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Effects of World Bank Afforestation Projects for Combating Desertification on Land use Land Cover Changes

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Abstract: ***After the United Nation Convention on Desertification (UNCD) in 1977 which was preceded by extensive, Regional, Local studies and consultations with numerous scientists, decision makers and relevant institutions. Global Plan of Action to Combat Desertification (PACD) was formulated, endorsed by member Countries. The role of implementing PACD was vested with Governments of Countries affected by desertification. The Federal Government of Nigeria as a signatory and World Bank funded and implement afforestation project aimed at combating desertification between 1988 and 1999. This research therefore applied Remote Sensing techniques to assess the effectiveness of the project. To achieve that a small portion of about 143,609 hectares was curved out from the project area. Normalized Difference of the Vegetative Index (NDVI) and Land Use Land Cover were derived from Landsat TM 1986, Landsat ETM 1999 and Nigeria Sat 1 2007 of the project area. The findings show that there were increase in cultivated area due to the project from 1986 through 1999 and 2007. This is further buttressed by the three NDVI imageries due to their high positive pixel value from 0.04 in 1986 to 0.22 in 1999 and to 0.32 in 2007 These signifies the gradual physical development of Afforestation project in the area. In addition it was also verified by histograms of changes in vegetation which indicted an increased in vegetative cover from 60,192 in 1986, to 102,476 in 1999 and then to 88,343 in 2007. The study concluded that Remote Sensing approach has actually confirmed that the project was indeed successful and effective.***

Keywords: Afforestation, Desertification,Land Use, Land Cover,Vegetation

1. Introduction

It has been established that about 3.6 billion or 70% out of 5.2 billion hectares of potentially productive dry land are presently threatened by various forms of land degradation or as it is called desertification, directly affecting the well-being and future of one sixth of the world population [1]. Recurrent drought is a persistent natural menace in these areas which is accentuated by in balance management of natural resources [2] The term "Desertification" has been in use since at least 1949 when Aubreville, a perceptive and well informed botanist and ecologist, published a book on *"Climate, forets, et desertification de l'Afrique tropicale"* [3]. Aubrreville sees desertification as a changing of productive land into a desert as the result of ruination of land by man induced soil erosion. He associated it with humid and sub humid tropics where he worked. The extent of accelerated soil erosion induced by indiscriminate felling and burning of forest and woodland in Africa and changes in the soil-water budget and hydrological cycle were understood as some of the factors leading to land degradation. There was also a growing recognition of the part played by human activities and climate changes such as prolonged or frequent droughts aggravating land degradation. This led to formally defining desertification as "land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities" [4], The process involves the loss of physical, biological and economic productivity and complexity of croplands, pastures, and woodlands, due to climate variation and unsustainable human activities. The most commonly cited forms of unsustainable land use are over cultivation, overgrazing, deforestation, and poor irrigation practices. 70% of the world's dry lands (excluding hyper-arid deserts), or some 3,600 million hectares, are degraded According to the United Nation's Convention to Combat Desertification [5]. It is also estimated that over 250 million people are directly affected by desertification. Similarly one billion people in over 100 countries are at risk of desertification. Studies have shown that out of the world land surface area, 6.1 billion hectares is dry land, out of which 1 billion hectares is naturally hyper-arid desert. The rest of the dry land has been threatened by desertification. One quarter of the world's population are in the dry lands and depend on the area for their livelihood. Desertification threatens the livelihoods of one billion people and has already made 135 million people homeless and every year desertification generates income losses totaling USD 42 billion [6].

The extent and severity of desertification in Nigeria has not been fully established neither the rate of progression properly documented. Nevertheless, there is a general consensus that desertification is by far the most pressing environmental problem in the dry lands parts of the country. Therefore monitoring of desertification is necessary.

2. The Menace of Desertification in Nigeria: an Overview

The dry land of Nigeria (Northern Nigeria) is dominated by undulating plain at a general elevation from about 450m to 700m. More than half of the region is covered by ferruginous tropical soils which are highly weathered and markedly laterised. A large proportion of the region is also characterized by sandy-fixed undulating topography. The sandy soil is usually low in organic matter, nitrogen and phosphorus and may degrade rapidly under conditions of intensive rainfall [7]. When over-use occurs in this generally sandy environment, denuded patches may appear when the wind-blown sand becomes mobile.

