SPATIO-TEMPORAL ANALYSIS OF THE NATIONAL PARKS IN NIGERIA USING GEOGRAPHIC INFORMATION SYSTEM.

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ABSTRACT

Human activities have caused unprecedented changes in the ecosystem and environmental process. These changes have created a loss in biodiversity and have also resulted in environmental degradation as a consequence of lack of planning. Therefore, Landuse/Landcover information is essential for a number of planning and management activities at local, regional and national levels. This is because they provide the basic information on the spatial location and distribution of human and natural resources both in qualitative and quantitative terms. These quests gave rise to the evaluation of the status and conditions of the Natural and built Resources in Nigeria at a scale of 1:100,000. This is with specific interest on National parks using NigeriaSat1 images of 2007, Landsat images of 2001 and FORMECU 1995, which were also subjected to comparative analysis. Various multi-Temporal Satellite data Layers were brought together in a GIS environment to assess the pattern and magnitude of changes in the Parks between 1995 and 2007. It was found out that the sizes of these National Parks (Forest and Game Reserves) were consistently on the decrease between 2001 and 2007.

Keywords: *NigeriaSat-1, GIS, Land-use/Land-cover,* National Parks, FOR*MECU.*

INTRODUCTION

Information on Landuse/Landcover and vegetation changes is the basis on which the past and present human interactions and the impacts of such interactions with the natural resources and the environment can be understood. Such knowledge is also required for rational and sustainable allocation of land resources for future development. In Nigeria, however, all land development programmes and projects have evolved without an appreciation of the value of landuse and landcover information (Adeniyi and Omojola, 1999). This has led to the uncontrolled conversion of forests into other Landcover types. Trees are seen as obstacles to development and their removal is viewed as the first stage in development, hence deforestation has prominently become one of the most important environmental issues of the century. Most attention is focused on the rapid disappearance of the tropical rain forest because of their wealth of biodiversity. The rate of deforestation and forest degradation in tropical countries caused by human interference has been high and has increased over the past few decades.

According to the World Food and Agriculture Organization (FAO, 2001, 2003, 2005), deforestation which is defined as the removal of tree cover, has increased at the rate of 2.38 percent per year in 2000 to 3.12 percent in the 2005. This indicated a 31.2 percent increase in the rate of deforestation within 5year. The absence of baseline landuse and landcover/vegetation dynamics information for most development projects in Nigeria has made it difficult to anticipate the possible socio-economic and environmental consequences of such developments. Although, the prediction of impacts arising from such developments can often be accomplished through post-project analysis, by the time the impacts of such developments are acknowledged, it is often too late to undertake baseline traditional survey to which the post-project conditions can be compared and evaluated.

The landuse/ landcover pattern of a region is an outcome of both natural and socio-economic factors and their utilization by man in time and space. Land is becoming a scarce commodity due to immense agricultural and demographic pressure. Hence, information on landuse/landcover and possibilities for their optimal use is essential for the selection, planning and implementation of landuse schemes to meet the increasing demands for basic human needs and welfare. Increasing human interventions and unfavorable bio-climatic environment has led to transformation of large tracts of land into

wastelands. Satellite Remote Sensing plays an important role in generating information about the latest landuse/land cover pattern in an area and its temporal changes through times. The information being in digital form can be brought under Geographical Information System (GIS) to provide a suitable platform for data analysis, update and retrieval. Apart from mapping the changes in forest areas by some scholars, several international agencies have mounted different conservation programmes to arrest deforestation. Some of these agencies are the United Nations Food and Agriculture Organization (FAO), United Nations Environmental Programme (UNEP), United Nations Development Programme (UNDP) and the World Wide Fund (WWF).The impacts of different development projects which cause these changes have also been investigated. The present study, using Nigeriasat-1 data, is another effort towards the same objective with specific interest on the National parks.The National Parks of Nigeria are some of the very few remaining natural ecosystems in the country, capable of enhancing ecological processes and life support system(Nigeria National Park Service, 2010). These national parks are part of the efforts of the governments of Nigeria at conservation of forests.

