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THE EFFECTS OF LAND USE CHANGE AND LANDSCAPE FRAGMENTATION IN ABUJA, NIGERIA

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ABSTRACT: *The study examined the effects of Land use change and Landscape fragmentation in Abuja. The Study revealed that main factor influencing Land use change and Landscape fragmentation in Abuja was the lack of opportunities to acquire other Land Uses. This factor was rated highest (Mean= 3.42, standard deviation= 1.10. The next factor that influenced land use fragmentation and land use change was the overgrowing population/slum formation. (Mean=2.98, Standard deviation=1.01. The Study further revealed that rain forest and groundcover Landscape Plants, such as Antiaria Africana, Anthocleista Nobilis, Elaeis Guineansis, Afzelia Africana and Anona Senegalensis; that were conceptualized in the Master Plan to serve as botanical, recreational and as weather conditioners in a micro-climate scale has reduced to an estimated 10% (800 square kilometer) of the total 8000 square kilometer Abuja land mass. Consequently, the research concluded that, the impacts of land use change and the landscape fragmentation includes flooding, food scarcity due to fluctuation in Rainfall, drought, increase in air pollution as well as outbreak of respiratory diseases such as Pulmonary tuberculosis(PTB), and acute lower respiratory tract infections(ALRTI) in Abuja.*

KEY WORDS: landscape fragmentation, land use change, Abuja

INTRODUCTION

Human actions are the drivers that affects landscape qualities. These includes actions such as deforestation, transportation and other mobility infrastructures. Others includes land conversion for agricultural, industrial and housing development. These leads to natural habitat diversion and Landscape Fragmentation. (Ledda et al;2019). Thus, Landscape Fragmentation is the process where habitat patches tend to become smaller and more isolated.

Landscape fragmentation could also be explained as the breaking up of larger areas of natural land cover into smaller more isolated patches independent of a change on the total area of natural land cover. It is a process where the single homogenous and continuous landscape is converted to a mosaic of complex, heterogeneous, discontinuous patches due to natural disturbances. The process usually reflects change in landscape structure, function and ecological processes, which are closely related to biodiversity and conservation of natural resources (Llausas et al; (2012).

This affects flora and wild fauna in both the long and short run and can lead to population extinction. Land use change is the changes in the human use of land for recreation,

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industrial, residential, commercial, public, transportation, and communication (Turner II et al; (1995). This causes landscape fragmentation by changing the landscape elements into qualitative different state leading to destruction of habitats and extinction of wildlife. The driving forces behind land use change includes population change, industrial landscape includes degradation which is the change from landscape to other land use; and urbanization which is a transition of landscape area into urban sprawl.

Therefore, this research focuses on the influence of the land use change and landscape fragment in Abuja. This is key towards improvement in policies involving ecosystem preservation and conservation.

LITERATURE REVIEW

Derya et al; (2017) researched into landscape fragmentation in an agricultural environment. The research applied a reference method for measuring fragmentation using Hedge Network (HN) approach in lower plain of the Ancient Meander River in Aydin Province Turkey, due to its agricultural character. The study concluded that landscape fragmentation has both positive and negative impacts on agricultural fields, causing modifications and degradation by dividing the fields.

In the same vein, Luis et al;(2019)'s work on Landscape Fragmentation observed, that fragmentation of natural landscape during urbanization processes is linked to biodiversity loss and changes in ecological ecosystem function. The Study therefore opined that fragmentation of the natural areas had varied effects in ecosystem services and negative effects on human wellbeing and biodiversity, for instance the research observed that, water infiltrate was negatively impacted by Fragmentation. Consequently, the research inferred that fragmentation on ecosystem services provision is dependent not only on the characteristics of the Landscape, but also the ecosystem service in question, as well as the historical and social characteristics of urbanization.

Furthermore, research conducted by Ledda et al; (2019) affirmed that Landscape Fragmentation is mainly due to human activities such as transport and mobility infrastructure as well as other activities in suburban areas that experience urban sprawl.