Figure 1: Map of Africa Showing Nigeria and the Study area

Average annual rainfall in dry land of Nigeria varies from 500mm in the north-eastern part to 1000mm in the southern sub-area, but it is unreliable in many parts. Unpredictability and unreliability characterize the pattern of rainfall. As in other arid and semi-arid areas of the world, it is not just the total amount of rainfall that is important, but the timing and distribution. In this respect, the pattern of rainfall in the region is highly variable in spatial and temporal dimensions with an inter-annual variability of between 15 and 20 percent.

The nature of rainfall in the region supports mostly savannah vegetation. Thus, apart from some relic forests in low lying ground along the southern boundary, the whole region is covered by savannah vegetation consisting of Southern Guinea Savannah, Northern Guinea Savannah, Sudan and Sahel with the density of trees and other plants decreasing as one moves northwards. Because of its generally low and variable biological production, the savannah ecosystem of the dry land in Nigeria is very sensitive to human and animal population pressure. In addition to high inter-annual variability, the rainfall regimes of dry land of Nigeria are characterized by high concentration in a few months, intermittence and violence of storms. Thus the region is, by nature, prone to recurrent and sometimes intense and persistent periods of drought. [8]

During extended dry periods, the land is under increased stress from both humans and livestock, and this may be severe enough to cause severe damage to the environment. Once the precarious equilibrium of the plant communities adapted to the characteristically variable climate is upset by persistent drought, complete ecological recovery may be impossible, even when the rains return. The high water deficit associated with this zone has compelled municipal, state and federal governments to explore and exploit groundwater sources which are more available in the zone than surface water as hinted earlier. Currently, the extraction of groundwater through boreholes and hand-dug wells is tapping one or more of the aquifers underlying the area. However, there is the general fear that there will be over-pumping of groundwater and thus the water table of the area will be low. For example, [9] recorded a decline of 6.5 m in the mean groundwater level, measured from a concrete well in Maiduguri, between 1963 and 1972. In the same period, a decline of 1.5 m was recorded in the dynamic level from boreholes in Dalori area of Maiduguri. Also, the soils in most part of the dry land, though well drained, are sandy, low in soil organic matter and are characterized by low water holding capacity as cited earlier. The only exception to this observation is the Fadama soil which is fine-textured with a higher organic matter content and water-holding capacity. Furthermore, this zone is the most grazed and recorded high drought incidence that led to changes in plant species, such as the invasion of the Kano area (Sudan) by thorn bushes native to the Sahel. It is also the zone where farmers have encroached on grazing reserves and climatically marginal areas, leading to increased incidence of pastoralists-farmers conflict and desertification. Moreover, in terms of human activities, the dry land areas of Nigeria have been inhabited and cultivated for centuries. It is a zone where the period of fallow has been reduced to the barest minimum in many areas, or non-existent over a radius of 30km around some urban centers. Thus, the pressure on land in the area is much more than other parts of the country.

The visible sign of this phenomenon is the gradual shift in vegetation from grasses, bushes and occasional trees, to grass and bushes; and in the final stages, expansive areas of desert-like sand. It has been estimated that between 50 % and 75 % of Bauchi, Borno, Gombe, Jigawa, Kano, Katsina, Kebbi, Sokoto, Yobe, and Zamfara States in Nigeria are being affected by desertification. These states, with a population of about 27 million people account for about 38 % of the country's total land area (Table 1) below.