Table 1 shows the areal extent of these National Parks as at 1995. Their states of location, ecological Zone and Geo-political zones were also highlighted in the table.

Table 1: National Parks in Nigeria1995

Geo-political Zone	State	National Park	Ecological Zone	Area (sq. km)
North East	Bauchi	Yankari National Park	Sudan Savanna	2244
North East	Bornu	Chad Basin National Park	Northern Guinea/Sudan - Sahel Sava.	2258
North Central	Niger, Kwara	Kainji Lake National Park	Northern Guinea/ Sudan Savanna	5382
North Central	Kaduna	Kumuku National Park	Northern Guinea/Sudan Savanna	1121
North Central	Adamawa	GashakaGumti National Park	Northern Guinea / Sudan Savanna	6731
South South	Cross River	Cross River National Park	High Forest	4000
South South	Edo	Okomu National Park	High Forest	181
South West	Oyo	Old Oyo National Park	South. Guinea /Sudan Savanna	2512

(Source: FORMECU 1995)

Environmental Significance of National Parks

The environmental significance of the National and other Parks lies in the objectives of the National Park Service of Nigeria, which is mainly to establish an ecologically and geographically balanced network of protected areas under the control and jurisdiction of the Federal Government.

The Park Service is to deal with the

(a) conservation of wildlife throughout Nigeria so that the abundance and diversity of species are maintained at the optimum levels commensurate with the other forms of land use in order to ensure the continued existence of wildlife for the purpose of their sustainable utilization for the benefit of the people;

(b) preservation of outstanding scenic, natural, scientific, recreational and other values in the National Parks;

(c) protection and maintenance of crucial wetlands and water catchments areas;

(d) implementation of relevant international treaties, agreements or other arrangements regarding, relating to, or connected with protected areas and wildlife management to

which Nigeria is a party, in so far as the power to implement those international treaties, agreements and arrangements is conferred on the National Park Service by the Federal Government;

(e) The promotion and provision of education about wildlife and nature conservation; and

(f) conservation of biological diversity in Nigeria.

Judging from the above, the National Parks in Nigeria are expected to play a pivotal role in the preservation, conservation, protection and management of biological diversities in the country. In furtherance of these objectives, her management is to advise the Federal Government on the development and preservation parks including the financial requirements for the implementation of such policies.

The present study evaluated the status of the National parks in Nigeria at a scale of 1:100,000 satellite data from NigeriaSat-1, Landsat ETM+ and validation data from FORMECU.

