79%) in 2010. The lower proportion of cultivated land area indicates that most of the inhabitant engage in other socio-economic activities rather than farming.

However, there was an increase in grassland area as findings indicated that grassland areas increased from 1189.85 km^2 (41.89%) in 1990 to 1414.17 km^2 (49.74%) in 2010, this may be attributed to conversion to lumbering activities. Similarly, forest cover also witnesses a decrease from 564.80 km^2 (19.88%) in 1990 to 437.56 km^2 (15.39%) in 2010 (figure 3). The decreased may be attributed to increased lumbering activities and forest exploitation in the area. The implication of the increase in grassland and continue decrease in forest might result to more flooding because of cutting down of trees for lumbering, charcoal businesses and so on which expose the land to flood. Furthermore, water body witness a slight increase to 12.47 km^2 (0.44%) respectively, while built-up areas cover 11.64% showing an increase from the last ten (10) years. An increased in the built-up areas and towards the river banks (eastern parts) indicates an increase in the level of communities exposure to incidences of flood occurrence in the study area. The rate of increase in the built-up of areas is also associated with the occupation of the communities such as farming and fishing. Flood help to increase the rate of fertility of the soil thereby increasing the cultivation rate towards the flood plains. This agrees with Israel and Browns (2012) which work on impacts of natural disasters on agriculture, food security, natural resources and environment in the Philippines stated that Floods improve soil fertility as they deliver nutrients from the uplands to the lowlands. Equally, fishermen prefers to live by the river banks which fishing activities easier for them. Therefore, nature of the occupation in these areas primarily responsible in the increase in the built and towards the river banks.

Land use/land cover Classification of 2020 for the study area.

Figure 4 shows the land use and cover map of the study area for 2020, findings reveal that Grassland was still the most dominant land use and cover type feature, however there was a decrease across the study area, an indication of increase in population expansion. The grassland decreased from 1414.17 km^2 (49.74%) in 2010 to 1171.24 km^2 (41.20%) in 2020. The reduction in the percentage of the areas covered with vegetation, grasslands, and an increased in the built-up areas has been associated with population increase in the study areas. As the population continues to rise, so the rate of increase in the major occupation of the people, and subsequently high level of flood vulnerability. This has extremely contributed to building of structures in the high risk areas to flood.

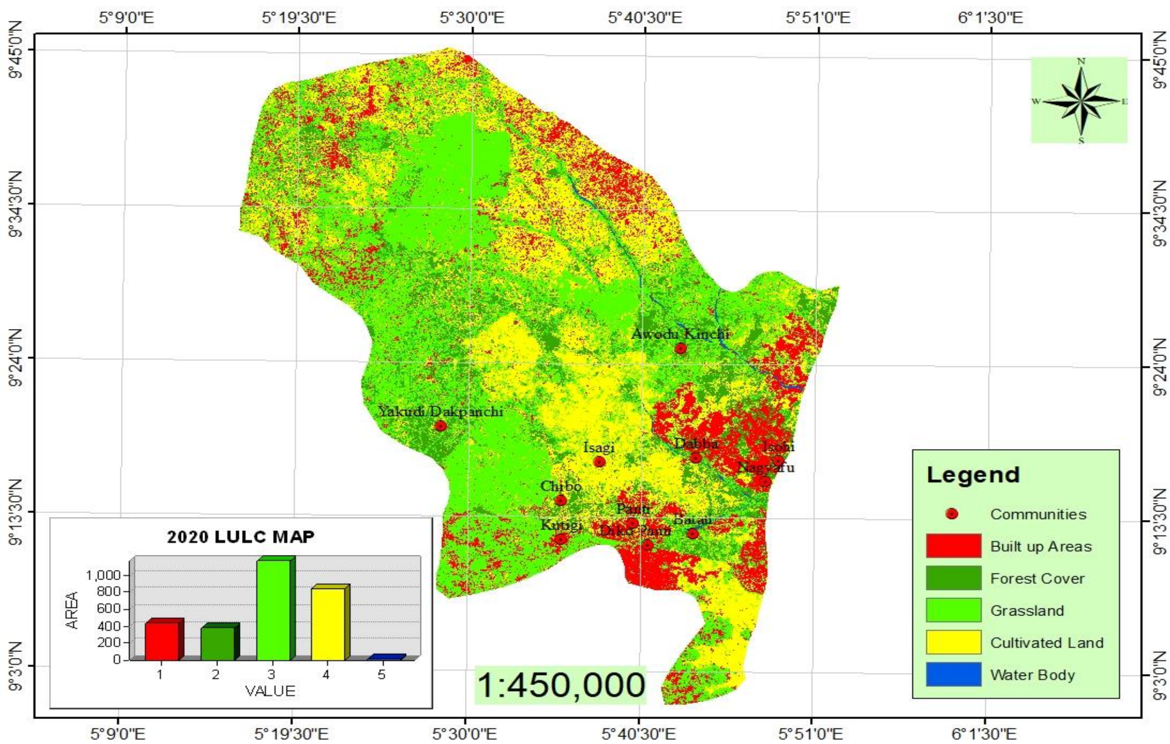
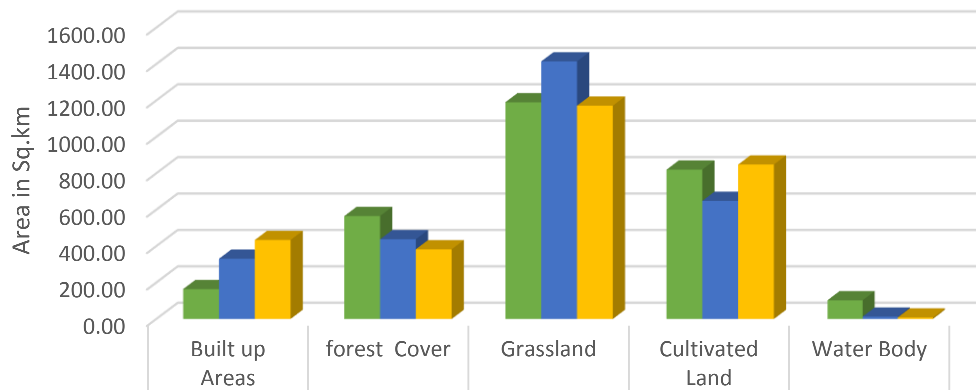