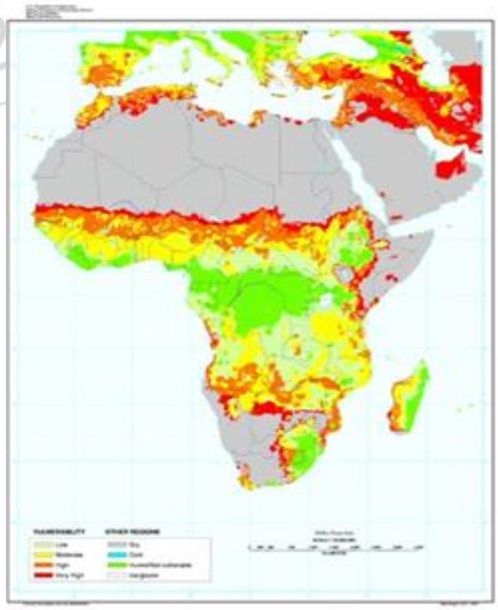

Figure 2: Desertification vulnerability of Africa

Table 1: Desertification Frontline States of Nigeria

State	Land Area (km^2)	% of Nigeria	Population	Density/km^2
Bauchi	45,837	5.03	4,653,066	102
Gombe	18,768	2.06	2,356,040	126
Borno	70,890	7.78	4,171,828	59
Yobe	45,502	5	2,321,339	51
Kano	20,131	2.21	9,401,288	467
Jigawa	23,154	2.54	4,361,002	188
Katsina	24,192	2.66	5,801,584	240
Sokoto	65,735	7.22	3,702,676	56
Kebbi	36,800	4.04	3,256,541	88
Zamfara	39,762	4.37	3,278,873	82
Total/Average	**390,771**	**42.91**	**43,304,237**	111

Source: Annual Abstract of Statistics: Facts and Figures about Nigeria: (Modified by the Authors 2013)

In these areas, population pressure resulting in over grazing and over exploitation of marginal lands has aggravated desertification and drought. Entire villages and major access roads have been buried under sand dunes in the extreme northern parts of Katsina, Sokoto, Jigawa, Borno, and Yobe States. The pressure of the migrating human and livestock populations from these areas are absorbed by pressure point buffer states such as the Federal Capital Territory, Plateau, Adamawa, Taraba, Niger, Kwara and Kaduna states. It is reported that these buffer states have about 10-15 % of their land area threatened by desertification. This action leads to an intensified use of fragile and marginal ecosystems resulting into progressive degradation even in years of normal rainfall. [10]

3. United Nations Declarations on Desertification

Desertification has long been recognized as a major environmental problem affecting the living conditions of the people in the affected regions in many countries of the world. The United Nations General Assembly in resolutions 3202 (s-vi) of 1st May 1974 recommended that the international community undertake concrete and speedy measures to arrest desertification and assist the economic development of the affected areas. The Economic and Social Council's Resolution 1878 (LVII) of 16 July 1974 requested all the concerned organizations of the United Nations system to pursue a broad attack on the drought problem. Decisions of the Governing Councils of the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) emphasized the need to undertake measures to check the spread of desert conditions [11]. The General Assembly then decided, by Resolution 3337 (xxix) of 17 December 1974, to initiate concerted international action to combat desertification and, in order to provide an impetus to this action, to convene a United Nations Conference on Desertification, between 29 August and 9 September 1977 in Nairobi, Kenya, which would produce an effective, comprehensive and co-ordinate program for solving the problem.

UNCOD concluded that desertification was of global magnitude and affected adversely large areas and populations in all continents, and adopted the Plan of Action to Combat Desertification (PACD), which was endorsed by the UN General Assembly that same year as one of the major world programmes. The implementation of PACD was severely hampered by limited resources.

4. World Bank And Federal Government of Nigeria Funded Afforestation Project

In response to rapid deforestation and desert encroachment, World Bank and Nigerian Government-funded Afforestation Project (AP) were implemented in Northern Nigeria from 1988 to 1996. Using an integrated, multi-dimensional approach, the establishment of shelterbelts, windbreaks, woodlots, orchards and nurseries was combined with social forestry, which involved awareness raising, campaigns, school forestry programmes, forestry extension services and a fuel wood conservation programme, to address the environmental and socioeconomic problems in the region. [12]

Although twelve states participated in the Project, Kano and Jigawa States were the most successful in achieving the desertification control objectives of the Project. Using lessons learned from the early years of Project implementation, the AP modified its operations to increase community participation in decision making and implementation and to develop programmes to address the role of women in afforestation efforts. Afforestation activities have continued without external funding and have a high potential for sustainability.

Figure 2: Some of the Shelter Belt in the Project Site
Source Field work 2012

Figure 3: Community woodlot in the project site
Source Field work 2012

5. Location of the Project Assessment

Kano and Jigawa States cover a combined area of 43,000 km2 in the Sudan Savannah vegetation zone of Northern Nigeria. The area is characterized by a long hot/dry season and a short rainy season of 90 to 110 days, with an average rainfall of 300 to 650 mm. Periodic droughts have been experienced over the past century, including severe droughts in 1972- 1974 and 1983-1985. The total population of the project area in 1991 was 8.5 million, with an annual growth rate of approximately 2.8 per cent. GNP per capita in 1993 was $1,000. Literacy rates are roughly 60 per cent for men and 40 per cent for women. Approximately 80 per cent of the populations are farmers, who traditionally use shifting agriculture and bush burning to produce the main economic crops in the region: millet, sorghum, cowpea and groundnuts.

