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Assessment Of The Impact Of Fuelwood Extraction In Yabo LGA Of Sokoto State: Implications On Vegetation Conservation

Zayyanu Ladan[1] & Dr. Hauwa'u Bello Dogon Daji[2]

[1,2]Department of Geography
Shehu Shagari College of Education, Sokoto, Nigeria
[1]zayyanuyabo247@gmail.com/ +2348062349394
[2]hauwadogondaji1@gmail.com/+2348036008035

ABSTRACT
In a quest to satisfy his energy needs, man engaged in incessant exploitation of forest and other vegetative resources. These and many more alter the physiognomy of the earth and will lead to series of ecological problems and climate change issues. Geographical Information System (GIS) and Remote Sensing technologies were used to assess the impacts of fuelwood extraction and its implication on vegetation conservation in the study area. The methodology used in this study involved data acquisition, data conversion, image exploration, supervised and unsupervised classification and change detection. Landsat imageries of the study area comprising 1995, 2005, 2015 and 2025 were downloaded and a total of 285 Ground Control Points (GCPs) were selected across study area, where a total of 180 GCPs were used for supervised classification while 103 GCPs were used for accuracy assessment. Using Maximum Likelihood Classification (MLC) the study area was divided into seven land use land cover classes were changes in each class was monitored. The study revealed that there was serious vegetation change in the area, this was attributed to incessant deforestation owing to climate change and fuelwood extraction. This study therefore recommends that an alternative sources of energy such as; cooking gas (LPG), kerosene, electricity etc should be made available and affordable to the general public in order to reduce pressure on the environment and to ensure vegetation conservation.
Keywords: Climate change, Fuelwood, GIS and Landsat

1.0 INTRODUCTION

Traditional cooking method (three stone fire) is widely used at both urban and rural households in many developing nations, burning up to 90% more wood than is necessary, costing poor families time and money that could be put to better use on education, health, and nutrition (Mongabay,2020). According to International Center for Energy Environment and Development, (ICEED, 2022) AllAfrica, 2013, and Agarwal et al. (2021), smoke from the traditional use of firewood is estimated to cause 95,000 deaths annually after malaria and HIV/AIDS; this was Nigeria's third highest killer mostly of whom are women and children.

The Clean Cooking Alliance (2011) stated that over 2 billion people globally are relying on traditional forms of energy (fuel wood) for cooking. This has spurred several SDG7 and 15-related initiatives at the global, regional, national, and local levels. One of such interventions in Nigeria was the launch of the National Assembly Intervention on Clean Cooking Initiative (NAICCI) in 2014 which according to the Federal Ministry of Environment (2016), has one key strategic goal of improving the socio-economic

status of beneficiaries (using income increases, gender, and reliance on forest resources such as trees for fuelwood as key performance indicators). NAICCI may have led to millions of improved cook stoves and clean fuel been deployed and adopted in several parts of Nigeria because of the ripple effect such a consumer awareness project may have in stimulating demand for clean cooking technologies. However, there are research gaps in understanding and measuring the SDG-related inter-linkages of this project in terms of socio-economic considerations, environmental sustainability, food security as well as the integration of these factors as an integrated policy model that may help in the achievement of SDG 1,2,4,7,13 and 15.

Remote Sensing technology has made it possible to overcome the limitations of using aerial photographs for vegetation studies. The availability of relatively fine resolution Landsat imageries has over the years, revolutionized the assessment of vegetation and corresponding degradation as may be caused by natural or anthropogenic activities. Vegetation indices such as the Normalized Difference Vegetation Index (NDVI) are widely used. The use of NDVI images for the analysis of land cover dynamics is very easy and more accurate because they are digitally processed and easier to interpret. Digital processing allows for vegetation mapping of an extensive area such as the whole of continent provided that the data to be used is available. As such this study used Maximum Likelihood Classification is one of the most widely used techniques in land use change detection and analysis.

