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ASSESSMENT OF THE EFFECT OF MARGINAL LAND ENCROACHMENT ON THE PHYSICAL ENVIRONMENT OF SULEJA, NIGER STATE, NIGERIA

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ABSTRACT

There is a link between recent marginal land policies and targets, increased demand for crop expansion, and adverse land use changes hereafter referred to as 'marginal-driven land use change. The large-scale problems of unprecedented population growth and inappropriate development are degrading the land, water, and atmosphere, and progressively

INTRODUCTION

Land is required for various uses in both the urban and rural areas of all society. It is a major factor of production and a vital element in the socio-economic development of any country or society (FMH&UD, 2006). Thus, as nations grew in size and rural areas become urban centers and urban centers become large metropolitan areas, there is always increased competition as well as demand for land for different purposes. This requires adequate planning and control to ensure harmonious development and functional efficiency of these uses and settlements. To achieve this fundamental and acceptable activity, layouts of various land uses such as residential, commercial. Industrial, open spaces and recreation, circulation and institutional uses among others are undertaken to standardize and control physical developments and ensure harmonious growth. To ensure adequate provision of these uses and meet

extinguishing a broad array of the Earth's organisms and the habitats they inhabit. By downplaying these problems or putting them aside in favor of what seem to be more imperative personal, group, or national priorities, we are courting global disaster. This study is geared towards analysis of the spatial transformation of marginal land in Suleja area and its environmental implication. Primary source of data was obtained from questionnaire administration and field observations about landuse in the area. Normalized Difference Vegetation Index (NDVI) was used to ascertain the environmental effect (land cover) of encroachment on marginal land. Data from the research was processed using image processing to obtain the desired output using Erdas Imagine 9.2. Change in the land use types was determined through: (i) Calculation of the Area in hectares of the resulting land use/land cover types for each study year and subsequently comparing the results(ii) Overlay/change detection Operations and (iii) Accuracy assessment. Findings revealed that there is no marginal land identified in Maje except in Suleja. Bareland experienced 16.8% decrease, water body experienced 93.0% decrease, and vegetation experienced 38.0% decrease. While, built-up area experienced 37.3% increase. which implies encroachment of development into marginal land. The identified effects of building on marginal land are: Erosion with 87.5% and 93.5% in Suleja and Maje respectively, Flooding recorded 58.35% and 71.0% in Suleja and Maje respectively, and air pollution. Based on the findings of this study, the following recommendations were made among others; development control which is an instrument for overall environment quality control should be effectively applied by Niger State Urban Development Board (NUDB) to eliminate the dangers of development on marginal land and ensure their sustainability.

Keywords: *Marginal lands, Landuse, Landcover, Physical environment, Encroachment*

the needs of users of urban facilities and services land allocation and space standards are necessary.

Several studies have shown that inadequate planning of urban land uses in Nigeria and great intensity of use has exacerbated urban problems (Onibokun and Faniran, 2015). Studying land use dynamics is essential in order to examine various ecological and developmental consequences of land use change over a space of time. This makes land use mapping

and change detection relevant inputs into decision-making for implementing appropriate policy responses (Fasona and Omojola, 2005). We as a species are rapidly altering the world that provides our evolutionary and ecological context. The consequences of these changes are such that they demand our urgent attention. The large-scale problems of unprecedented population growth and inappropriate development are degrading the land, water, and atmosphere, and progressively extinguishing a broad array of the Earth's organisms and the habitats they inhabit. By downplaying these problems or putting them aside in favor of what seem to be more imperative personal, group, or national priorities, we are courting global disaster. By attending to them, we can begin to build a more stable foundation for lasting peace and prosperity (Plyzos and Minetos, 2009).

This high rate of population growth in Suleja and environs was generated by its proximity to the Federal Capital Territory which leads to the concentration of workers from Abuja who settled in Suleja due to the high cost of accommodation in the city of Abuja. It is more observable on humans and environmental poverty, the declining quality of life and the problem of encroachment (Sanusi, 2007). Therefore, Suleja is witnessing tremendous change in its current status from a quiet life to a high prolific town with a new experience in economic advantages. With this drastic change, residents in Suleja are forced to move into the suburb for cheap accommodation, thereby converting agricultural and marginal land to built-up areas.