In Northern Nigeria there is widespread land degradation, mainly attributed to deforestation. Increasing agricultural intensity and livestock over-grazing, combined with increasing demands for fuel wood have led to a rate of deforestation estimated to be 3.5 per cent, one of the highest in the world. For example, from 1978 to 1992, in Jigawa State, the area of land used for intensive agriculture increased from 36.8 per cent to 69 per cent and undisturbed forest decreased from approximately 1.1 per cent to .01 per cent. Livestock densities are high, the majority owned by the nomadic Fulani, who retain large herds for security. Soils in the region are ferruginous tropical soils, generally of poor structure and low fertility. The hot and dry climate causes bare, un vegetated soils to easily heat up, especially during the dry season, resulting in soil baking. Coupled with high evaporation rates, the soil becomes powdery and easily blown away by the wind. Thus, in the absence of vegetation, wind and water erosion on exposed soils have had extremely detrimental effects, limiting plant growth and productivity. In the far northern areas, increasing sand dune formation is evident. Until the early 1980s, the forestry sector in Nigeria had been a low government priority, comprising only 2.4 per cent of Federal budgets or even less. There was an inadequate and outdated national forest policy and improper forestry management strategies, as manifested in over-exploitation of forest resources and lack of inventory to ensure sustained yield. Forest revenue systems were outdated, which tended to treat forest resources as free commodities, and State forestry departments had not been managing forest reserves systematically. [12]

The Afforestation Project (AP) was one of three main components of Forestry II, a World Bank and Federal Government (FGN) funded project implemented in Nigeria from 1986 to 1996. The main objectives were to stabilize soil conditions in arid regions, to develop forest reserves and plantations in Southern Nigeria, and to strengthen Project Management through policy development and institutional strengthening. Forestry II followed Forestry I (1980-1986), which focused on plantation development in South-Central Nigeria and infrastructure development and institutional support for the Federal and State forestry departments.

The Forestry Management and Evaluation Coordinating Unit (FORMECU) were established in 1987 to oversee Forestry II. Simultaneously, the Afforestation Programme Coordinating Unit (APCU) was established to manage the AP directly in all northern states, and State Coordinating Units were established to implement the field programmes, working in collaboration with local governments. The Kano State Afforestation Programme (KNAP) was established in 1988. The Jigawa State Afforestation Programme (JIGAP) was established in 1991, after Kano was divided into two States: Kano and Jigawa. JIGAP took on activities in the newly formed States which were formerly managed by KNAP. Although the overall AP was judged a success for achieving or exceeding its targets, Kano and Jigawa States were considered to have been the most successful of all 12 states, particularly with regard to desertification control.

6. Efficacy of Remote Sensing Application In Monitoring Vegetation Changes

[13] Documented that after taking into account all the resolutions of the United Nations on desertification by member countries, the need to measure land degradation and desertification processes has increased substantially. While standard ground survey methods for undertaking such measurements become imperfect or expensive it has been demonstrated that satellite-based and airborne Remote Sensing systems offer a considerable potential. Earth observation satellites o the other hand provide significant contributions to desertification assessment and monitoring, particularly by providing the spatial information needed for regional-scale analyses of the relationships between climate change, land degradation and desertification processes.

Remote sensing and GIS techniques both are increasingly valued as useful tools for providing large-scale basic information on landscape characteristics [14] They are used for habitat and species mapping, biodiversity determination, land change detection, monitoring of conservation areas, and the development of GIS layers [15] In many cases, Remote Sensing data can partially replace the time consuming and expensive ground surveys [16]. Additionally change detection of the earth's surface can be investigated due to the availability of long-term data [17] furthermore,the spectral characteristics of green leaves are highly absorptive of energy in visible blue, yellow, and red wavelengths (0.4-0.5, 5.7-0.7 microns) of the electromagnetic spectrum, but highly reflective in the near infrared wavelengths (0.7-1.1 microns). Spectral responses of vegetation are further modified based on the leaf density and structure of the canopy. The relative differences in red (RED) and near infrared (NIR) spectral characteristics form the basis of several vegetation indices which are designed to assess the condition of vegetation. [18]

7. Normalized Difference Vegetation Index (NDVI)

In arid conditions vegetation provided protection against degradation process such as wind and water erosion. Vegetation reflects the hydrological and climate variation of the dry ecology. Decreasing vegetation cover and changes and the species composition of vegetation are sensitive indication of land degradation [19]. Vegetative cover can be extracted from remotely sense data.