Figure 4: land use and land cover distribution map generated from LandSat 8 OLI
Source: Author's Analysis, 2020.

Result further shows that built up area increase from 330.64 km^2 (11.63%) in 2010 to 433.34 km^2 (15.24%) in 2020(figure 4). The built up expands towards the city western, southern, north west and south western section of the study area as more people to influx the area who make the inhabitants to encroached the river bank. The implication of this is that more people and settle in the study area despite the frequent occurrence of flood, that is why more structures are affected. Also the influx of people might be as a result of the fertility of the land and the cutting down of trees for charcoal.

There was an increase in cultivated land area as result shows that cultivated land but still occupies more land area than other land use category. Findings shows that cultivated land increased from 648.0324 km^2 (22.79%) in 2010 to 847.91km^2 (29.83%) in 2020(figure 4). Similarly, forest cover also witnesses a further decrease from 437.56 km^2 (15.39%) in 2010 to 382.38km^2 (13.45%) in

2020. The decreased may be attributed to increase lumbering activities as well as exploiting other forest resource such as fuel wood, planks and other resource in the area. In addition, water body decreased slightly to 8.01 km^2 (0.28%) respectively. Similarly, figure 5 shows the land use and land cover comparism chart, it indicates that built up area was on increase while other shows a fluctuating trend.



	Built up Areas	forest Cover	Grassland	Cultivated Land	Water Body
1990	163.85	564.80	1189.85	819.65	102.43
2010	330.6393	437.5593	1414.1736	648.0324	12.4695
2020	433.34	382.38	1171.24	847.91	8.01

Figure 5: Land use and land cover comparism chart
Source: Author's Analysis, 2020.

The result from the Analysis of Land use and land cover Change satellite imageries revealed that flood hazard is not the prime function of rainfall in the study area as haphazard development also plays a fundamental role, but among the major cause of flood in the study area is River flood, the cutting down of trees and reduction as shown in the chat for lumbering, firewood, charcoal which the Niger state Government have banned the sale of charcoal and disallowed the cutting down of trees without planting them. Built up areas have increase which there are influx of people in the communities because of the fertility of the land to farm and to tap other resources. The classified satellite image also indicates that most human activities are concentrated along flood channels and the river bank an indication of man's encroachment on the natural drainage. The built up villages within the study area which originally was a floodplain and natural drainage way but have been occupied by people due to influx of people from different places and was submerge by flood water in almost every year. Adeaga (2009) used GIS techniques to produce flood probability map and

Land use/land cover pattern information of part of Lagos NE region, which was used to estimate flood risk and probable peak discharge of the different land use/land cover classes. The study integrated this information into a GIS decision support system to provide a detailed flood pre-disaster and lead time geo-information services within the city.

The spatio-temporal analysis of the three decade images has shown the degree at which Land use and land cover changes that have taken place over time and space which build up areas have increase from 163.85 km^2 (5.77%) in 1990 to 433.34 km^2 (15.24%) in 2020, cultivated land 819.65 km^2 (28.86%) to 847.91km^2 (29.83%) have also increase as grassland 1189.85 km^2 (41.89%) to 1171.24 km^2 (41.20%) and forest cover 564.80 km^2 (19.88%) to 382.38km^2 (13.45%) have decreases, this is as result of inflow of people and human settlement is on the increase towards the riverbank. This certainly increases the vulnerability of built-up areas and cultivated land to flood events.

CONCLUSION

Flood disaster is the most frequent and common natural disaster in the study area which have affected lives and properties, loss of farmland and business in various communities in the study area. This study establishes that Human settlement is on the increase towards the eastern and south eastern part of the area as a result of the influx of people, because of the soil fertility to carryout farming activities, fishing and lumbering activities. Generally floodplain are suitable for agricultural practices because of the soil fertility, these have attracted people to settle in these places which also pose a threat and make the communities vulnerable to flood.

RECOMMENDATIONS

Base on the findings it is recommended that there should be relocation and resettled of all the communities that are discovered to be highly vulnerable to flood to medium or low vulnerable areas and discouragements of future settlements in flood prone areas, this is in line with international best practices for flood prone areas. People should be discourage to settle in the eastern and south eastern part of the study area as it is more vulnerable because it’s in low elevation and floodplain areas, this should be done through sensitization and public enlightment. Also the lumbering activities should be checked to stop people from cutting down of trees without replacing them as a lot of tress are cut down to produce charcoal, if possible should be stopped.

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