

Assessment of the Effects of Deforestation using GIS and Remote Sensing Applications in Shendam District, Plateau State Nigeria

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ABSTRACT

Deforestation is the process of removal or damage of vegetation in a region, mostly trees and shrubs, without the intention or effort of replacement through tree planting (afforestation). Forests provide many products and benefits to the people but these resources are depleted continuously without replacement.

Shendam District is geographically located between latitude 8°53'43.88"N and longitude 9°27'13.41"S in Shendam Local Government of Plateau State, Nigeria. This research presents an assessment of the nature of forest exploitation, dependence on forest resources and its effects on livelihood and the environment. The research also outlined the causes of continuing deforestation in the study area and also focused on three main effect of deforestation; biodiversity loss, high temperature, soil erosion and flooding damaging roads, culverts and bridges in Shendam District and its environs. The aim is to assess the causalities of deforestation and make suggestions for improved forest management practices that could help to reduce deforestation.

The research was a case study undertaken in the three wards (Ward A, Ward B and Pangwasa Ward) of Shendam District. Geographic Information System (GIS) and Remote Sensing Applications was used and a Landsat Thematic Mapper (TM) 30m Resolution, generated the Land use Cover Data for the years, 1994, 2004, 2014 was obtained from the Center for Remote Sensing, Jos, Plateau State and used in estimating an annual loss of 128.3hectares (2004 -2014) and 173.3 hectares (1994–2014) of forest.

The forest lost was due to anthropogenic activities in the study area. curtailing the rate of deforestation and enhancing forest regeneration in Shendam district and its environs, there is the need for forest conservation and public sensitization on the effects of deforestation, Public Private Partnership (PPP) in tree planting, Rural–Urban Afforestation Program, and the policy of cut-one-tree and plant-five trees instead, should be enforced in Shendam District. Poverty alleviation programs and Subsidy Reinvestment Program (SURE-P) entrepreneurship initiatives should be strengthened for capacity development and human empowerment. The implementation of the recommendations will help to reduce and control soil erosion, land degradation and flooding. The suggested measures will create alternative means of livelihood and reduce their over dependence on forest resource. The information obtained from the study will be useful to researchers, institutions and policy makers.

(Keywords: GIS, remote sensing, deforestation, land degradation, tree planing)

INTRODUCTION

Generally, deforestation is the process of cutting down or removal of trees in an area without replacement or without any intention of re-planting. Afforestation refers to planting new trees to replace the trees that have been cut down due to activities like farming, fuel wood collection and construction. The anthropogenic activities of humans are factors rapidly depleting trees and there by affecting the land's protective and regenerative capabilities.

According to Lee (2002), deforestation accounts for approximately 30 percent of the atmospheric buildup of carbon dioxide over the past century, and rainforests are being depleted by approximately 160,000 square kilometers annually. Theoretical thinking has for several years dominated research processes relating to deforestation. Several discussions have portrayed the Global need for a sustainable forest management, development and effective afforestation programs. The concept of sustainability ensures using the earth's natural resources in providing the needs of the present generation without compromising the needs of the future generations. Therefore, to achieve this, replacement of trees through afforestation must be embraced. With the rapid growth of the world's population many societies have been demanding more from the earth's resources and affecting its land surface at ever increasing rates.

The 1992 and 2002 Earth Summits were direct result of the Brundtland Commission which is the most successful in forming International ties and drawing the attention of government, multinational corporations, voluntary organizations, institutions, and individuals that focused on environmental protection to regain its regenerative capability in meeting the needs of the both the present and the future generation for the achievement of a sustainable living environment. The three main pillars of sustainable development are environmental protection, economic growth, and social equity, to be achieved through the use of alternative resources, renewable energy, recycling and regeneration.

Agenda 21 reinforces the importance of finding ways to generate economic growth without hurting the environment, presently leading to great improvement in a number of people willing to invest in green technologies and renewable energy world-wide. The rapid increase of Nigerian future population, still poses problems as more pressure will be on the available trees in the environment due to increasing housing constructions, fuel wood and farming activities among others. Other States in Nigeria are facing similar consequences of deforestation and this need to be addressed through sustainable measures.

STATEMENT OF PROBLEM

The highest rate of deforestation in the global world is found in the Amazon rainforest which is the second longest river after River Nile of Egypt in Africa. The Amazon rainforest covers more than a billion acres across nine (9) countries namely: Brazil, Bolivia, Peru, Venezuela, French Guiana, Guyana, Suriname, Colombia and Ecuador. (Sukanta Sarkar, 2014).

Branson (2003), stated some control measures for deforestation in Africa, emphasizing that the African deforestation problem can be solved by regulating the activity of the logging industry to reduce excesses; creation of forest protections and reserves to minimize the use of the rainforests; restructuring land ownership in Africa; and finally, controlling the population growth rate, so that less land would be needed by families, preserving even more of the rainforest. Cutting the birth rate would reduce the number of trees cut down for fuel wood. Biodiversity loss accounts for the loss of many life-saving medicines which are being destroyed in the deforestation processes (Leah, 2014).

However, the last suggestion stated above by (Branson 2003), will not work for Nigeria. Nigeria is a complex society with diverse ethnic, culture, and religious background, most especially the issue cutting birth rate for the purpose of reducing the number of trees being cut down is not possible in Nigeria. The point that Branson did not mention is afforestation or forest regeneration back-up by forest management laws and regulations, which could have been an additional solution of solving deforestation problem in Africa. Murali and Hedge (1997), only focused on the different factors of different countries influencing deforestation and they stated that it may be difficult to generalize that one factor or several factors are the most important for consideration.

However, this study focused on establishing the pattern and consumption rate of deforestation in Shendam District and its environs, with the aid of Geographic Information Systems (GIS) and Remote sensing (RS) Applications.

Since the creation of Shendam L.G.A in 1976, there has been continuous cutting of trees in Shendam L.G.A most especially Shendam District where the deforestation activities are being carried out by the inhabitants. The study seeks to identify the major actors / activities causing and increasing the rate of deforestation and its consequences on the environment. Presently only few trees exist in Shendam District and the trees are being cut down every day without replanting the trees. The few existing species of trees and animals in the environment will soon be extinct entirely, if necessary measures are not taken.

This issue and effects of deforestation in Shendam District and its environs, calls for a great concern from government, environmentalists, institutions and stakeholders for sustainable mitigation measures, for deforestation is part of the global environmental issues requiring international attention. There is the need for a comprehensive study in finding suitable measures to curb the anthropogenic activities globally. The research for this type of study is the first of its kind and forms a base for further research to be carried upon in Shendam Local Government Area and other parts of Plateau State.

AIM AND OBJECTIVES OF THE STUDY

The aim of this project is to assess the effects of deforestation activities in Shendam District using GIS and Remote Sensing. The specific objectives are to:

- i. Examine the major causes of deforestation in Shendam District.
- ii. Examine the consequences of deforestation in Shendam District
- iii. Determine the rate of deforestation in Shendam District using GIS/RS Applications
- iv. Make sustainable recommendation for improvement.