The Normalized Difference Vegetation Index (NDVI) is a simple numerical indicator that can be used to analyze remote sensing measurements, typically but not necessarily from a space platform, and assess whether the target being observed contains live green vegetation or not.

NDVI has been in use for many years to measure and monitor plant growth (vigor), vegetation cover, and biomass production from multispectral satellite data. The NDVIis a non-linear transformation of the visible (RED) and near-infrared bands of satellite information. NDVI is defined as the difference between the visible (RED) and near-infrared (NIR) bands, over their sum. The NDVI is an alternative measure of vegetation amount and condition. It is associated with vegetation canopy characteristics such as biomass, leaf area index and percentage of vegetation cover.

In particular vegetation index dynamics in time are correlated with the Canopy Leaf Index **(LAI)** and other functional variables [20]. These variables are strongly conditioned by the behaviour of precipitation, temperature and daily radiation of the observed area [21]. Vegetation index therefore is representative of plants' photosynthetic efficiency, and it is time varying due to changes in meteorological and environmental parameters. The NDVI values range from -1 to +1 (pixel values 0-255).
The principle behind NDVI is that Channel 1 is in the red-light region of the electromagnetic spectrum where chlorophyll causes considerable absorption of incoming sunlight, whereas Channel 2 is in the near-infrared region of the spectrum where a plant's spongy mesophyll leaf structure creates considerable reflectance [22], [23], [24]. As a result, vigorously growing healthy vegetation has low red-light reflectance and high near-infrared reflectance, and hence, high NDVI values. This relatively simple algorithm produces output values in the range of -1.0 to 1.0. Increasing positive NDVI values, which, indicate increasing amounts of green vegetation. NDVI values near zero and decreasing negative values indicate non-vegetated features such as barren surfaces (rock and soil) and water, snow, ice, and clouds.

The (NDVI) data range is -1 to +1 and it is unit less. Green vegetation will have positive NDVI values opposite to clear deep water, which has low negative. The NDVI of soils is near zero. According to [25] "Remote sensing research suggests that emerging vegetation in an area begins between 0.04 and 0.07 NDVI, values higher than 0.6 are seldom found" NDVI relates to the amount of photo synthetically active or standing green biomass; therefore NDVI can detect differences between stressed and non-stressed vegetation.

Where 0 or negative values indicate no green leaves and +1 indicates the highest possible density of green leaves. Low positive values of NDVI, where little difference exists in RED and NIR wavelengths, is typical of low density vegetation such as grassland or desert. High values, where NIR is much greater than RED, indicated high density vegetation such as forest. Daily indices are usually combined into multi-week composites and then compared to previous weeks to assess trends in the density and stress of the vegetation.