Likewise, Battisti et al; (2007) and Astiaso et al; (2013) divulged that Landscape Fragmentation is caused by human infrastructural development and settlement which affects protected areas and biodiversity. Also Hernando et al; (2017) studied Landscape Fragmentation in Spain using Morphological Spatial Pattern analysis. The research acknowledged that habitat conservation depends on the available cover maps. Further studies also conducted by Piquer- Rodriquez et al; (2012) into Land Use Change effects on protected area network on South Eastern Spain. The research declared that conservation planning should take into consideration probable future Land-use Change.

In like manner, Tomaselli et al; (2012) studied the degree of habitat fragmentation for the monitoring of protected areas and to determine if the value of Landscape metrics can characterize fine-resolution landscape patterns. The Habitat Maps for the study were

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derived from the Vegetation Maps generated integrating, phytosociological releves and Earth observation data. A selected set of Landscape metrics was applied in order to investigate their performance in assessing fragmentation and Spatial Patterns of habitats. Thus, the research failed to examine the sociological causes and implications of habitat and landscape fragmentation.

Uniquely, Di Guilio et al; (2009)'s work opined that Landscape Fragmentation has great influence on human well-being in addition to being an ecological problem. Thereupon, the research tried to evaluate whether there were similarities and dissimilarities between ecological and the human aspects of Landscape Fragmentation. The research concluded that for both humans and biodiversity, the loss of semi-natural areas has more drastic effects than the fragmentation of the areas. The research thus recommended that in densely populated Landscape, a shift from responsive planning to an intentional design of environment is required. As a result, the research failed to examine the constraints posed by Land use change as a factor that also contribute to Landscape Fragmentation.

In addition, studies by Arowolo et al; (2018) observed that landscape changes were caused by the ever growing – large population. The research interest was on the impact of landscape fragmentation on ecosystem. The study employed the Globe Land 30 Land cover Maps for 2000 and 2010 to evaluate the changes in the value of eco-system services. To this end, the research concluded that the conservation of the natural ecosystem is required to curb the continuous loss of ecosystem, such as climate and water regulation. The research did not examine the phenomenon of government land-use product as well a people's response to economic opportunities to live as a factor that contributes to landscape fragmentation.

Similarly, Tscharntke et al; (2012) observed that landscape characteristics affects biodiversity and ecological processes. The study focused on the influence of human modified Landscape fragmentation which brings about spillover of energy, resources and organisms across managed and natural ecosystems. However, this study examines the effects of land use and landscape fragmentation on human wellbeing and also as a constraint on government land use policies.

Forthwith, Desta et al; (2019) posited that landscape dynamics are consequences of alien plant species, climate change frequent droughts and weak traditional Law. In addition, Obsa et al; (2018)'s work employed Raster data sets imputed in FRAGSTAT to analyze the extent of landscape fragmentation. The study concluded that there was increase in Class Area (CA) for cultivated land and settlement while the number of Patches (NP) rose for forest land, shrub land, grass land, settlement and cultivated land.

Again, research conducted by Abdullah et al; (2007) employed Remote sensing (RS) Techniques to monitor forest cover change. Forest cover changes was analyzed using Geographical Information System (GIS) and FRAGSTATS. The research discovered that annual Forestation rate was 152ha per year, and that number of smaller Patches (Patches in 0 – 100-hectare size class increased, indicating more fragmented landscape. The increase

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of forest areas was attributed to demographic movement of rural areas concentration to urban area; Mecka city center in Turkey.

In the same way, Gulcin et al; (2017), and Fischer et al; (2007), observed that the impacts of Landscape fragmentation differ in many ways, which include the quantity of elements, naturalness and ecological values of landscape mosaic. The research applied a reference method for measuring fragmentation. Hedge Network (HN) approach was also adopted. The research concluded that Landscape Fragmentation has both positive and negative impacts on cultural fields. The research submitted, that negative impact implies the modification and degradation of the agricultural fields.

Also, Batistella et al; (2000) posited in their studies, that designs of Architectures of colonization contributed greatly into landscape fragmentation in Rondonia, Brazilian Amazon. Similarly, Llausas et al; (2012) researched into the indicators of landscape fragmentation. Quantitative indicators capable of measuring landscape patterns and changes were used to examine landscape fragmentation and assess the impacts on the environment and biodiversity. In addition, qualitative indicators were used to measure the social dimension and perception of landscape fragmentation by humans. The study concluded that it was convenient and feasible to design an indicator of landscape fragmentation that is consistent with the European Landscape Convention (ELC). Thus, the research applications were designed to address impact of landscape fragmentation in the European Countries only.