Significance of the Study

The issue of deforestation in Shendam District is continuous and a lot of trees in Shendam District are being cut down on daily basis with less regard to the effects. The benefit of this study will go a long way to provide alternative sustainable means to ensure continuity of trees in the area. The

policy of cutting a tree and planting three (3) instead, will help in regenerating trees population that will help in regulating the temperature of Shendam District and its environs. Tree provides cover for soil erosion control, retains soil nutrients, regulates environmental temperature making it conducive for living and provides food and shelter to the inhabitants. The study will serve as a roadmap for afforestation program implementation the Shendam Local Government Area. This study will form a base to other researchers in the related field to carry out further studies and to those interested in filling the gap in the study.

Scope/Limitations of the Study

The study only covers Shendam District and its environs. The study examines the various human activities in the deforestation process such as farm clearing, fuel wood harvesting, building constructions, furniture designs, logging for industrial and electrical poles purposes. Some of the species of trees that are suitable for electric pole production are no more and other tree species are extinct in Shendam District. The study was narrowed to Shendam District and its environs to enable an in-depth study of deforestation and its attendant consequences on the environment.

Data Analysis

Personal observation and the use of Geographic Information Systems and Remote Sensing Applications were used in Shendam District and its environs in establishing the rate of deforestation in the study area. The information was obtained from the Center for Remote Sensing, Jos, Plateau State using a Landsat Thematic Mapper (TM) 30 meter resolution in obtaining the land use cover data for the years, 1994, 2004, 2014 at ten year intervals.

CONCEPT OF THE STUDY

Causes of Deforestation

The deforestation taking place in the African rainforests has many causes, including logging, which is responsible for 20 to 25 percent of the

deforestation, cattle ranching, cash crops, construction, population growth, economic development, clearing for cultivation, and by government policy (Branson, 2003).

About 60 percent of deforestation in Africa is due to conversions of commercial and subsistence agricultural lands. In Africa, 90 percent of the population uses wood for fuel. Wood is used in Africa for 52 percent of all energy sources. The deforestation in Africa is a major contributor to global warming, erosion, annual flooding and medicinal compound/food shortage in Africa (Branson, 2003). Joel (1991) stated that forest plays a significant role in the overall balance of carbon content in the atmosphere and forest carbon sequestration can reduce the accumulation of greenhouse gases in the atmosphere.

Effects of Deforestation

Deforestation is among the global environmental challenges affecting the whole world and it requires concerted responses from the international community to address such problems that is affecting every nation and causing a

serious adverse long term effect on the lives and health of the populations. The eradication of millions of species and the depletion of the rainforest is occurring at such a rapid rate that scientists predict that 42 percent of the region will be totally deforested by 2020 (Roads, 2001).

Disregard of ascribed value, lax forest management and deficient environmental laws are some of the factors that allow deforestation to occur on a large scale. In many countries, deforestation, both naturally occurring and human induced, is an ongoing issue.

Deforestation causes extinction, changes to climatic conditions, desertification, and displacement of populations as observed by current conditions and in the past through the fossil record. More than half of all plant and land animal species in the world live in tropical forests. The tropical rainforests are the most diverse ecosystems on Earth and about 80% of the world's known biodiversity could be found in tropical rainforests, removal or destruction of significant areas of forest cover has resulted in a degraded environment with reduced biodiversity. (Marlon Henkel, 2015).



Plate 1: A Street in Shendam District without Trees. Source: (Field Survey 2014)

Fuel Wood Collection

In the West Africa sub-region: in Nigeria, Togo, Zambia, Tanzania and Uganda, several cases of illegal exploitation of wood and forest products have been reported (Uchegbu, 2002). The creation of forest reserves in Ghana for example has generated much local opposition (FAO, 2006). Such opposition was responsible for the delay in the passage of the proposed forestry laws in late 1900, a time by which significant damages had been done to the country's forest estates.

Population growth in developing countries during the 1970s and 1980s led to substantial encroachment on forests throughout the tropics (Hiemstra-van, derHorst, and Hovorka 2009). Beginning in the mid-1990s, however, researchers began to study the "fuel wood crisis" and discovered that for the most part of the world. Although fuel wood is part of the major drivers of deforestation on a global scale, it can have significant effects at the local level (FAO 2010).

Wood fuels have long been a major source of energy and are expected to remain so for some time. Fuel wood use is expected to remain relatively level over the next 20 years, while charcoal use is expected to increase considerably. This increase in charcoal demand correlates with the expected increase in urbanization, as urban dwellers use more charcoal than rural ones.

The effects of fuel wood does not only differ among regions, but also vary among other sources of fuel types, such as the use of charcoal being a problem in some areas creating a different effects from the industrial fuel wood in other part of the regions. Across the tropics about 1.4 billion cubic meters of fuel wood are used each year and around 40 million metric tons of charcoals are produced. Based on a wood-to-charcoal conversion rate of between 8 and 17, the global charcoal supply in tropical countries is between a quarter and a half of the fuel wood supply and these numbers vary greatly by region how fuel wood is collected and used (Plates 2-5).



Plate 2: Participation of Men in Deforestation (Sheanut Tree). Source: (Bernice, 2011).



Plate 3: Women Carrying Fuel Wood in the African Rift Valley, Kenya. (Source- Girard 2002)



Plate 4: Collecting Fuel wood in Basankusu, Democratic Republic of Congo. (Source- Girard 2002)

For most regions of the world large commodity agriculture is the major driver of tropical deforestation. However, in Africa the importance local actions like wood fuel collection have in relation to land use change is higher. Particular attention has been paid to fuel wood use in the

semi-arid tropical regions of Africa (Sahel and savanna), since for many years fuel wood collection fuel wood, charcoal usually comes from trunks or large limbs and requires cutting trees (Girard 2002).



Plate 5: Gbagyi Women Carrying Fuel Wood in Abuja, Nigeria. (Source: Jim, 2013)

In Nigeria, the situation relating to deforestation looks pathetic as the most vulnerable groups in the society (female/poor solely depend on the forests for the supply of their fuel wood (Hagan, 2006). Ocholi (2007) described the condition as a form of drawback with pronounced consequences on future generation.

Significance of Forest Conservation

The resources of the Amazon include the tree and animal life. The plants of the Amazon have provided greatly in terms of medicinal compounds, and are expected to contribute far more in the future, and the possibility of getting life-saving compounds for cancer, Acquired Immune Deficiency Syndrome (AIDS) and Ebola. However, the greatest resource of the Amazon rain forest is its contribution to the world's oxygen supply.

The Amazon rain forest is so massive but is being affected by high rate of deforestation for farming / logging purpose and burning, consuming an estimate of 28 million acres per year, burning by itself contributes 20 percent of the carbon dioxide

in the atmosphere, resulting to global warming (Richard, 2007).

In many parts of the world, especially in East Asian countries, reforestation and afforestation are increasing the area of forested lands. The amount of woodland has increased in 22 of the world's 50 most forested nations. Asia as a whole gained 1 million hectares of forest between 2000 and 2005. Tropical forest in El Salvador expanded more than 20% between 1992 and 2001.

Based on these trends, one study projects that global forest will increase by 10%—an area the size of India by 2050. In the People's Republic of China, where large scale destruction of forests has occurred, the government has in the past required that every able-bodied citizen between the ages of 11 and 60 plant three to five trees per year or do the equivalent amount of work in other forest services. The government claims that at least 1 billion trees have been planted in China every year since 1982, and March 12 of every year in China is the Planting Holiday. (Chaitanya, 2009).