The Study Area

The Federal Republic of Nigeria is located between Latitudes 4°N and 14°N, and Longitudes 3°E and 15°E (Fig. 1). It lies within the tropics along the Gulf of Guinea, on the west coast of Africa. It is bounded in the west by the Republic of Benin; in the north by the Republic of Niger; in the east by the Republic of Cameroon and in the south by the Atlantic Ocean. The country has a population of over 140 million (NPC, 2006) and a land mass of about 923,768.64 Sq kilometres (356,669 sq miles). The country occupies about 14% of West Africa, but supports more than 60% of the population of the region. Nigeria has 36 states and 774 LGAs with Abuja as the Federal Capital city.
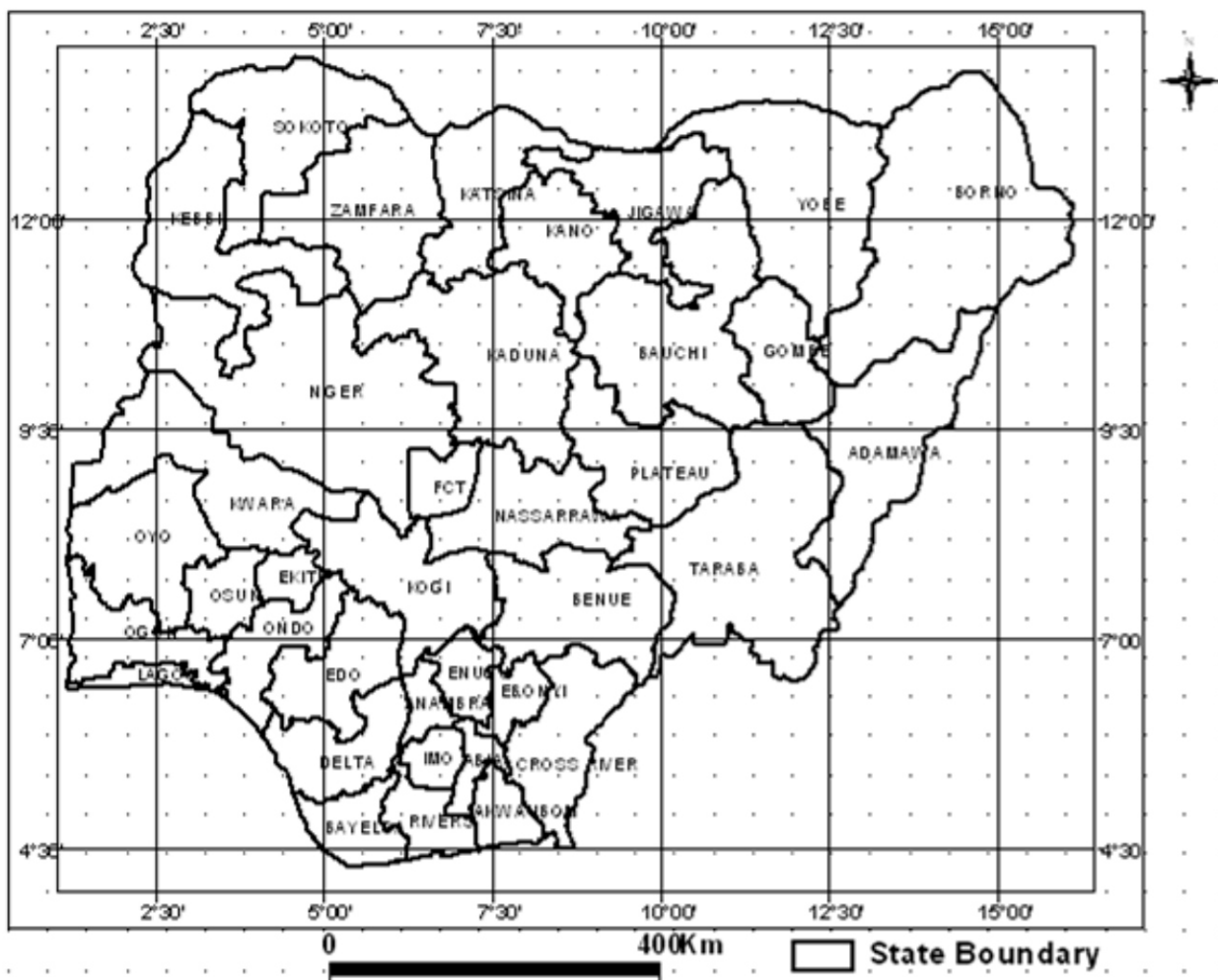

Fig. 1. Map on Nigeria Showing the Thirty Six States and the FCT.

MATERIALS AND METHOD OF STUDY

This study utilized NigerianSat1 taken in 2007(NASRDA); Landsat ETM taken in 2001 (NASRDA); Index Map (Federal Surveys); Topographic Sheets (Federal Surveys); Settlement Map (NASRDA); Goggle Earth (Internet); Encarta Map (Microsoft Corporation Inc); Digital maps (in shape files) of landuse/landcover covering the entire country (FORMECU).Several software which include Leica's ERDAS Imagine 8.6 were used for sub-setting and image classification. ESRI's ArcView 3.2a was used for map composition; Adobe's Photoshop CS5 for preparing the map for printing; Microsoft Excel for computing statistical analysis; and ITT's ENVI 4.3 for creating the vegetation indices.