Another work by Badach (2019), and Luo (2015) utilized various analysis and software programs such as Fragstats, Spatial analysis of landscape Patches (Patch analysis) or Landscape Fragmentation Tool (LFT) for ARC GIS to calculate specific parameters in an accessible format. The study was however targeted at agricultural landscape.

Equally important for this study is the research conducted by Cui et al; (2018) who examined established Landscape Metrics such as Patch Area, Patch Density (PD), and isolated intensity in land use and landscape fragmentation processes. The research observed that the identified single metric is inadequate for representing the degree of Habitat Fragmentation (DHF) to this end, the study suggested a combination of Landscape metrics referred to as the effective mesh size to achieve effective representation and analysis of land scape fragmentation.

Likewise, Frazier (2017) deduced that fragmentation is a physical process of dividing habitats, ecosysteams land-use types into smaller parcels (Andren 1994, Llausas et al;(2012).

Thus, most available studies focused on landscape fragmentation from agriculture perspectives. This study therefore attempted the examination of the impacts of land use change and landscape fragmentations on an evolving Federal Capital Territory, Abuja. Nigeria.

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RESEARCH METHODOLOGY

Estimation of land use and landscape changes using satellite images

The Spatial data base was derived from land Sat generated in 2006, 2009 and 2021 (Abuja Geographical Information System, AGIS); these are shown in figure i, ii and iii respectively.

Analysis and results

The youth constituted 17.9% of the respondents in the study area. It was also established that most of the respondents were in the age bracket of 31-60 years. This age group represented 68.7% of the respondents. The adult respondents constituted the lowest proportion (13.4%) of the residents, due to the high cost of living. (Table 1).

Table 1: Age group of respondents

Age group in years	No of respondents	%
Youth (18-30)	600	17.9
Young adult (31-60)	2300	68.7
Adult (above 60 years)	450	13.4
Total	**3350**	**100.0**

Source: Authors' Field Survey, 2021

Second, each of the landscape factors were ranked on 5 – point Likert scale, Residents were asked to choose factors that contributes most to the landscape fragmentation and land use change in the residences. 1- denotes Not at all; 2 – denotes Not very high; 3 = Not high; 4 = high; and 5 = Very High. The chosen factors with their scores are then ranked in the order of their importance. (Table 2)

Analysis of Factors influencing landscape fragmentation and land use change

It was observed that main factor that influences landscape fragmentation is the lack of opportunities to acquire and or the constraints for other land uses. This factor was rated highest (mean = 3.42, standard deviation = 1.101). The next factor influencing landscape fragmentation and land use change is over growing population /slum formation (mean = 3.41, standard deviation = 1.120). In the same vein, the third factor in the ranking is degradation/increase in human activities (mean = 2.98, standard deviation = 1.100). (Table 3)

In the same vein, the next ranked factor influencing landscape fragmentation and land use change is cultural/attitudes/beliefs. Uniquely, the next ranked factor is poverty. (Table 2 and 3)

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Table 2: Factors influencing Landscape Fragmentation and Land use change

Variables	
Va	Degradation/increase human activities
Vb	Intensification
Vc	Cattle rearing/livestock farming
Vd	Over growing Population /slum formation
Ve	Poverty
Vf	Economic opportunity
Vg	Opportunities /constraints for other land uses as created by local and national planning regulations and government policies
Vh	Political
Vi	Cultural/attitudes/ beliefs
Vj	Technological
Vk	Natural

Source: Computer Output 2021

Table 3: Analysis of Factors influencing Landscape fragmentation and Land use change in Abuja