Figure 1: The Countries of the Amazon. Source: Amazonia Blog (2014)

Forests conservation is very important and it plays a significant role in the ecosystem as different species of plants and animals use them as habitats. Forests also serve as green frontier for mankind since creation. Trees play a vital role in regulating our atmosphere, ecosystem and weather systems and they recycle carbon dioxide and the accumulation of carbon dioxide in the atmosphere contributes to global warming. The trees help in releasing moisture to the air regulating local and global climate which also contributes to rainfall. The trees also nurture traditional cultures by giving shelter, food, wood, medicine, reduced soil compaction and improves soil fertility. These benefits are lost when the trees are destroyed.

THE STUDY AREA AND METHODOLOGY

The Study Area

The natives of Shendam are the Goemai and the Goemai Kingdom originated from the Kwararafa Kingdom, with its cultural activities similar to that

of the Jukun in the former Gongola State but now in Taraba State. Prior to the advent of European influx, Shendam was said to be under the Muri-Province with its headquarters at Ibi. After the creation of Plateau State in 1967, Shendam Local Government Area was created in 1976 with its headquarters in Shendam District and other local governments that were created out of Shendam Local Government Area are Langtang, Quan pa'an, and Mikang Local Government.

According to the 2006 population census Shendam Local Government has a land mass of 2,477Km² with a total population of 208,017 (109,519 males and 97,498 female) about 2.27% of Nigerian population. Shendam Local Government is under the ruling of the Long Goemai (Chief) with his Palace located in the Shendam District (Plate 7). The Chief has four districts under his jurisdiction namely; Shendam District, Dorok District, Derteng District and Dokan Tofa Districts. Shendam District (study area) has three wards namely Shendam Ward A, Shendam Ward B and Pangwasa Ward, all with a population of 61,310 (2006 NPC).

Location

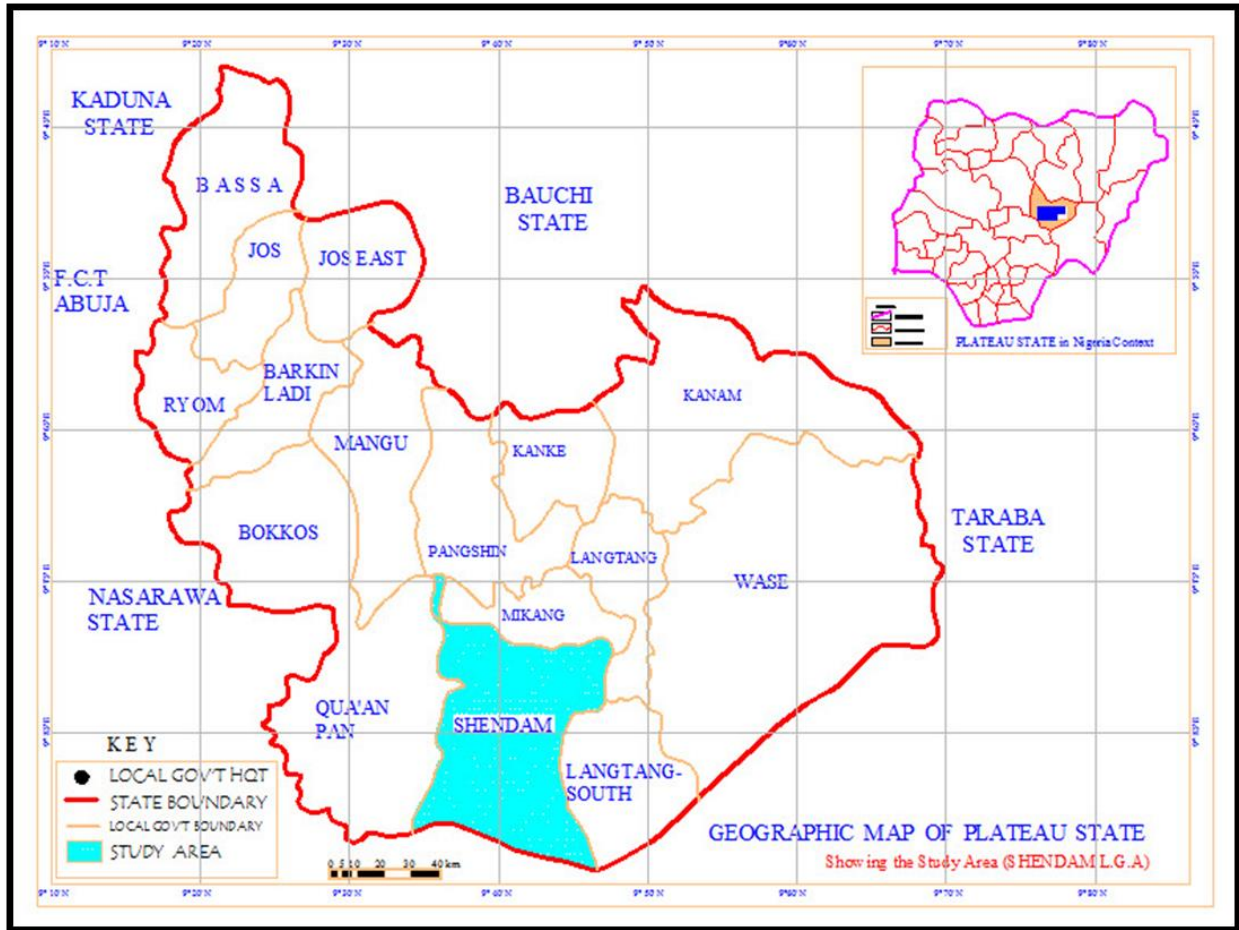
The geographical location of Shendam District is between latitude 8°53'43.88"N and longitude 9°27'13.41" E of the prime Meridian, covering about (12,335 Hectares) 123.35 Km² out of (247,700 Hectares) 2,477 Km² of the entire Shendam Local Government Area, in the low land area of Plateau State. The Local Government

Area shares common boundaries with Qua'an Pan Local Government Area to the West, Mikang L.G.A. to the North and Langtang South to the East. It also shares boundaries with Ibi Local Government Area of Taraba, and Awe Local Government of Nasarawa State to the South and South West respectively. The area in question is located in the Guinea savanna region of Nigeria (Figures 2 - 4 and Plates 8-10).



Latitude 10° 00' N, Longitude 8° 00' E
 Source: Plateau State Ministry of Lands and Survey, 2014

Figure 2: Nigeria showing Plateau State.