1.2 Statement of the Problem

Yabo Local Government being part of the relatively dry Sudano-sahelian environment is being seriously encroached as considerable area of land is being degraded due to exploitation of fuel wood, bush burning, over cultivation and extensive grazing among others this has led to pronounce changes in the land cover of the area (Dangulla, 2013). Certainly changes in land cover in the study area are primarily the result of the change in land use caused by increased human population in the area. Such land use activities are likely to cause soil and gully erosion which would subsequently render a vast portion of land across the study area susceptible to further degradation (Getachew, 2020).

Even though previous studies have highlighted the degree and causes of degradation in the area, little has been made to stop further exploitation of vegetation or improve the general condition of the ecosystem. Apparently, people are using fuel wood as the cheapest source of energy for domestic uses while cultivation is now at an unprecedented rate. In addition, because of the rapid population growth in the area, a vast area of land is always needed for shelter, infrastructures and commercial structures.

1.3 Research questions

This study is guided by the following research questions:

- What are the different classes of vegetation in the area?
- What is the cause and extent of vegetation change in the area?
- What are the ways of mitigating the impacts of fuelwood extraction in the area?
- Are there other sources of energy in the study area?

1.4 Aim and Objectives

The aim of this study is to assess the impact of fuelwood extraction on vegetation conservation in Yabo LGA of Sokoto state. The following specific objectives are to;

i. Classify vegetation types in the area using remote sensing and GIS.
ii. Determine the cause and extend of vegetation change in the area.
iii. Identify the ways of mitigating the impacts of fuelwood extraction in the area.
iv. Identify other sources of energy in the area.

1.5 Significance of the Study

Vegetation is a very important component of the ecosystem because of its role as carbon sink, conservation of biodiversity, soil formation and protection, as well as facilitation of the earth's geo-chemical cycles. Degradation of vegetation therefore, affects man both directly and indirectly as his survival to a large extent depends on vegetation. Similarly other organisms including larger animals on which man depends for his food, shelter and medicines are also adversely affected when vegetation is degraded. This study therefore is important to policy makers and academicians as well as non-governmental organizations as it is an attempt to unravel the state of vegetation in the study area and the

underlying causes of its degradation. It will also propose correctional measures that will be used in solving the problem and initiating further studies. Vegetation is a very important component of the ecosystem because of its role as carbon sink, soil formation and protection, and facilitation of the earth's geo-chemical cycles. Degradation of vegetation therefore, affects man both directly and indirectly as his livelihood to a large extent depends on vegetation.

1.6 Scope of the Study

Fuelwood extraction is one of the most pressing environmental issues in developing countries which lead to a number of environmental disasters more especially in arid and semiarid regions of the world. This study intends to assess the impacts of fuelwood extraction on vegetation conservation in Yabo LGA of Sokoto state. Due to the nature of the study which requires data acquisition and processing, a relatively small area is chosen for effective assessment of the impact of Fuelwood extraction in the study area. The study will make use of time interval of thirty year period from 1995 to 2025 in order to determine the level of vegetation decline/ change within the study area. Hence 1995 will be used as base year while 2005, 2015 and 2025 will be used as subsequent years to show the magnitude of vegetation change during the period.

The Concept of Remote Sensing

"The art or science of obtaining reliable measurement by means of Photography" (American Society of Photogrammetry, 1944; 1982; 1966) another definition reads; "The act of examining photographic images for the purpose of identifying objects and judging their significance (Pearce, 2012).

Remote sensing was formally defined by the American society for Photogrammetry and remote sensing (ASPRS) as; "The measurement or acquisition of information of some properties of an object or phenomenon, by a recording device that is not in physical or intimate contact with the object or phenomenon under study". In 1988, ASPRS adopted a combined definition of Photogrammetry and remote, sensing as; Photogrammetry and remote sensing are the art, science and technology of obtaining reliable information about physical objects and the environment, through the process of recording, measuring and interpreting imagery and digital representation of energy patterns derived from non-contact sensor systems" (Pearce, 2012).