Variables	Factors	Number of observation	Relative Importance Index (RII) (Mean)	Standard deviation	Rank
Va	Degradation/increase human activities	3350	2.98	1.100	3
vb	Intensification	3350	2.10	1.301	8
vc	Cattle rearing/livestock farming	3350	2.24	1.12	6
vd	Over growing Population /slum formation	3350	3.41	1.120	2
ve	Poverty	3350	2.27	1.083	5
vf	Economic opportunity	3350	2.01	1.09	9
vg	Opportunities /constraints for other land uses as created by local and national planning regulations and government policies	3350	3.42	1.101	1
vh	Political	3350	2.20	2.003	7
vi	Cultural/attitudes/ beliefs	3350	2.85	1.56	4
vj	Technological	3350	1.97	1.23	11
vk	Natural	3350	2.00	1.627	10

Source: Computer Output, 2021

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The research also revealed that the rain forest and ground cover plants, shrubs and trees constituted about 20% (1,590 square kilometer) of the Federal Capital Territory(FCT) total land mass (8000 square kilometers). The land cover is intended to be kept intact and serve as botanical and recreation areas and as weather conditioners in the Nations New Federal Capital Territory, (Doxiadis,1983; and Benna (2009).

Landscape elements found in the FCT includes two types of forest and three types of savannah. These five plant communities include Rain Forest, Riparian Forest, Savannah Woodlands, Park Savannahs and Shrub Savannah. The FCT landscape consists of shade – tolerant shrubs, herbs, small trees and large woody vine which occurs throughout the FCT.(Table 4).

Thus, the landscape of Abuja plays a define role in the formation of its climate and they are of great importance in the maintenance of the favorable weather conditions for which the Abuja was chosen as. the Nation's new Federal Capital Territory. The landscape elements are expected to be kept intact and enhanced so as to serve as botanical, recreational areas and as weather conditioners in *a* microclimatic scale. ((Doxiadis,1983)

The total value of land use land cover change was estimated as follows:
ESV=$\sum$ ($A_k \times VC_k$) (Hu et al;2007)where ESv is the estimated landscape and land use change value, Ak is the area (ha) and VC_k the value coefficient. Thus, the change in landscape value was estimated by calculating the differences between the estimated values for each landscape and land use change value between 1983 through 2006 and 2021.

Table 4: Abuja Natural Landscape

Rain Forest	Riparian Vegetation Complex	Savannah Woodlands	Park Savannah	Shrub Savannah
Antiaria Africana	Elaeis Guineensis	Afzelia	Albizia zygia	Anona
Anthocleista Nobilis	Anogeissus	Africana	butyrospermum	Senegalensis
Celba Pentandra Cola	Leiocarpus Afzeiia	Anogeissus	paradoxium	Piliostigma
Gigentea Ceitis	Africana Albizia	Leiocarpus	Daniellia	Thonningii
species Chlorophora	Zygia Terminalia	Butyrospermum	Oliveri Parkia	terminalia
Excelsa Khaya	Laxiflora Phylanthus	Paradoxium	Clappertoniana	Macroptera
Grandifolia Terminalia	Discoideus	Daniellia	Terminalia	termialie laxiflora
Sueperba Triplochiton	Anthocleista Nobilis	Oliveri	Piliostigma	Uapaca
scleroxylon Dracaena	Alchonea Cordifolia	Khaya	Amona	Togoenesis
Arborea	Uspaca Heudelottii	Senegalensis	Nauclea	Adenodolichos
Piptadeniastrum	Mitrogyna Inermis	Prosopis	Bombex	Adenodolichos
Africanum	Allophyllus Africana	Africana	Constratum	Paniculatus
	Erythrophleum	Uapaca	Andropogon	Chrossopteryx
	Suaveoleus	Togoensis	species	Febrituga
	Pendandus	Albizia Zygia		Detarium