Latitude 9° 10' 0"N Longitude 9° 45' 0" E
 Source: Plateau State Ministry of Lands and Survey, 2014

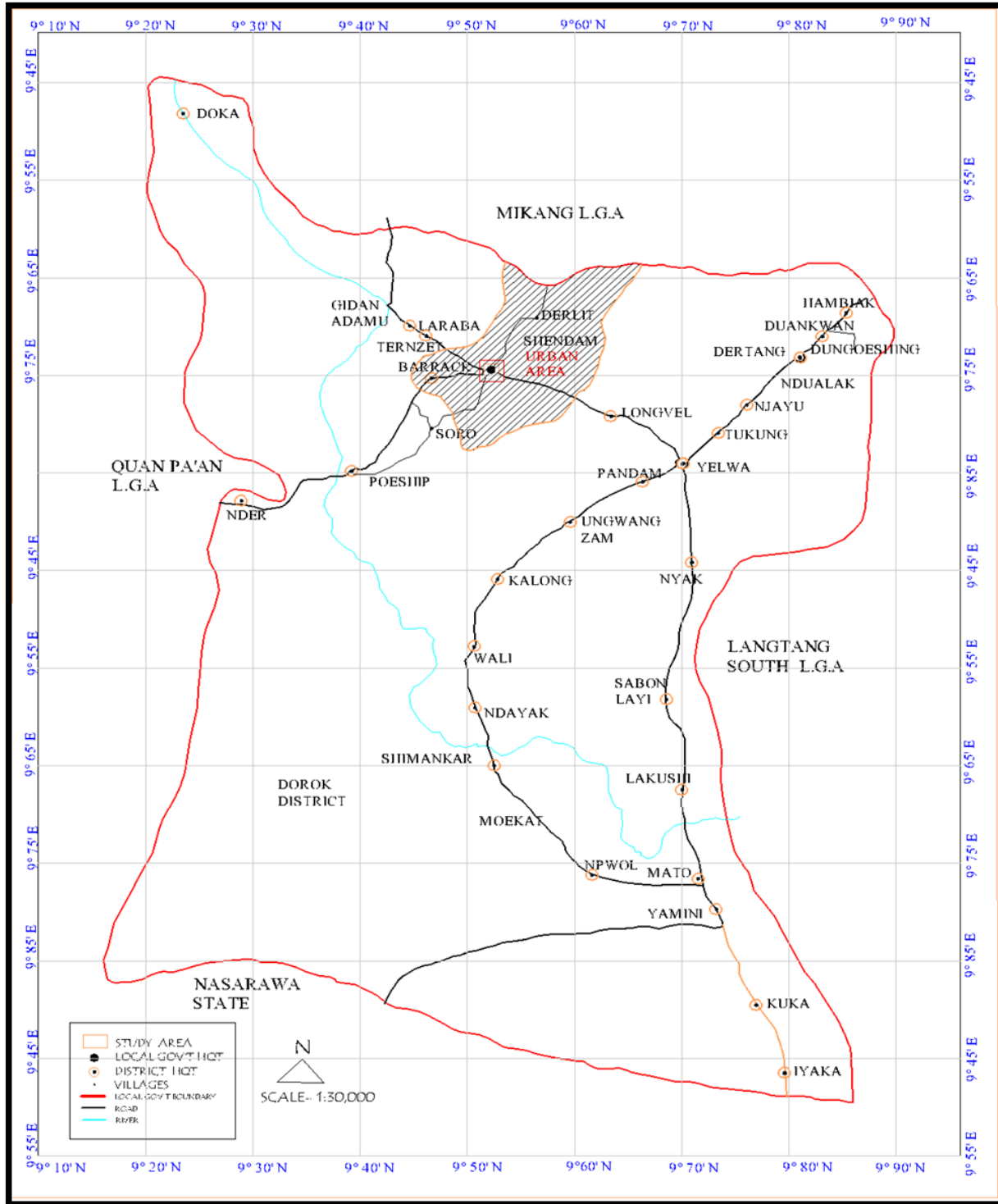
Figure 3: Plateau State showing Shendam Local Government Area (L.G.A.)

Topography

Plateau State has an elevation of about 1500m – 1800m which descends gradually in a series of steps to the low land area of plateau where the study area is located within the plains of River Benue. The terrain is relatively flat with few dispersed mountains. The study area has a dam located close to a big mountain known as Pangwasa Hill, which supplies water to the inhabitants of Shendam District and it is also the main source of River Cong- Hess. (Source: Uriah, Ezekiel, Tochukwu and Jesse 2014).

Geology

The major basement rocks are granite, basalt and magmatides. The basement rocks found at 1702 meters deep below the ground surface. Other are sedimentary and metamorphic rocks in the Precambrian beds, the ground level contains water (Aquifer). The soil are ferruginous soils (ferrisols), gravel and sandy loamy soils which is suitable to withstand heavy construction and well fertile for Agriculture activities. (Source: Lar Uriah et al. 2014).



Source: Plateau State Ministry of Lands and Survey, 2014
 latitude 8°53'43.88"N and longitude 9°27'13.41" E

Figure 4: Shendam Local Government Area showing Shendam District.



Plate 6: Satellite imagery of Shendam District. Source: Google Earth (2014)



Plate 7: The Long Gamai Palace in Shendam. Source: (Field Survey 2014)



Plate 8: Commercial Activities along the busy street in Shendam District. Source: (Field Survey 2014)



Plate 9: Scanty Trees in Shendam District. Source: (Field Survey 2014)



Plate 10: Huge Hectares of forest Land cleared by farmers in Shendam. Source: (Field Survey 2014)

Climate

In Nigeria we have two seasons namely: the dry season and the wet season. The dry season occurs during Harmattan period which is dry and dusty blowing from Sahara Desert from the month of November to March, mostly experienced in the northern part of Nigeria. The wet season (rainy season) starts from the month of April to the month of October. (Source: <http://en.climate-data.org/location/399975/>).

Rainfall

The rainy season is from April to October, Shendam has an annual rainfall variation between 1000mm to 1450mm with an annual mean of 1250mm. However, the rainy season in Shendam commences from the month of March which increases gradually to the peak in the month of August and further declines gradually to October. (Source: <http://en.climatedata.org/location/399975/>).

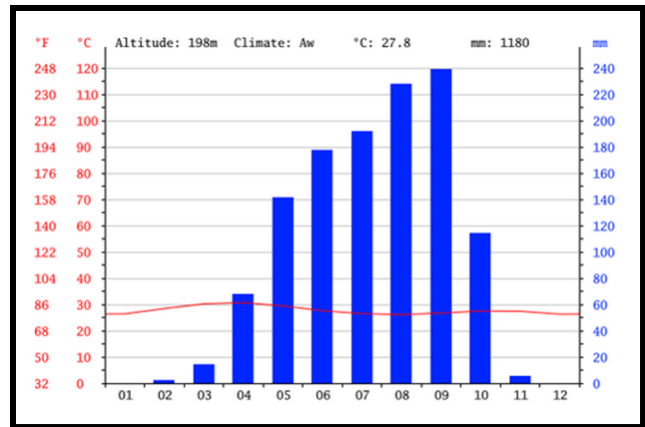


Figure 5: Temperature and Rainfall Graph of Shendam Local Government Area.

(Source: <http://en.climate-data.org/location/399975/>, 2014)



Plate 11: Collapsed Shendam Bridge. Source: (Buba Y. Alfred 2012)



Plate 12: Bridge linking other Villages. Source: (Buba Y. Alfred 2012)



Plate 13: Trees being destroyed by Flood. Source: (Buba Y. Alfred 2012)

Table 1: Popular Tree Species in Shendam District.