8. Global Perspectives of Vegetation Change Detection Techniques

[26}. In their study they used Intergrade Land Sat Thematic Mapper (TM) and Spot High Resolution Geometry (HRG) Images to detect vegetation changes in Brazilian Amazon, using the image differencing approach based on the TM and HRG fused image and the corresponding TM image. A rule-based approach was also used to classify the TM and HRG multispectral images into thematic maps with three coarse land-cover classes: forest, non-forest vegetation, and non-vegetation lands. A hybrid approach combining image differencing and post-classification comparison was used to detect vegetation change trajectories. The Result shows promising vegetation change techniques, especially for vegetation gain and loss, even if very limited reference data are available. The hybrid approach provides such change information as forest degradation and non-forest vegetation loss or gain which indicates that the conversion from forest to non-forest vegetation or from non-forest vegetation to non-vegetation land accounts. The approach is especially valuable when same sensor data and reference data are not available hence may not be applicable for a dry region like the Sahel savannah region. Conversely [27] Used multi-temporal satellite imagery to detect land cover changes in El Rawashda, Gedaref State of eastern part of Sudan where they applied two different change detection techniques in order to assess land cover changes in El Rawashda forest, Sudan, by comparison of classification and multivariate alteration detection. Firstly, they acquired two satellite imagery, in 2003 by Landsat ETM+ and by ASTER in 2006, and were classified into four main land cover classes namely grass land, close forest, open forest and bare land. A change matrix was created in order to map the land cover changes from 2003 to 2006. The results show a noticeable increase in area on both close forest and open forest areas with decrease in grass lands within the period 2003-2006 they discovered that more than one third of grassland (36%) was converted to close forest, one fourth (24%) to open forest areas. In the three-year period, 9079 hectares of open forest, (8% of the investigation area), were transformed to close forest It has also been found the MAD transformation to be good unsupervised change detection method for satellite images and it can be applied on any spatial and/or spectral subset of the full data set which may likely not be suitable for supervised classification and shrubs or young vegetative cover. While [28] compared Techniques of Forest Change Mapping Using Landsat Data in Karnataka, India. They analyzed imagery of 1986 and 2003 using two change detection techniques: (1) image differencing of the Normalized Difference Vegetation Index (NDVI), the second principal component (PC2), and the Kauth-Thomas greenness index (KT-G), and (2) post-classification comparison (PCC). As field validation data did not exist for 1986, extensive visual assessment was conducted to locate and identify errors of commission and omission in the change maps. The image difference vegetation maps did not display obvious errors of omission, but they discovered that NDVI difference performed better than KT-G and PC2 differences in terms of errors of commission. Furthermore [29] used Multi-temporal Landsat image classification and change analysis of land cover/use in the Prefecture of Thessaloiniki, Greece. They used Nine different land cover/use categories, namely coniferous, broadleaves and mixed forest, agriculture lands, rangelands, grasslands, water bodies, urban areas and others uses. The overall classification accuracies were 85% for the three years, and the change detection accuracy was 88-91%. The classifications have provided an economical and accurate way to quantify, map and analyze changes over time in land cover. [30] In their research, they used normalized difference vegetation index (NDVI) differencing and classification to analyze land use-land covers changes methods in southern part of Ardakan, they used two Landsat ETM+ images of the years 1990 and 2006 to derive NDVI images and perform image classification. At first stage, differences between two correspondent NDVI images of the area was calculated to demonstrate the areas with 10% increase or decrease in NDVI values. From the results, 18.83% of the region's NDVI values have decreased by about more than 10% from 1990 to 2006, while only 1.38% of it has increased at the same time period. At second stage, supervised classification was performed and outputs of the two time periods were compared to derive information on changes that occurred over a period of time. During the study period, urban areas were increased from 10.68% of the total land in 1990 to 17.16% in 2006 whereas, the agricultural lands were decreased from 30.15 to 21.76% in the same period. This approach will be adopted in this paper with little bias on vegetation since the paper will look into afforestation project.

9. Result and Discussions

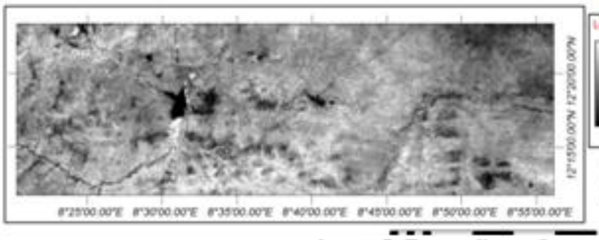

Figure 4: Normalized Difference of the Vegetative Index (NDVI) Derived from Landsat TM 1986