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Lophira Alata	Canonelabrum	Vitex Doniana	Hyparrhenia	Microcarpum
Terminalia Invorensis	Borassus Aethiopium	Bombax	species	Hymenocardia
Anogeissus		Constatum	Imperata	Acida Afromosia
Leiocarpus, Albizia		Pterocarpus	Cylindrica	Lexiflora Lophira
Zygia Alzelia Africana		Erinaceus		Lanceolata
Elaeis Guineensis		Bridelia		Parinari
Khaya Senegalensis		Ferruginea		Curatellifolia
Erythrophleum		Anona		Nuclea Latifolia
Suaveoleus		Senegalensis		Pseudocendrela
		Parinari		Kotschyi
		Curatellifolia		Andropogon
		Crossopteryx		Gayanus
		Febrifuga		Andropogon
		Afromosia		Schirensis
		Laxiflora		Andropogon
		Andropogon .		Ascinoidis
		Brachiaria		Andropogon
		Deflexa		Pseudapricus
		Acanthacea		Hyparrhenia Rufa
		families		Hyparrhenia
		Araceae		sublumosa
		families		Hyparrhenia
		Gomelinaceae		Bateri
		families		Pennisetum
		Afranomum		Pedicellatum
		species		Schizachyrium
				Sanguineam
				Imperata
				Cylindrica
				Loudetia
				Arundinacea
				Butyrospermum
				Paradoxium
				Daniellia 0liveri
				Parkia
				Clappertoniana

Sources: Mabogunje (1976), Doxiadis (1983)

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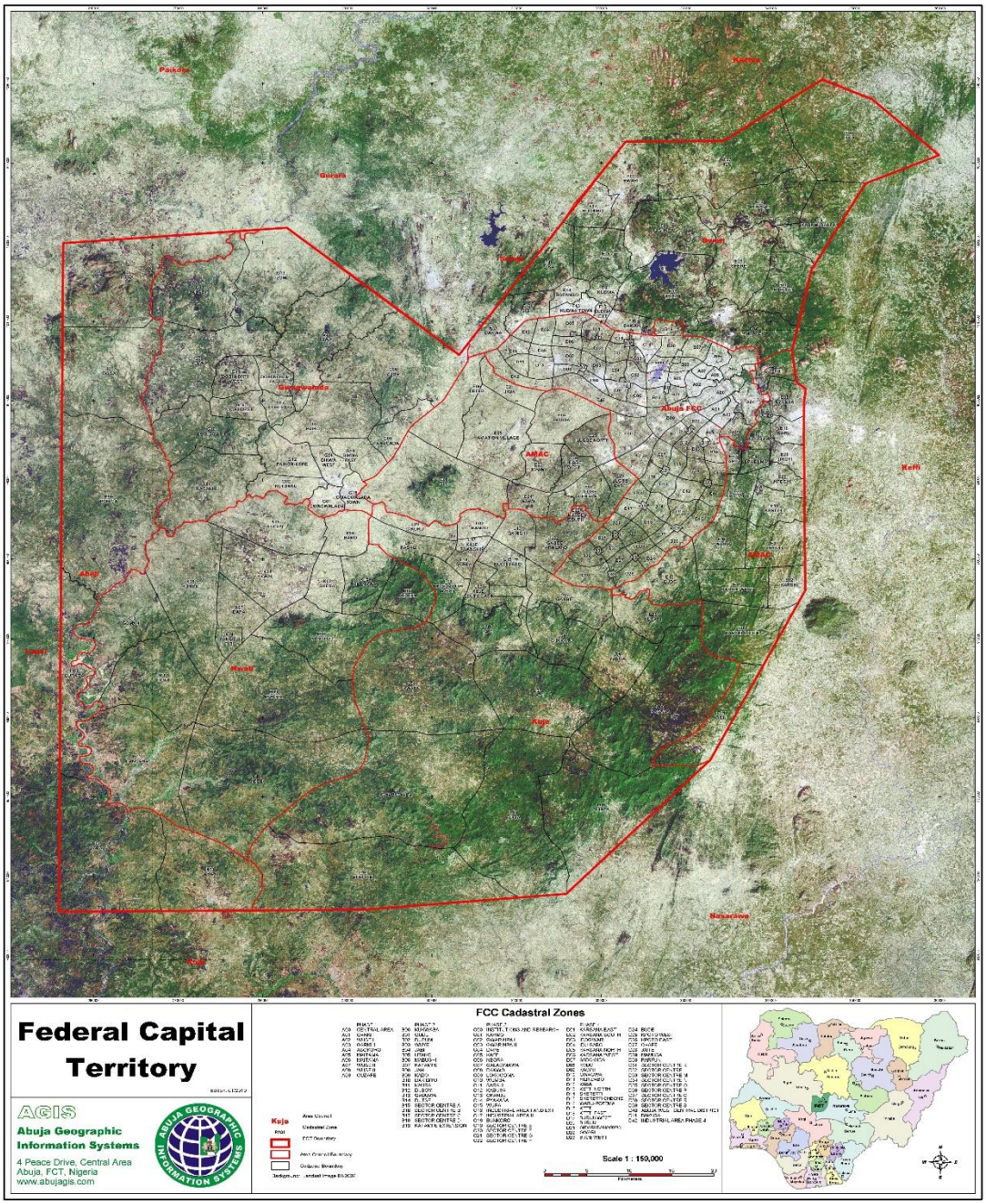