STUDY AREA AND RESEARCH METHODS

The Study Area

The study area (Yabo Local Government Area of Sokoto State) lies between latitudes $12^0$56'25"N and $12^0$55'47''N and longitudes $4^0$48'33''E and $5^0$08'16''E. It has a total land area of 789 km^2 and a population of 115,011 according to the 2006 census. The area is geologically located in the Taloka formation belonging to the broad cretaceous Rima group which is part of the extensive Sokoto basin (Kogbe, 1979). The Taloka formation has a maximum thickness of 180m and consists of fine to coarse sand, silty sands, shales and sandstones with many layers of clay/shale within the latter (Bello, 2012).

The climate of the area is that of sudano-sahelian ecological zone which is semi-arid types characterized by three distinct seasons - the cool, dry; the hot, dry and hot, wet. Temperature in the area ranges from 22^0C to 40^0Cs. Rainfall with emphasis to the annual totals, incidence and distribution is highly variable from year to year (Dangulla, 2013). The mean annual rainfall is 814.33mm (Sokoto State Government, 2004). Vegetation of the area is mostly the short feathery grasses with some trees and other woody species most of which are deciduous, dotting the area. The pattern of vegetation distribution is to a large extent, influenced by human activities though physical factors may assume local importance.

The people of Yabo local government predominantly engage in agricultural activities (farming and rearing of livestock). Fishing is equally practiced in riverine areas of Muza, Kibiyare, Fakka etc. while irrigation farming is practiced in virtually all areas in the local government. Foodstuff such as onions, pepper, tomatoes, vegetables are grown. Others are sweet potatoes; water melon and sugarcane are grown in commercial quantities.