Satellite images of 2001 and 2007 were used to generate the spatio-temporal patterns and evolutional trend of the National parks. With the integration of FORMECU LU/LC maps of 1995, Landsat images of 2001 and NigeriaSat1 images of 2007, change detection analysis was carried out to detect how forested the reserves of the country were in the last 13 years.

RESULTS AND DISCUSSION

The results of the analysis are presented in Figures 2 - 5 and Tables 2-5. Table 2 contains the areal extent of the eight National parks in 1995, 2001 and 2007 while Table 3 shows the percentage coverage of the parks with respect to the total area coverage of Nigeria. Tables 4 and 5 show the rate of depreciation of the parks between 1995 and 2001 and between 2001 and 2007.

The results showed that Kainji, Kamuku, the Cross River and the old Oyo National Parks showed a steady decline from 1995 to 2007. For example, the Kainji National Park lost 1,672 sq km of forest cover within the twelve year period. This amounted to a loss of about 139 sq km of forest per annum. The decline in the forest cover in the old Oyo National Park appeared even more dramatic. This park lost a total of 3,547 sq km of forest cover during the twelve year period representing a loss of about 296 sq km of forest cover per annum. Gashaka Gumti National Park recorded a rejuvenation of the forest cover to the tune of about 2,185 sq km between 1995 and 2001, perhaps, due to a mounted reforestation program during the period. However, about the same amount of forest cover in the park (1,927 sq km) was degraded by the year 2007.

Government efforts at conservation achieved the greatest success at the Okomu, Yankari and the Chad Basin National Parks which stayed virtually unchanged in areal extent. Yankari and Chad Basin National Parks even recorded some gains of 104 sq km and 171 sq km respectively between 1995 and 2001 (Table 2). However, both parks between the year 2001 and 2007 lost 287 sq km and 1000 sq km respectively.

Table 2: The Areal Extent of the National Parks in 1995, 2001 and 2007

s/n	Name of Parks	Area (km^2) 1 995	Area (km^2) 2001	Area (km^2) 2007
1.	Kainji National Parks	5,382	3,965	3,710.37
2.	Kamuku National Park	1,121	919.87	695.36
3.	Gashaka-Gumti National Park	6,731	8,916.23	6,989.15
4.	Cross River National Park	4,000	3,077.15	2,368.27
5.	Old Oyo National Park	5,212	1,970.01	1,665.14
6.	Okomu National Park	181	100.64	67.59
7.	Yankari National Park	2,244	2,348.66	2,061
8.	Chad Basin National Park	2,258	2,429.43	2,429.43

Table 3: Coverage as Percentage of Total Area of Nigeria

s/n	Name of Parks	% Area 1995	% Area 2001	% Area 2007
1.	Kainji National Parks	0.58	0.43	0.40
2.	Kamuku National Park	0.12	0.09	0.07
3.	Gashaka-Gumti National Park	0.72	0.96	0.75
4.	Cross River National Park	0.43	0.33	0.25
5.	Old Oyo National Park	0.56	0.21	0.18
6.	Okomu National Park	0.01	0.01	0.01
7.	Yankari National Park	0.24	0.26	0.26
8.	Chad Basin National Park	0.24	0.26	0.26

**Table 4:** Statistical Analyses of Change in the Areal Extent of the National Parks between 1995 and 2001.

s/n	Name of parks	Area (km^2) 1995	Area (Km^2) 2001	Mag. of change (B - A)	Annual Fre q. of change C/B	% change C/A *100
1	Kainji National Parks	5,382	3,965	-1,417	-236.1666667	-26.32850242
2	Kamuku National Park	1,121	919.87	-201.13	-33.52166667	-17.94201606
3	Gashaka-Gumti National Park	6,731	8,916.23	2185.23	364.205	32.46516119
4	Cross River National Park	4,000	3,077.15	-922.85	-153.8083333	-23.07125
5	Old Oyo National Park	2,512	1,970.01	-541.99	-9033166667	-21.57603503
6	Okomu National Park	181	100.64	-80.36	-13.39333333	-44.39779006
7	Yankari National Park	2,244	2,348.66	104.66	17.44333333	4.66399287
8	Chad Basin National Park	2,258	2,429.43	171.43	28.57166667	7.592116918