Tree Species	Causes of Change	Types of Change	Use
Ebony (<i>Diospyros spp</i>)	Deforestation	Decreasing	Wood carving
Mahogany (<i>Khaya spp</i>)	Over exploitation	Nearly extinct	Timber, Medicinal
Neem (<i>Azadirachta Indica</i>)	Over exploitation	Decreasing	Timber, Medicinal,
Doka (<i>Isoberlinia spp</i>)	Deforestation	Nearly extinct	Bio-pesticide, fuel wood.
Sheanut (<i>Vitellaria paradoxa</i>)	Deforestation	Nearly extinct	Fruit, fuel wood
Cassia spp (<i>Locus bean</i>)	Deforestation	Nearly extinct	Fuel wood, fruit, Medicinal
Mango (<i>Mangifera indica</i>)	Deforestation	Nearly extinct	Fuel wood, fruit, shade
Oil Palm(<i>Elaeis guineensis</i>)	Deforestation	early extinct	Fuel wood, fruit, shade Food, Brum

Source: (Field Survey 2014)

METHODOLOGY OF THE STUDY

Primary Sources of Data

Three sets of satellite raw imagery of Shendam District for 1994, 2004 and 2014 were acquired from the National Center for Remote Sensing using Land-sat Thematic Mapper at 30 meter Resolution.

Secondary Sources of Data

The secondary sources involves review of literature, published/ unpublished dissertation, Journal publications, conference papers, Google earth, internet, population data, base maps and information from the Shendam Local Government.

Software used for the Study

The software used for this study involves Global Positioning System (GPS), Geographic Information System and Remote Sensing Applications tools/ softwares such as ArcGis 10.0, ILWIS 9.3, ERDAS Imagine 9.1, IDRISI Andes, Global Mapper, Snagit 10.0, Microsoft Word and Excel.

Data Presentation and Analyses

The data are presented in histograms, bar charts, figures, plates, imageries and tables using descriptive method of statistics.

Population of Shendam L.G.A and Estimation for 2014

The study involves the use of population data for 2006 NPC Population (61,310 at Growth Rate 3.0%) as the base year population for year 2006 to obtain the estimated population for 2014 of Shendam District.

Population Projection formula $P_2 = P_1 (1+r)^n$
(Source: Jennifer H. L. et al. 2007)

P_1 (Previous year population) = 61,310 (2006 NPC)

P_2 (Present year Population) = ? (2014)

r (Growth Rate) = 3.0%

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<http://www.akamaiuniversity.us/PJST.htm>

n (Number of years) = 8 years (2006 – 2014)

$P_2 = P_1 (1+ r)^n$

$P_2 = 61,310 (1+ 0.03)^8$

$P_2 = 61,310 \times 1.26677008139$

$P_2 = 77,665$ Approx. Projected Population 2014.

RESULTS AND DISCUSSION

The three set of imageries for 1994, 2004 and 2014 were used and analyzed using time series analysis to establish the rate of changes over time in Shendam District.

Rate of Deforestation in the Study Area

The indiscriminate cutting down of trees in Shendam District and its environs without any effective tree management policy or regulations to control the human activities in the study area, has destroyed a lot of tree species making the area prone to erosion. Landuse Cover Map of Shendam District from 1994, 2004 and 2014 using Geographic Information Systems (GIS) and Remote Sensing Applications was carried out to estimate the rate of deforestation in Shendam. From the analysis, about 173.3 hectares of forest is lost annually (1994 - 2014) in Shendam District and its environs (Figures 6 - 14).

Landuse Cover Analysis of Shendam District and Environs

Deforestation activities have been in existence over a long period of time in Shendam District but the rate of deforestation was minimal in those days. Figure 6 shows the Landuse Cover nature of Shendam District and its environs in 1994 through the use Landsat Thematic Mapper at 30m Resolution. The imagery shows that Shendam District was mostly covered with green representing forest (39.3%) and shrubs (31.9%), followed by farmlands (20.8%) scattered all over the Shendam District. Baresurfaces (0.0%) was not visible, the water body ((4.8%) was much visible at the dam and was higher than the settlement (3.2%). During the period there was less farming activities, less construction and less population (Figure 7).

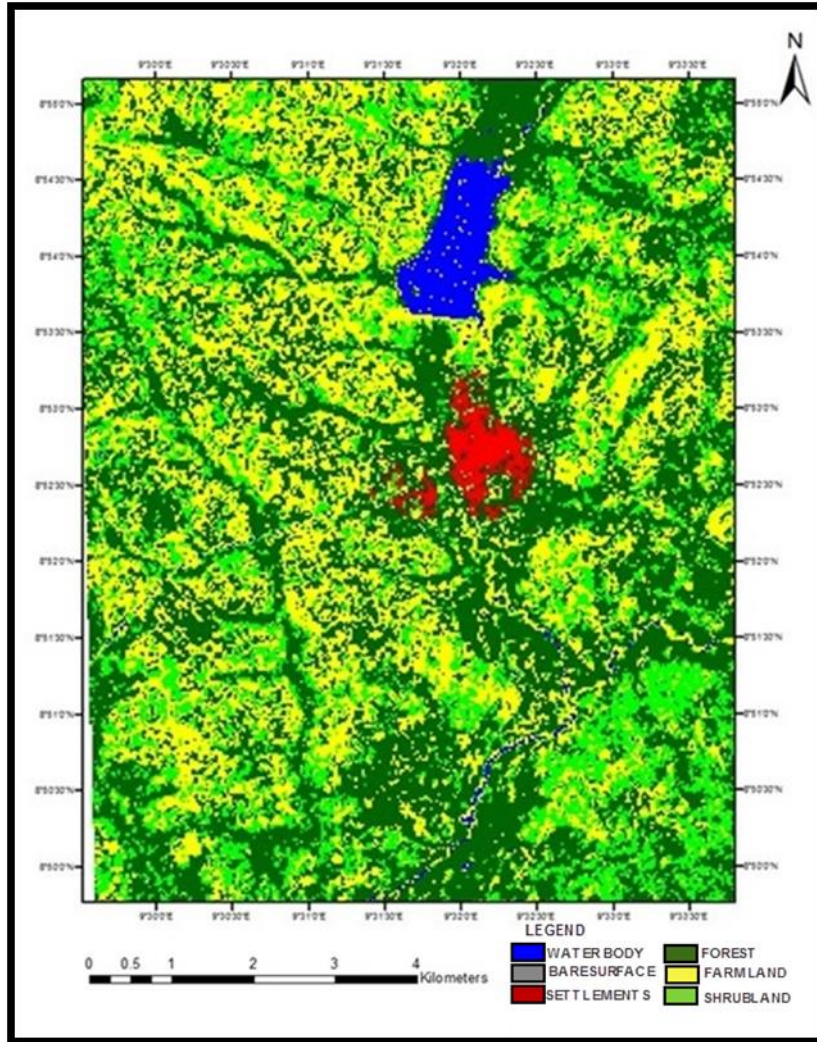


Figure 6: 1994 Landuse Cover of Shendam District and its Environs.
(Source: Center for Remote Sensing Jos, Plateau State 2014)

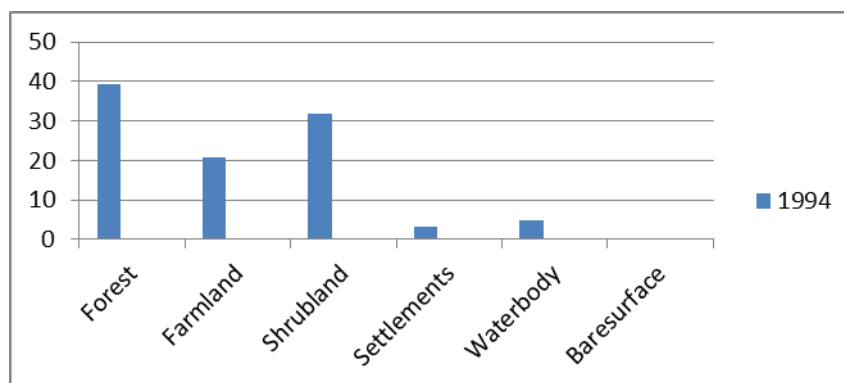


Figure 7: Landuse Analysis of Shendam District in 1994
(Source: Center for Remote Sensing Jos, Plateau State, 2014)