Figure i: Land use landscape composition of Abuja in 2006

Source: Abuja Geographic Information System (2006)

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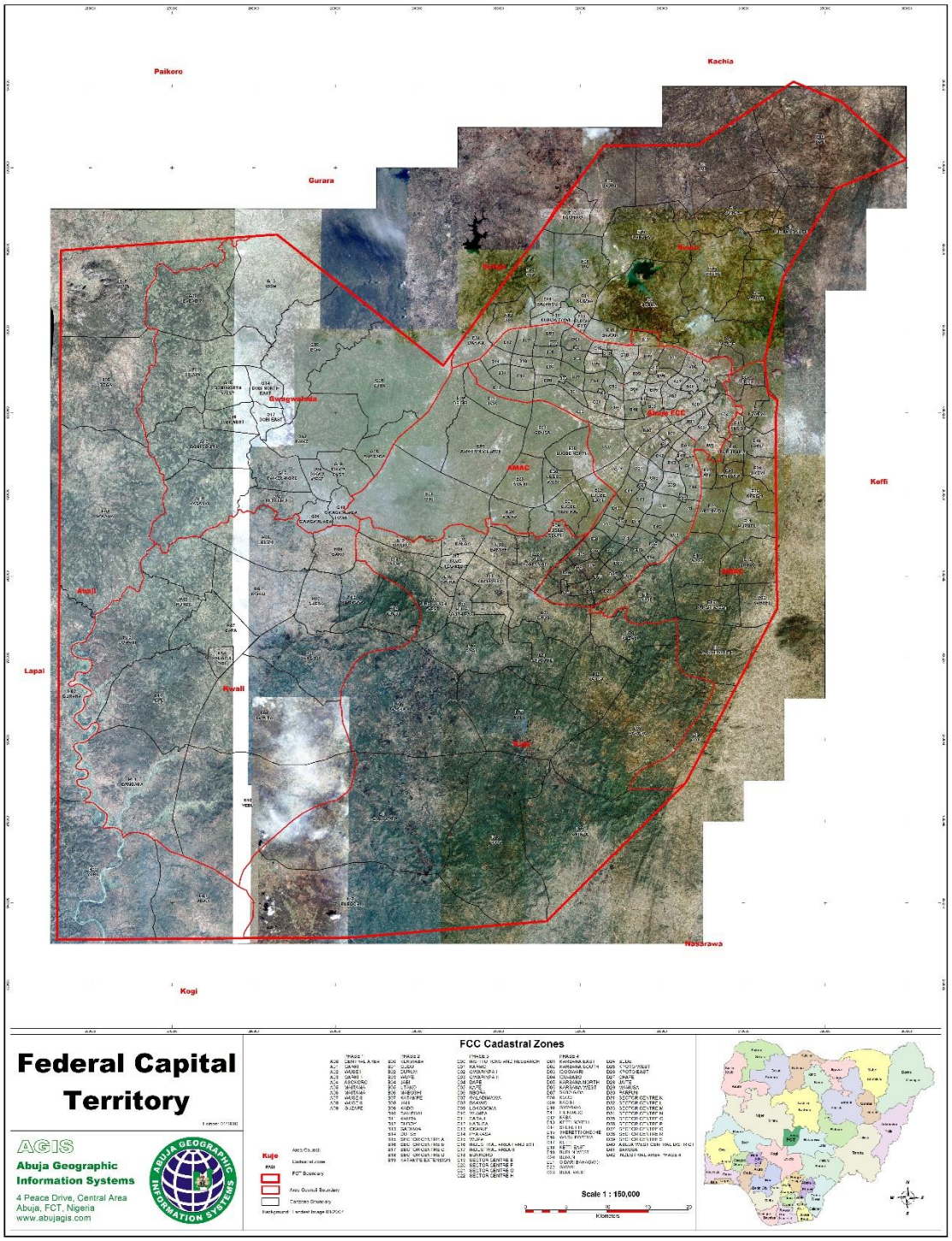