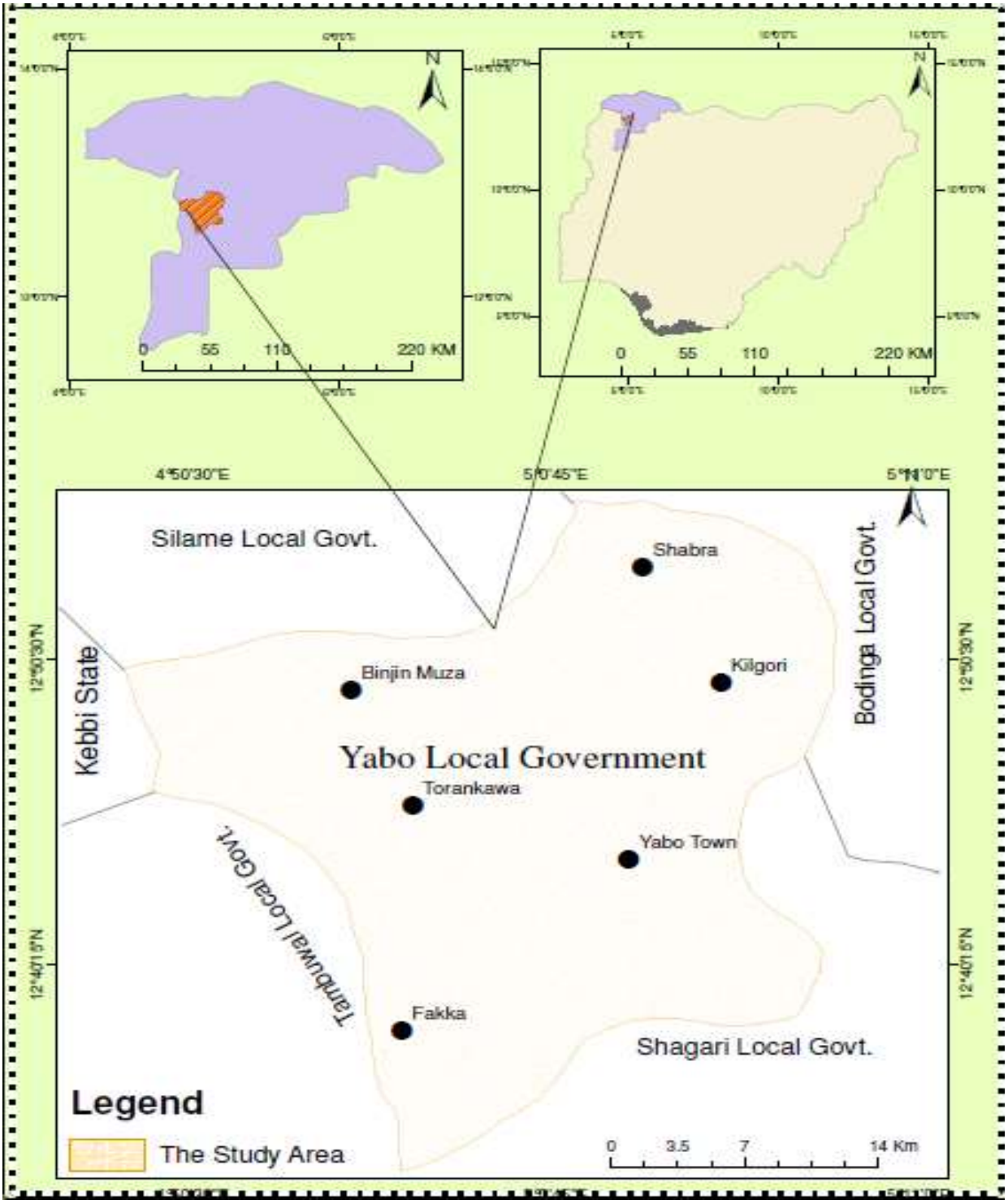

Figure 1: The Study area

Source: GIS Lab UDUS, (2022)

RESEARCH METHODS

Two data sets will be used for this study; primary sources of data which include the data on environment of the study area, the nature and magnitude of human activities and on the characteristics of vegetation will be obtained from field survey, observation and measurement. While secondary data will be obtained

from already published material, the secondary data includes a Landsat ETM$^+$ Satellite Imagery, Obtained from the Global Land Cover Facility (GLCF) 2005 and downloaded from the University of Maryland (USA)'s website. The imagery when processed will be used to identify the area's land use/ land cover type and also to generate sample points used for studying vegetation characteristics. Other secondary data will be sourced from text books, journals, reports, the internet as well as both published and unpublished theses and dissertations.

Landsat Data

Landsat 5 TM of 1995 (23-11-1995), Landsat 7 ETM+ of 2005 and Landsat 8 OLI-TIRS of 2025 (02-12-2025) were selected for the study. The data were of 30m spatial resolution and located in path/row 191/051 archive centre of the United States Geological Survey (USGS). The data were downloadable via glovis.usgs.gov. Processed to Level 1T (precision and terrain corrected) and stored in GEOTIFF format, the data were relatively cloud free, corresponding to November/December near-anniversary images

Therefore the methodology used for this study entails data acquisition, data conversion, image exploration, unsupervised classification, ground truthing, supervised classification and change detection in a given vegetation or land cover. All procedures leading to change detection in this study will be performed using idiris 32 series 2 software package. This is Geographical Information System (GIS) software for processing raster and vector images. A raster image is that which is formed from a multitude of independent dots called picture element (pixels) which are arranged in rows and columns on the computer screen, while vector is formed from the collection of lines not pixel.

Sampling and Data Collection

The field study starts with a reconnaissance survey which is the first major activity to be carried out. The aim of the reconnaissance survey is to enable the researcher get acquitted with the local environment and identify stakeholders and community leaders. The second major activity is ground truthing exercise which will be carried out to verify the true nature of and location of points as well as areas and objects as they appear on the downloaded imagery already generated by the computer software. According to Nathaniel (2007), ground truthing refers to field observation which helps to gather local knowledge beforehand to guide the interpretation and get information about features or areas that cannot be studied from the image data.