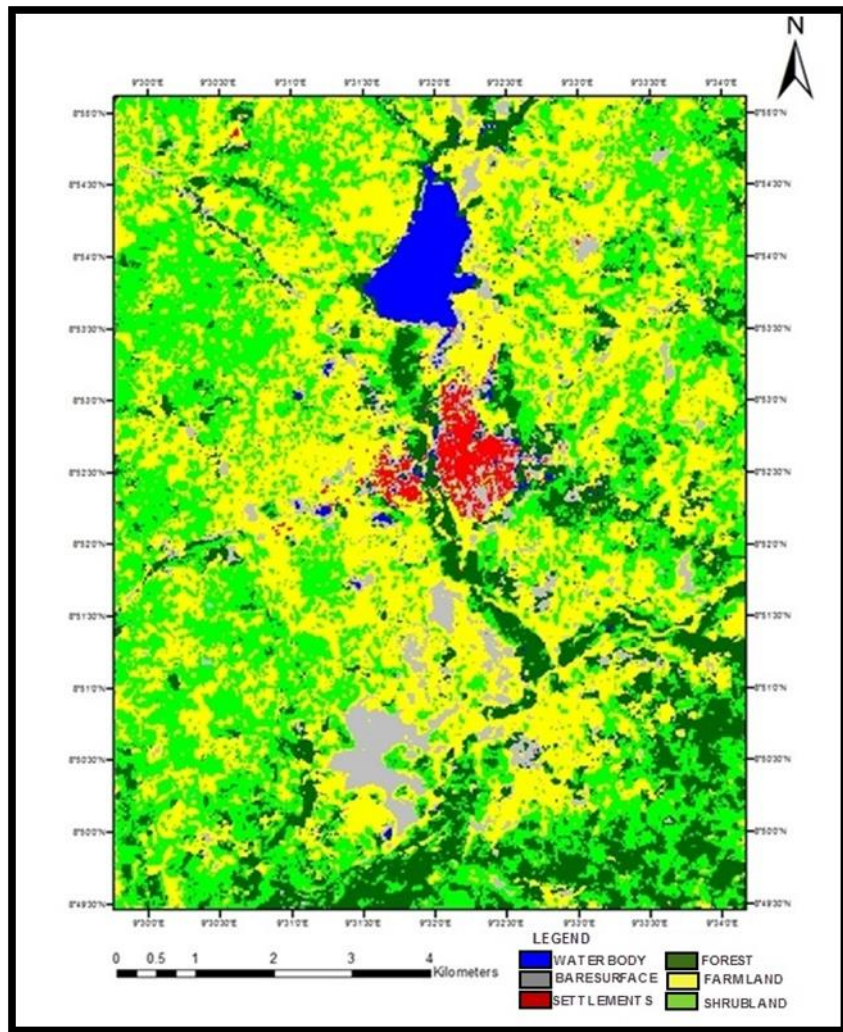


Figure 8: 2004 Landuse Cover of Shendam District and its Environs.
(Source: Center for Remote Sensing Jos, Plateau State, 2014)

From the imagery of 2004 shows decrease in the green color signifying increase in deforestation, cutting down of trees for farming activities or farmland expansion and for fuel wood collection due to population increase and increase in demand. The landuse Analysis shows that forest has decreased to (21.6%) due to deforestation, waterbody decreased to (4.5%) due to evaporation and increased demand of water by the increasing population. The percentage increase was on shrubland (32.4%) The cleared trees creates way for shrubs grow and be visible (indicated in light green colors), Farmland also

increased to (27.0%) due population increase and demand, Settlement increased to (5.2%) due to population increase and constructions, Baresurface increased significantly form (0.0% to 9.3%) due to infertile farmland that were left to regain its nutrients in the process known as shifting cultivation (Figure 8).

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The 2014 landuse imagery shows continuous decrease in the green from 1994 to 2014 signifying a high rate of deforestation in Shendam District and its environs. Forest decreased significantly to (11.2%) due to continuous and increasing rate of deforestation in Shendam District as a result of population increase (birth, migration), farming, fuel wood collection, unemployment, furniture works and construction (of houses, schools, office complexes, roads), (Figures 10 and 11).

Farmland increased to (38.1%) due to population increase, the unemployed engaged in farming to earn income and migrants from upper Plateau come to Shendam District and engaged the farming activities through leasing, hired or borrowed farmlands.

Shrubland also decreased to (25.6%) due to farming and construction activities while the Settlement increased significantly within the short period due to population increase through birth, migration of people as a result of increased Government establishments/transfer, increased Commercial activities which creates the needs for the construction of houses, offices and schools in Shendam District. Some settlements emerged over time and scattered all over Shendam District in the form of farmhouses, hamlets and small communities, represented with red color on the imagery.

The decrease in the waterbody was insignificant (4.3%) while the baresurface land also decreased to (7.5%) because some baresurface land scattered within the district regained their nutrients and allowed plants to grow while other baresurface land were part of construction land (Figure 12 and Table 2).

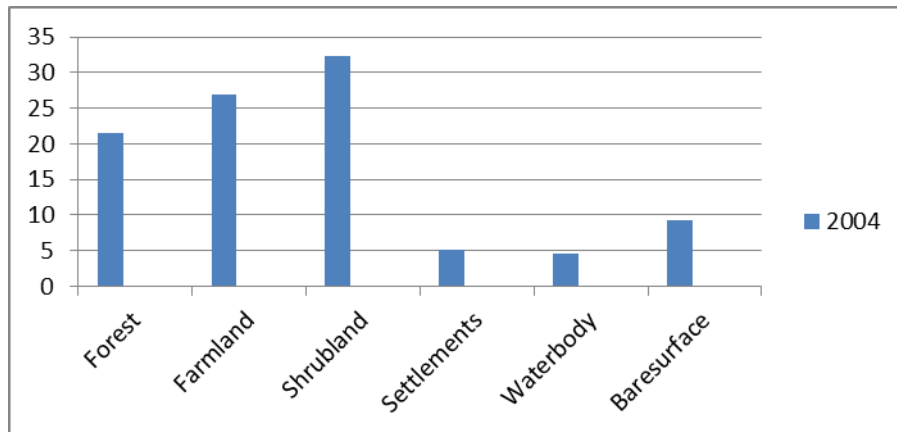


Figure 9: Landuse Analysis of Shendam District in 2004.
(Source: Center for Remote Sensing Jos, Plateau State, 2014)