Figure ii: Land use and landscape composition of Abuja in 2009

Source: Abuja Geographic Information System (2009)

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Figure ii: Land use landscape composition of Abuja in 2021

Source: Abuja Geographic Information System (2021)

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Table 5: Landscape fragmentation and Land Use Change between 1983 to 2021

Types Of Distortion	Number Of Plots
Encroachment into Green	84 plots subdivided and allocated as residential 30 Neighborhood parks converted to corner shops
Encroachment on Sewer lines	70 plots
Encroachment on Water pipelines	166 plots
Encroachment into highway corridors	216 plots
Development of residences on plots allocated for educational institutions	22 plots
Conversion of green areas to agriculture use	200 plots
Conversion of green areas to cattle rearing(livestock farming)	50 plots

Source: Benna (2009), Author's Survey 2021

The study inferred, that in Abuja Landscape fragmentation and land use change has occurred significantly and the natural Landscape in Abuja has reduced to less than 10% (800 square kilometer) of the total Abuja land mass (8000 square kilometer).These conditions has led to tremendious climate change in Abuja, evidenced in the prevalent of flooding, harsh weather condition, increase frequency of fire outbreak, drying up of water source, increase in water scarcity,outbreak of tropical diseases; such as Changas diseases, echinococcosis, Leishmaniasis,Lymphatic filariasis and Burulli Ulcer(Olatunwa et al;2014 and WHO (2020).

Other effects of the climate due to landscape fragmentation in Abuja, includes food scarcity due to fluctuation in the period of rainfall, malnutrition due to low agricultural yields, drought, outbreak of respiratory diseases;such as Pulmonary tuberculosis(PTB) and acute lower respiratory tract infections(ALRTI) (Akor et al;2019); as well as increase in air pollution(Kasim et al; 2018)

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CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

The research concluded that Landscape fragmentation has social perspectives and influences human beings. It was also established that Landscape fragmentation and land use change in Abuja has brought about a devastating impacts on the natural landscape elements. Expressively, a total change to natural Landscape; as envisaged as conceptualized in the Abuja Master; was observed to have occurred in Abuja leading to the destruction of the areas wilderness heritage. The effects are the mirage of climate change effects and diseases outbreak in Abuja; as well as the difficulty faced by the Authority in the implementation of Abuja Master Plan.

Therefore, the study concluded that Landscape fragmentation and Land use change is an Ecological and Social problem. Consequently, the study identified degradation (change from green area to other Land Use) as one of the major Landscape fragmentation processes experienced in Abuja. Thus, the Federal Capital Territory Administration (FCTA) through the Department of Urban and Regional Planning should consider a prohibition of any change of Land Use that involves green or landscape areas.

Also, there is the need for the provision of incentive programs in form of a reduction in Ground Rent for Developers who develops the landscape area of their proposal as approved by the Planning Authority. The Study also established that in Settlements inhabits by the Abuja Natives, intensification involving changing of green areas to intensive Agricultural Use was the predominant land use change and landscape fragmentation processes identified in the study area. In like manner, Federal Capital Territory Administration need to ensure that adequate Farm Land is provided in Resettlement Layouts, to enables the Natives continue with Farming as a traditional occupation of the Original Inhabitants of the Nation's New Federal Capital Territory, Abuja.

Additionally, other forms of Land use change and Landscape fragmentation practice identified in the study area, includes the conversion of Landscape areas into Cattle Rearing (livestock Farming). Forthwith, Federal Capital Territory Administration should ensure the implementation and Construction of all designated Grazing Reserves as provided in the Abuja Master Plan. The study further recommend that all areas designated as Protected Areas should be kept intact and holistically implemented as conceptualized in the Abuja Master plan.

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