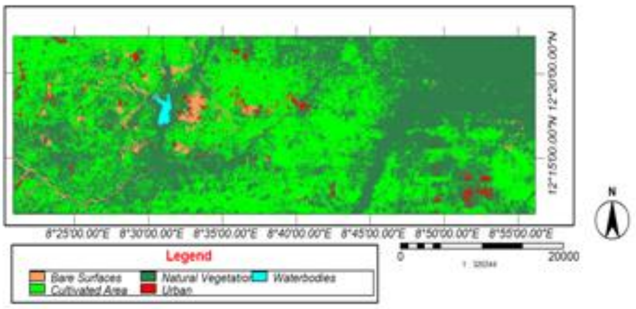

Figure 5: Land use land cover (LULC) image derived from land sat TM1986

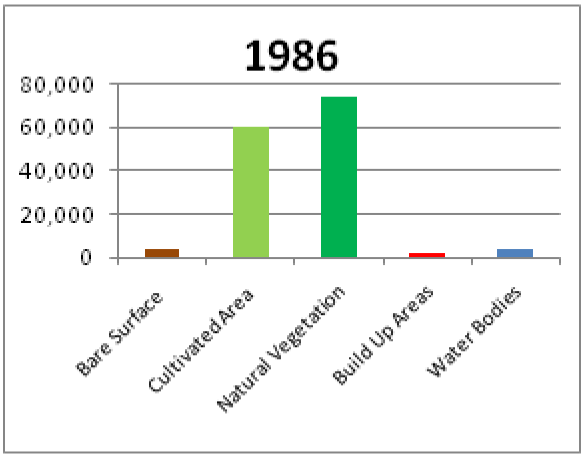

Figure 6: Land use Land Cover Statue as at 1986

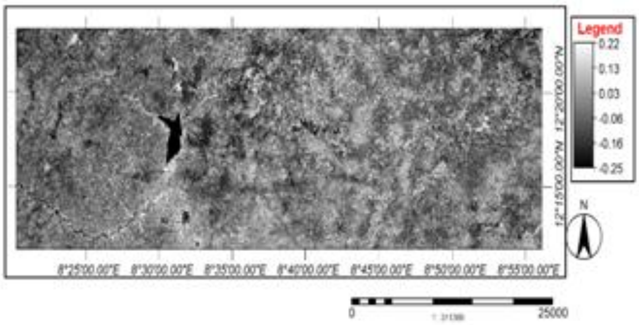

Figure 7: Normalized Difference of the Vegetative Index (NDVI) Derived from land sat ETM1999

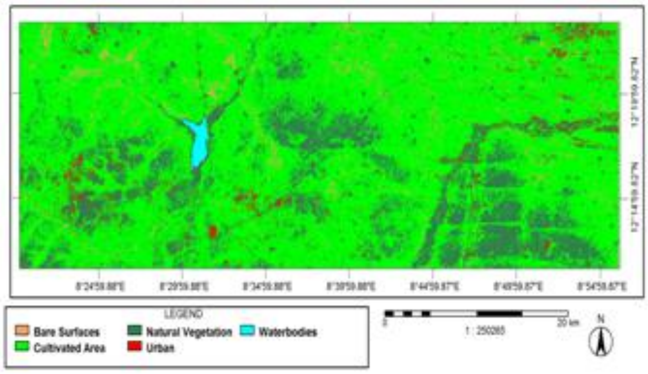

Figure 8: Land use land cover (LULC) image derived from Landsat ETM1999.

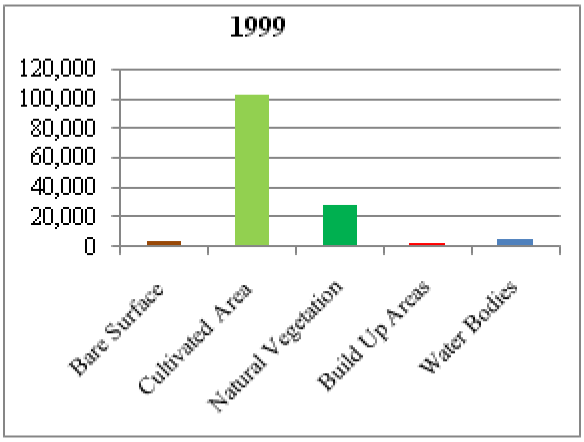

Figure 9: Land use Land Cover Statue as at 1999

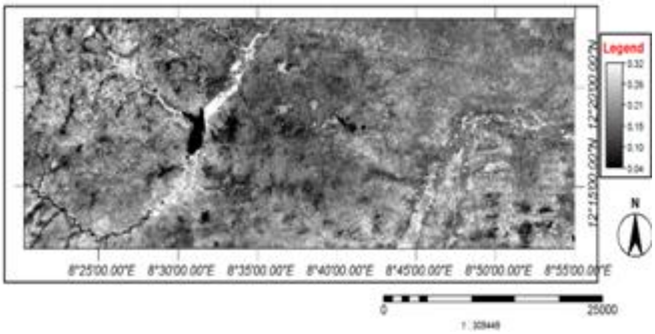

Figure 10: Normalized Difference of the Vegetative Index (NDVI) Derived from Nigeria sat 1 (2007)