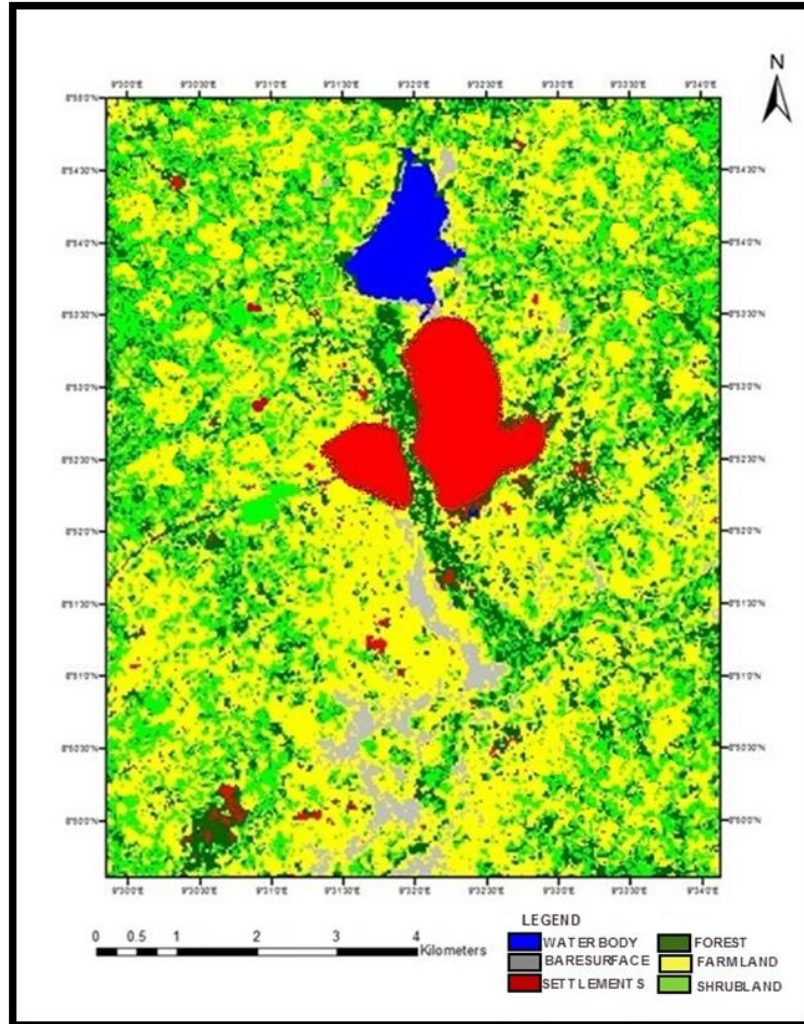


Figure 10: 2014 Landuse Cover of Shendam District and its Environs.
 (Source- Center for Remote Sensing Jos, Plateau State, 2014)

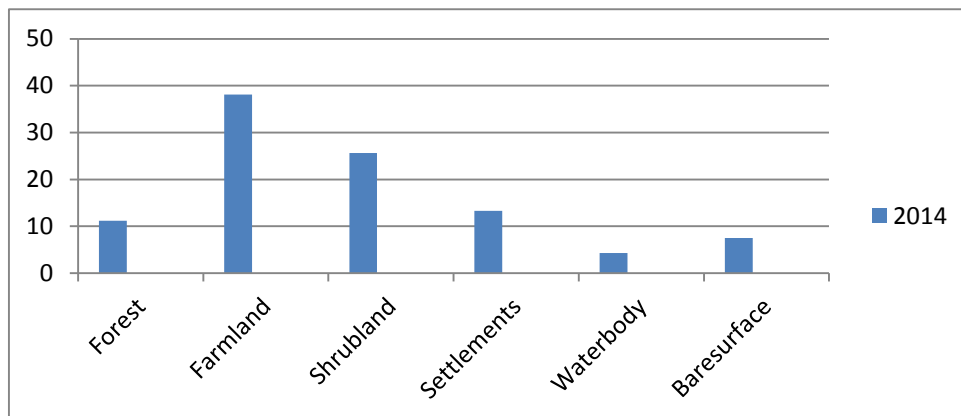


Figure 11: Landuse Analysis of Shendam District in 2014
 (Source: Center for Remote Sensing Jos, Plateau State, 2014)

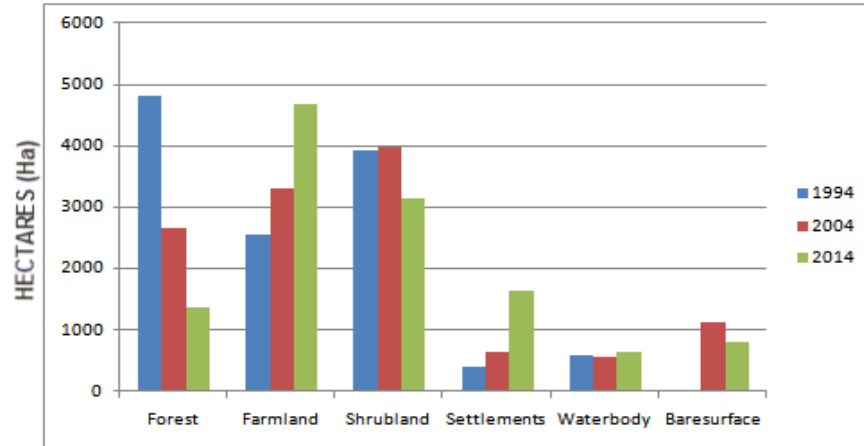


Figure 12: Shendam District General Landuse Analysis of 1994, 2004 and 2014. (Source: Center for Remote Sensing Jos, Plateau State, 2014)

Table 2: Shendam District Landuse Analysis of 1994, 2004 and 2014.

Class Name	1994		2004		2014	
	Hectare	%	Hectare	%	Hectare	%
Forest	4,847.7	39.3	2,664.3	21.6	1,381.5	11.2
Farmland	2,565.7	20.8	3,330.5	27.0	4,699.6	38.1
Shrubland	3,934.9	31.9	3,996.5	32.4	3,157.8	25.6
Settlements	394.7	3.2	641.4	5.2	1,640.6	13.3
Waterbody	592.0	4.8	555.1	4.5	530.4	4.3
Baresurface	0.0	0.0	1,147.2	9.3	925.1	7.5
Total	12,335.00 Ha	100	12,335.00 Ha	100	12,335.00 Ha	100

(Source: Center for Remote Sensing Jos, Plateau State, 2014)

Calculating the Rate of Deforestation in Shendam District and its Environs

More emphasis is given to forest, to get an estimate of forest lost in shendam and its environs from 1994-2004-2014 Landuse cover data.

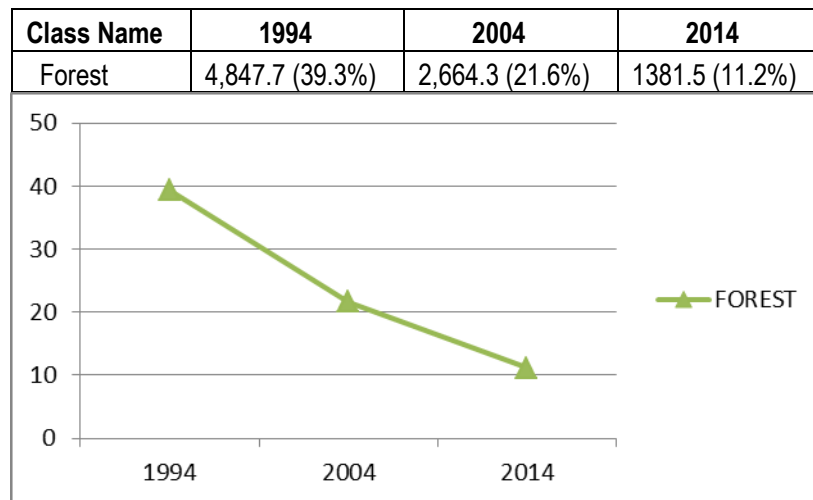


Figure 13: Forest Decrease in Shendam District from 1994 – 2004 – 2004. (Source: Center for Remote Sensing Jos, Plateau State, 2014)

1994 - 2004 = 4,847.7 Ha – 2,664.3 Ha = 2,183.4 ha divided by 10 years to arrived at 218.3 Ha lost annually within the period.