Table 5 Statistical Analyses of Change in the Areal Extent of the National Parks between 2001 and 2007

s/n	Name of parks	Area (km²) 2001 (A)	Area (km²) 2007 (B)	Magnitude of change (C=B-A).	Annual Frequency of change C/B	Percentage of change C/A *100
1.	Kainji National Parks	3965	3710.37	-254.63	-42.43833333	-6.421941992
2.	Kamuku National Park	919.87	695.36	-224.51	-37.41833333	-24.40670964
3.	Gashaka-Gumti National Park	8916.23	6989.15	-1927.08	-321.18	-21.61317059
4.	Cross River National Park	3077.15	2368.27	-708.88	-118.1466667	-23.03690103
5.	Old Oyo National Park	1970.01	1665.14	-304.87	-50.81166667	-15.47555596
6.	Okomu National Park	100.64	67.59	-33.05	-5.508333333	-32.83982512
7.	Yankari National Park	2348.66	2061.03	-287.63	-47.93833333	-12.24655761
8.	Chad Basin National Park	2429.43	1429.43	-1000	-166.6666667	-41.16191864

Fig 2 shows bar graphs depicting also the areal extent of the eight National Parks in the same three years (1995, 2001 and 2007). Kainji, Kamuku, Cross river, Old Oyo and perhaps Okomu, showed steady decline over the three time periods. Gashaka, Yankari and Chad Basin recorded increases between 1995 and 2001. Yankari and Chad Basin stayed almost steady during the period while Okomu faces a threat of extinction if not rejuvenated soon.
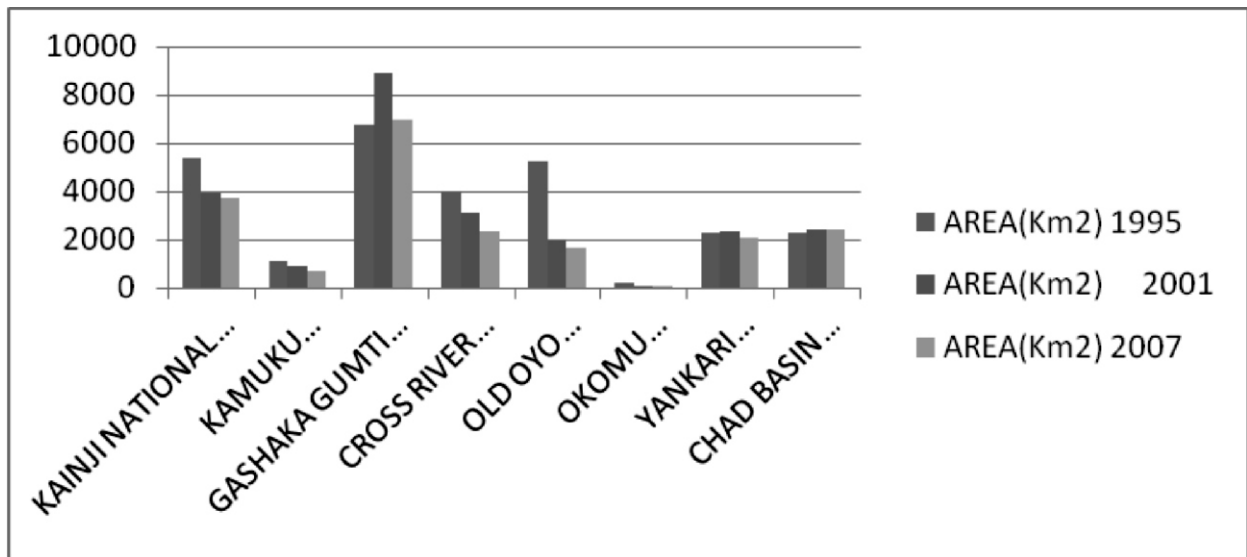
Figure: 2: Bar Graph Showing the Areal Extent of the National Parks In 1995, 2001 And 2007
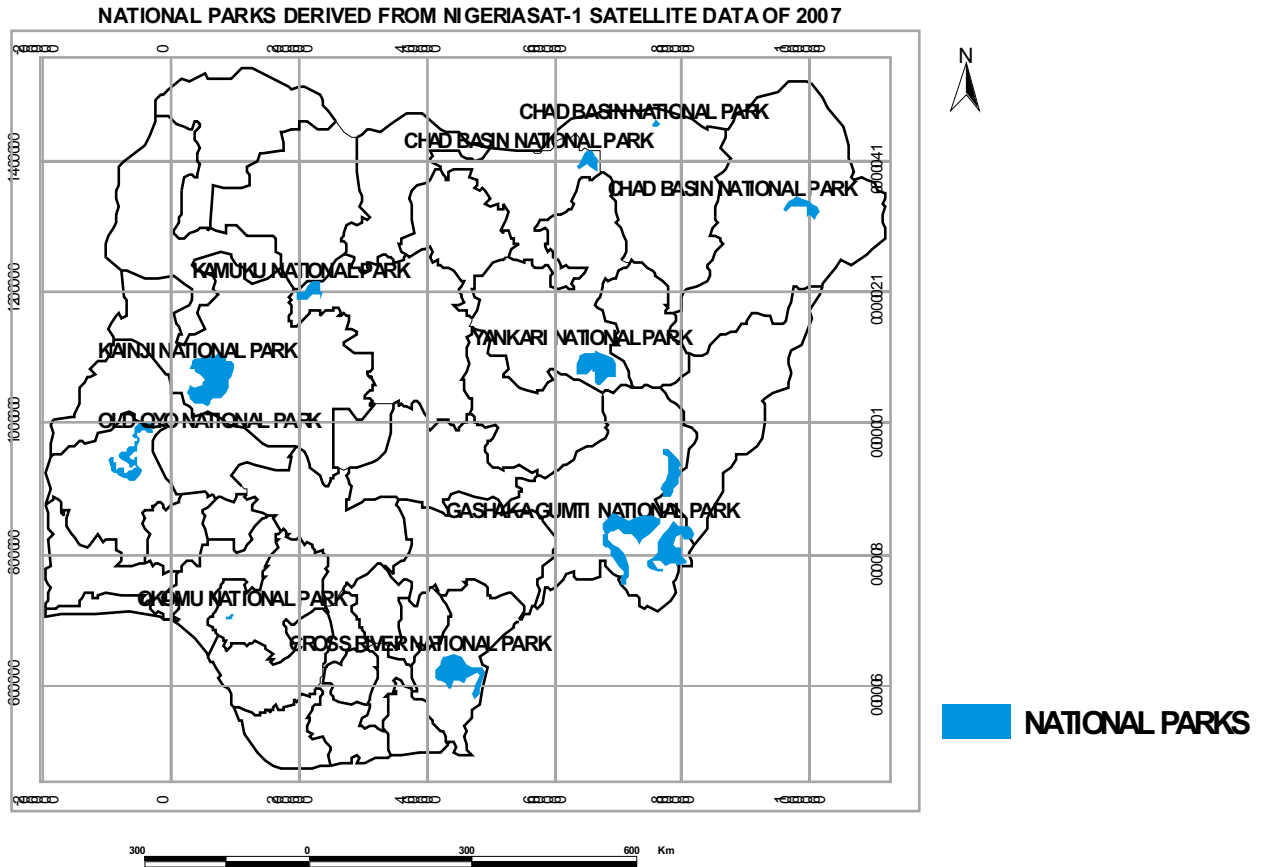
Figure: 4: National Park Derived from NigeriaSat-1 Imagery of 2007
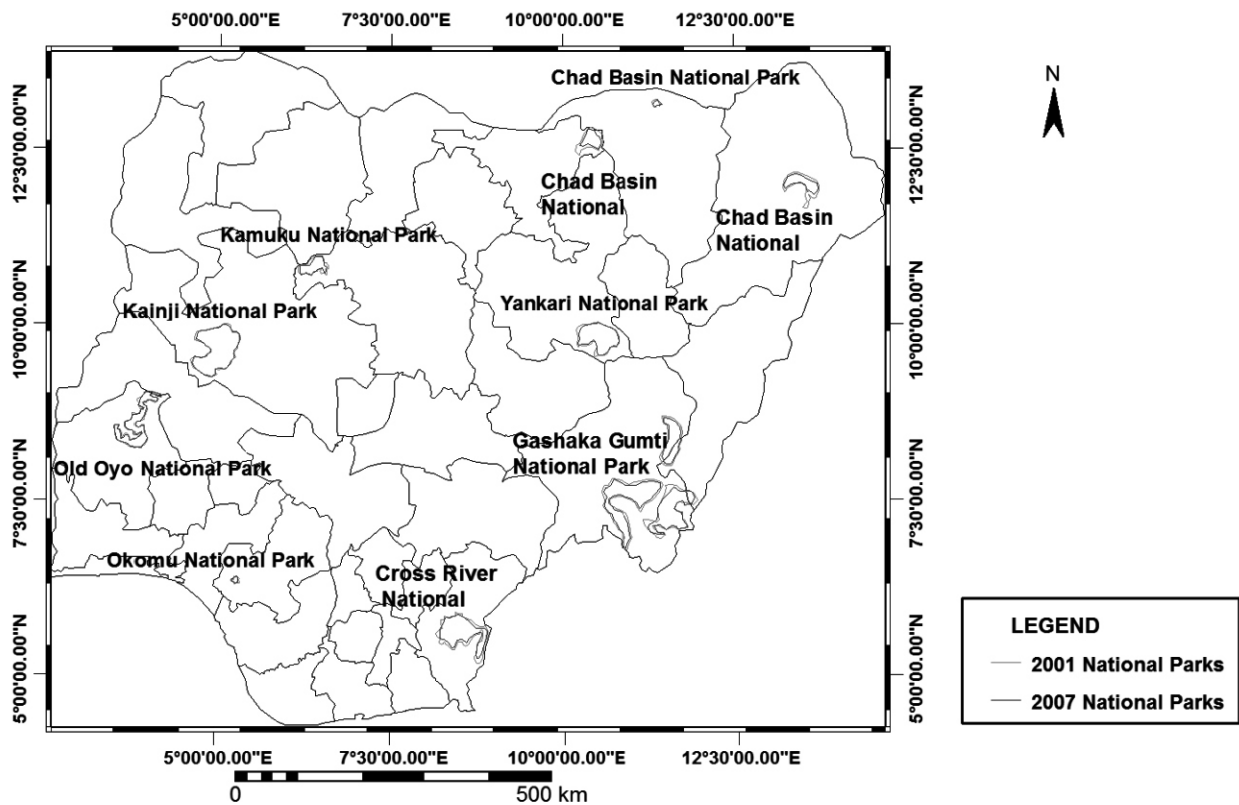

Figure 5: Combined Boundaries for National Parks of 2001 and 2007

Figure 3 shows the location and sizes of these parks in the year 2001while Figure 4 shows the same information as they existed in 2007. Figure 5 is the result of the superimposition of Figures 3 and 4.These are the visual expression of the results contained the tables.

CONCLUSION

The study shows that all the parks are being degraded at a fast rate. This trend will likely continue in the near future unless drastic actions are taken immediately to reverse the trend Okomu National Park may completely disappear in the not too distant future. Kamuku, Gashaka Gumti, Old Oyo, Okomu and the Chad Basin National parks may need an immediate Government additional intervention, if they are to remain as Government reserved National parks.

The Local Empowerment and Environmental Monitoring Project (LEEMP) sponsored by the World Bank to empower the inhabitants living as neighbors to these National Parks through alternative livelihood assets will probably help to elicit their cooperation in the conservation efforts for these National Parks. There is also the need for sustained reforestation programme and increased security patrol to keep off poachers who depend on the fauna and flora in national parks for their livelihood.

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