Thirdly, the downloaded vegetation data sets will be imported into Idrisi software and processed for final land use classification and analysis. To curve out the study area, windowing operation will be performed because the images cover a very wide area. Hence, the coordinates of the study area will be inputted into the software as input parameters for the operation. This will be used to create the portion of the study area from the entire image.

Sampling will be the next activity which involves selection of units from which vegetation data will be collected. Appropriate number of sample points will be automatically generated from the satellite imagery using the IDRISI ANDES software. Using the software, the points will be randomly (but proportionately) selected and from which, study quadrats of appropriate dimension will be developed to form the basis for data collection and subsequent post classification analysis (Nathanie, 2007).

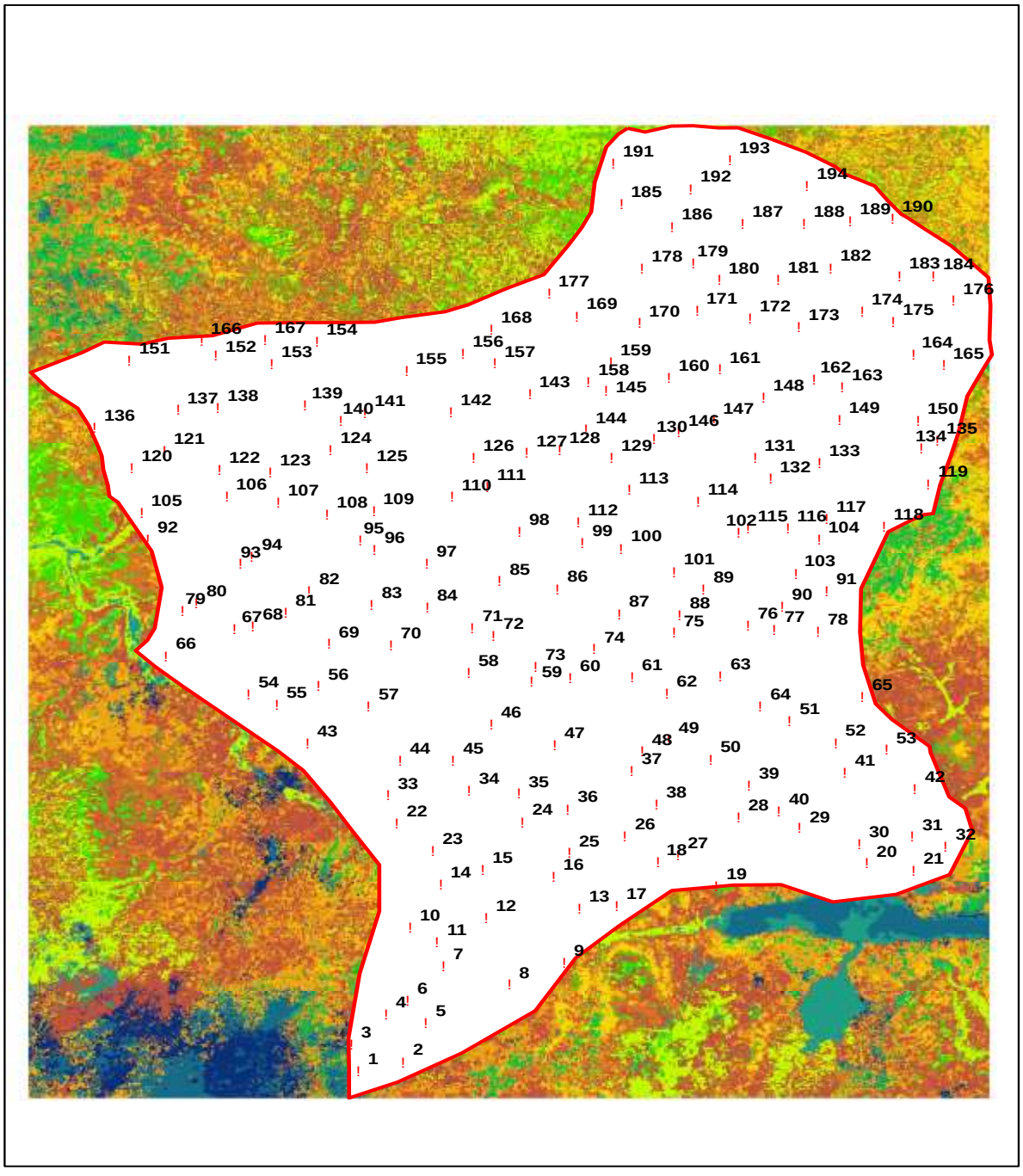

Figure 2: Ground Control Points (GCPs) randomly selected across the study area.

DATA PRESENTATION AND ANALYSIS

Classification of vegetation of the area using GIS

In the course of this research the land cover classification was done using Idrisi Taiga (version 16.0) and a total of seven (7) vegetation classes were identified. These were made possible through signature development, where each vegetation type emits certain reflective characteristics and thus classify accordingly using maximum likelihood classification algorithms.