2004 – 2014= 2,664.3 Ha - 1,381.5 Ha = 1,282.8 Ha divided by 10 years to arrived at 128.3 Ha of forest lost annually within the period.

1994 – 2014= 4,847.7 Ha - 1,381.5 Ha = 3466.2 Ha divided by 20 years to arrived at 173.3 Ha of forest lost annually within the period.

(Source: Center for Remote Sensing Jos, Plateau State, 2014)

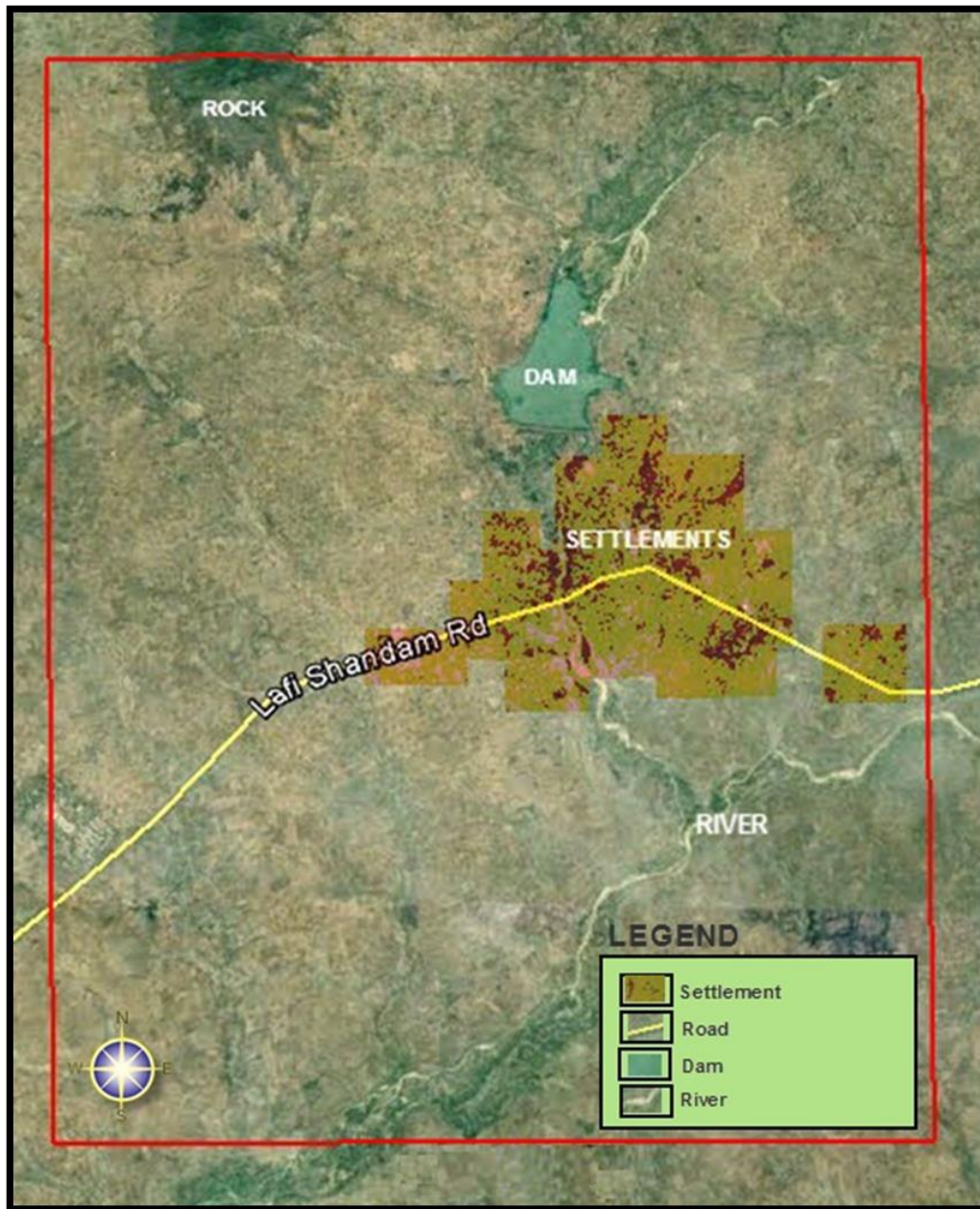


Figure 14: The Study Area Showing the Scope and its Present Nature
(Source: Google Earth Satellite Imagery 2014)

CONCLUSION

The study clearly revealed indiscriminate cutting down of trees in Shendam District and its environs. The Land Use Cover Map of Shendam District and its Environs from 1994-2004-2014, obtained from the Center for Remote Sensing revealed an approximated value of 128.3 hectares (2004 -2014) and 173.3 hectares (1994–2014) of forest lost annually, within the period. The process of deforestation in Shendam is continuous on daily basis, and the few scanty species of trees will soon be extinct if sustainable measures are not applied.

This study further clarified and revealed the factors responsible for deforestation in Shendam District and its environs. They are individuals / government sponsored projects which require clearing more land, poverty related issues and population growth. Others are livelihood activities such as farming, construction, charcoal and fuel wood collection are the principal socio-economic factors impacting the quality of the forest and reducing the number of trees. These factors are deeply rooted in the daily needs of communities, in search of forest products that cater for the growing population, rather than awareness of forest resources depletion and its consequences. The irreversible loss of these natural resources and the ignorance of the resulting effects of deforestation, destructive processes or consequences in the environment is more than the social and economic gains. The application of sustainable measures coupled with public awareness will correct the anomaly, to make Shendam District and its environs sustainable.

RECOMMENDATIONS

From the conclusion, there is need for sustainable measures to address the means of livelihood, identified and implemented in Shendam, such as alternative sources of energy, sustainable farming practices, diversification of income sources and good governance for the benefit of all the youth and the marginalized members of Shendam. Further recommended means are:

- There should be Rural/Urban Afforestation Programmes equipped financially to carry out tree planting and also educate the people on the

significance of tree planting in the urban centers and villages.

- The afforestation policy of cut one-plant five trees should be enforced and rewards system for environmental services should be implemented for compliance and partnerships and co-operation among stakeholders on overall management.
- Promote agreement among stakeholders on the need for forest protection/ conservation and also strengthen enforcement capacities on National forest law and regulations, made known to the general public with no exemption; that offenders will be fined and punished accordingly.
- The governments should train/employ more staff in forest management and formulate policy measures on forest management.
- Poverty Alleviation Programmes (PAP) should be strengthen and embrace Subsidy Reinvestment Programme (SURE-P) Entrepreneurship Initiatives for human empowerment should reach the local governments, since poverty is a major cause of deforestation and the result is biodiversity loss, efforts should be made to satisfy the basic needs of the people.
- The government should provide stable electricity readily accessible and affordable by the community through public private partnership (PPP), to control the use of fuel wood.

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