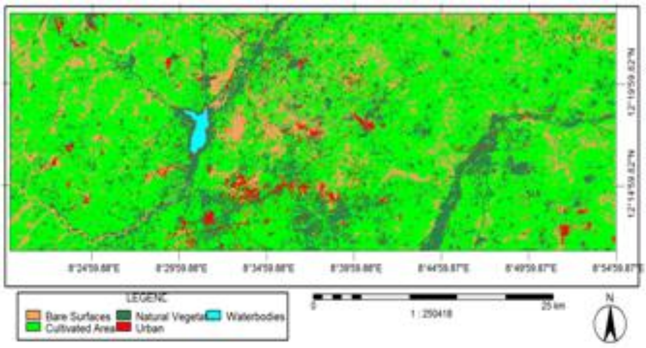

Figure 11: Land use land cover (LULC) image derived from Nigeria sat 1 (2007)

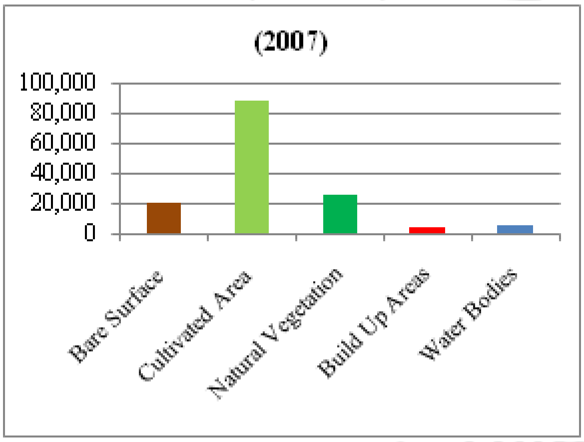

Figure 12: Land use Land Cover Statue as at 2007

Table 2: Combine LULC images derived from Land sat TM 1986, Land sat ETM 1999 and Nigeria sat 1 2007

Groups	1986 (Ha)	%	1999 (Ha)	%	2007 (Ha)	%
Bare Surface	3,769	2.7	4,242	3	20,642	15.2
Cultivated Area	60,192	42.9	102,476	74.32	88,343	65.5
Natural Vegetation	74,412	53	28,597	20.3	25,819	16.1
Build Up Areas	1,682	1.2	2,642	1.9	3,716	2.8
Water Bodies	3,554	0.2	5,652	0.5	5,089	0.5
Total	143,609	100	143,609	100	143,609	100

The positive pixel value increases from 0.04 for land sat TM 1986 in fig 4 to 0.22 for land sat ETM 1999 in figure 6 and to 0.32 for Nigeria sat 1 in figure 8. 1986 NDVI indicated that there is small shrubs and grasses in the area this because the Afforestation project has not commences by that time conversely the high positive pixel values of 0.22 and 0.32 for 1999 and 2007 respectively indicated fully grown vegetative cover this is because the project has ended by that time and the plantation has grown in the area. Also from the three NDVI images, bare surface is increasing due to reduction in negative pixel value that approaches zero form -0.07 in 1996 to -0.25 in 1999 and -0.04 in 2007. These finding was verified in table 2 of combine land use Land Cover changes for the three imageries in figure 5, 7, and 9 for 1986, 1999 and 2007.

The table also indicated the high rate of deforestation in the area by the depletion of the natural vegetation from 74,412 hectares which represent 53% in 1986 in figure 5 and 6 to 28,597.93 hectares which represent 20.36% in 1999 in figure 8 and 9 and to 25,819.19 hectares which represent 16.11% in 2007 in figure 11 and 12. Conversely the cultivated area increases from 60.192 hectares representing 42.9%, to 102,476 hectares representing 74.32% (This is in the middle of project implementation) and then decreases to 88,343 representing 65.5% however there is corresponding increases on build up areas which means the population of the area also increases there by increasing the agricultural activities in the area.

10. Conclusions

The application of Remote Sensing technique has proven to provide a reliable data on the progressive development of afforestation project aim a mitigating the impact of desertification in addition it has also provided a more robust tool for monitoring and evaluation of afforestation project by providing challenges the project face in each stage of the project development. The approach provided different vegetation changes trajectories.

From the three NDVI and LULC images presented it clearly show that there is relative increase in vegetation of the study area this is because of the increase in the positive values, which was observed that there is increase in the soil productivity of the area which may be attributed by afforestation project From the three classified images, and their statistical tables it clearly indicated that there is very high rate of deforestation activities in the area. This means that community woodlot provided by the project is not adequate to serve.

Even though the afforestation project was very succeeded in increase the vegetative nature of the study area it has not completely stopped human activities encroachment to forest reserved areas.

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