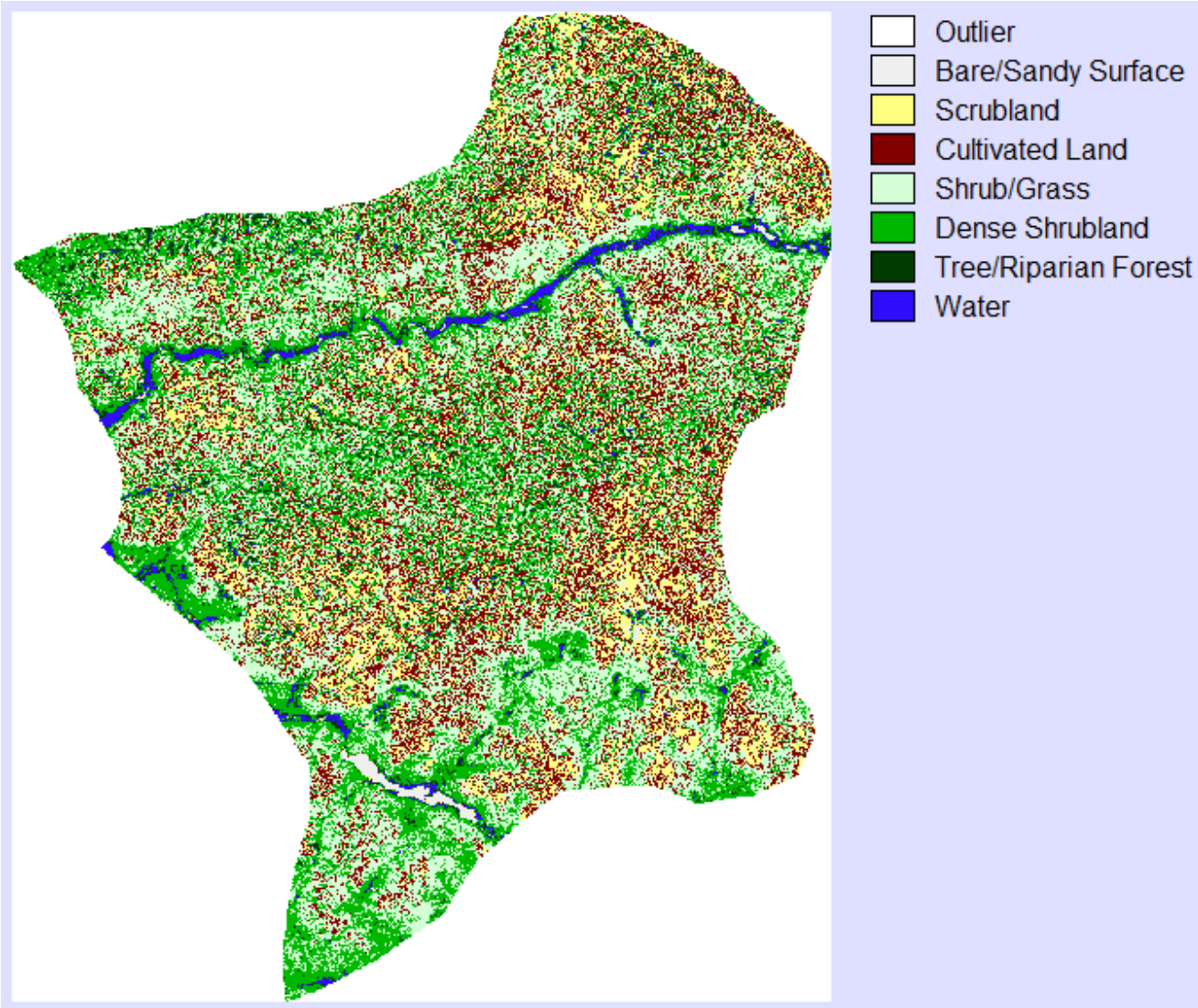

Figure 3: Land use Land cover classification image of the study area.

Areas of land cover change in the area.

It is possible to monitor and detect vegetation changes in a particular area using remotely sensed data and other software packages through identifying differences in the state of an object by observing it at different times (Getachew, 2020). This can be understood through recent estimates on changes in cropland, agricultural intensification, tropical deforestation, posture expansion, urbanization as well as utilization of other vegetative resources for human uses. Land cover change is usually as a result of land use change, as they go hand in hand. In the study area there are significant changes in land cover due primarily to series of activities that are currently taking place example an area that was hitherto scrubland or shrubs was now converted to either agricultural land, residential or put to other infrastructural uses, also an area that was considered as wetland was now drained by man and converted to other uses. Couple with climate change these activities change the land cover of the study area. It is clear that there was significant loss of dense shrub and shrub land at the expense of cultivated land and scrubland. Bare surface continue to increase from 551ha in 1995 to 2,260 ha in 2025, this can be

attributed largely to gradual shift of different vegetation classes from their normal status to bare surface either as a result of drought, over grazing, exploitation, excessive cultivation or change in land use.

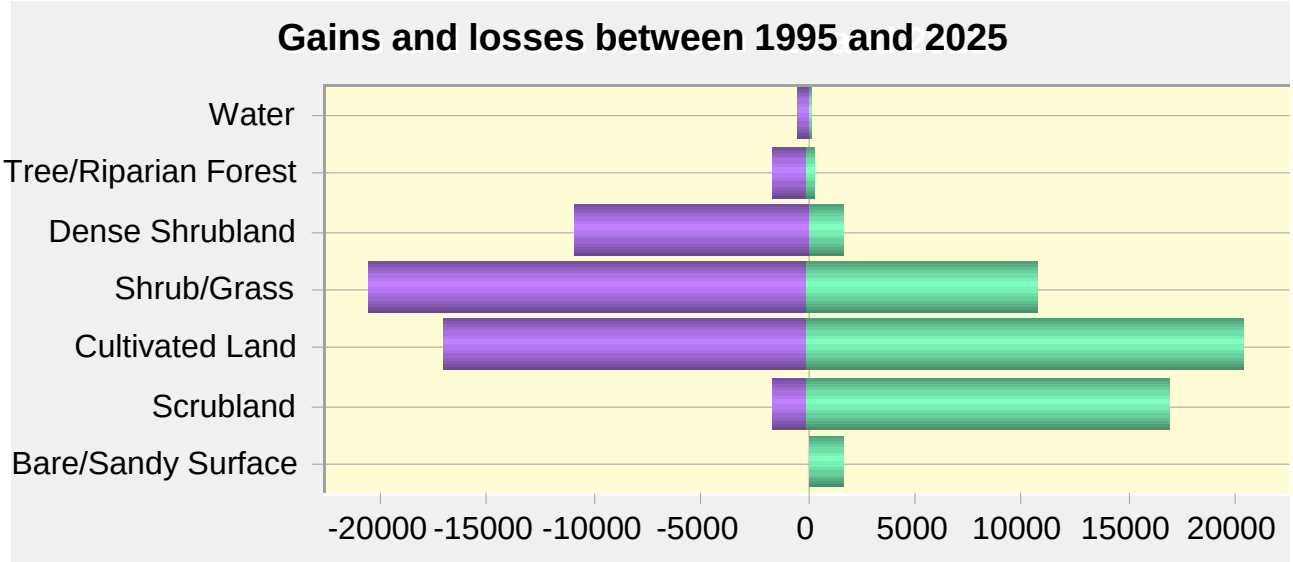

Figure 4: Gain and Losses in Vegetation Classes from 1995 To 2025

LEGEND

LOSS
GAIN

The above chat shown that the changes that occurred on the seven (7) vegetation classes within the study area in the period under review (1995-2025) all vegetation classes experienced one form of change or the other due to reasons advanced earlier. More importantly is the reduction in the size of water/ wetland from 1,340 ha in 1995 to 938 ha in 2025, this can be attributed to climate change that caused drought, high temperatures and reduction of vegetation cover. Trees/ Riparian forest also decreased from 2,975 ha, in 1995 to 2,218 ha in 2025. This is due to exploitation of forest resources for fuelwood and other uses such as expansion of agricultural lands for farming.

CONCLUSION

The most important source of energy in the study area is fuel wood which is considered by many as the cheapest, this is because many families cannot afford kerosene or cooking gas for their domestic uses. This allows for illegal cutting down of trees and shrubs in an unsustainable manner all in the quest of getting energy. Fuelwood consumption in Nigeria remains significant despite urbanization, this might not be unconnected with high cost of other energy sources like kerosene, liquefied petroleum gas (LPG), and electricity. Several factors contribute to the high use of fuelwood, including affordability, limited access to alternative energy sources, and cultural practices. Several factors contributing to Fuelwood use in Nigeria include the followings: Affordability and Economic Factors: Fuelwood is generally cheaper than other alternatives like LPG or electricity, making it more accessible to low-income households. Also poverty and other socio-economic challenges drive many families to seek the most affordable energy sources hence fuelwood provides a cost-effective option. Access and Availability of Alternatives, inconsistent access to electricity and the high cost of kerosene and LPG often make fuelwood a preferred choice for cooking and heating. In many rural areas in Nigeria electricity supply is unreliable, and fuel costs are frequently high, which discourages the use of modern cooking fuels. Cultural Preferences and

Cooking Methods also contributed greatly in fuelwood use as traditional Nigerian dishes often require prolonged cooking at high temperatures, making fuelwood a preferred option for its high, steady heat, similarly, some households prefer the taste of food cooked with wood, as such cultural practices play a significant role in fuelwood usage patterns, finally Population growth and rural livelihood increase the demand for affordable and sustainable energy options, often resulting in increased fuelwood use.

RECOMMENDATIONS

Addressing fuelwood consumption in Nigeria requires a multifaceted approach that includes economic, environmental, and social interventions to shift toward cleaner energy alternatives. The followings are some of the recommended options:

1. Promotion of Cleaner Fuels: Making cleaner fuels like LPG more affordable and accessible can help reduce dependence on fuelwood.
2. Improved Cook stoves: Energy-efficient stoves that require less fuelwood could reduce wood consumption, leading to health and environmental benefits.
3. Renewable Energy Initiatives**:** Expanding renewable energy access, like solar power, can offer reliable energy and reduce over dependence on wood-based energy.
4. Community Awareness and empowerment Programs: Educational programs about the health and environmental impacts of fuelwood use, at the same time enhance economic fortunes of the rural populace can encourage people to adopt cleaner energy alternatives.
5. Strong Enforcement: Laws and policies regulating deforestation and fuelwood extraction require strict enforcement.

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