A large number of studies (Gibbs *et al.*, 2011; Nepstad *et al.*, 2010; Searchinger*et al.*, 2012; Al-Riffai, Dimaranan and Laborde 2010; Tyner *et al.*, 2013) have suggested a link between recent marginal land policies and targets, increased demand for crop expansion, and adverse land use changes hereafter referred to as 'marginal-driven land use change.But, there is a dearth of research in this topic in Suleja. The urbanization of Suleja has generally been rapid and chaotic with deficiencies in regulation and infrastructural development within the fringes. It is important to note, therefore, that detailed analysis should be carried out as this study attempts to do, in order to understand the vulnerability level of landuse. This could be achieved through systematic,

comprehensive and elaborate evaluation of those changes in these areas in order to ascertain the level of changes, impact, percentage and trend of land-use hazards to be "condoned". This study is aimed at analysing the spatial transformation of marginal land in Suleja area and its environmental implication.

Study Area

Suleja is a city in Niger State of Nigeria just north of Abuja, capital of Suleja emirate, it lies between latitude 9° 6'N and 9° 17'N and longitude 7° 6'E and 7° 12'Eas shown In Figure 1. It has an area of 136.33 Km2with the estimated population of approximately 635,314 (NPC, 2011) as at 2012. Due to its proximity to Federal Capital City (Abuja), the population keeps on increasing on daily basis not only because of natural increase, rather due to migration to FCT and lack of accommodation and cost of living in the FCT. The city was originally called Abuja before the Nigerian government adopted the name from the then Emir Sulayman Barau for its new federal capital in 1976. Suleja Emirate is made up of three Local Governments, namely Suleja, Tafa and Gurara. However, the social and economic influence of Suleja city covers the two other local governments.

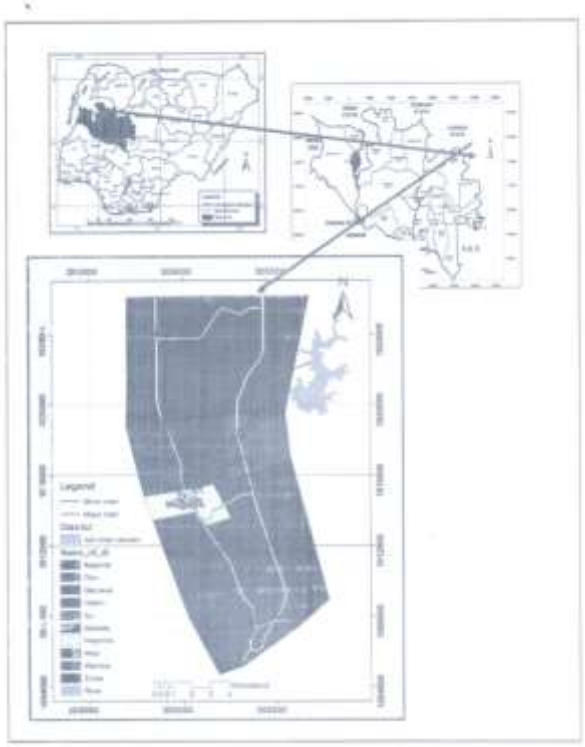

Figure 1: Location of Suleja
Source: Niger State Ministry of Land and Housing, Minna

LITERATURE REVIEW

Marginal Lands

Many different names are used to designate lands in terms of their production, fertile, marginal, low potential and high potential, fragile, vulnerable or degraded. Terms which relate to "marginal" areas are frequently used

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interchangeably and often without definition. The difficulty in formulating a clear definition stems from the fact that "productivity" varies according to the type of land use. A tract of land that is "marginal" for crop production may be well suited for grazing. "Fragile" lands may be sensitive to degradation under cultivation but may be sustainably used for forestry (Ceng, 2010).

The concept of marginal lands has evolved across time, space, and discipline. The concept is often interchangeably used with other terms such as unproductive lands, waste lands, under-utilized lands, idle lands, abandoned lands, or degraded lands (Sugrue, 2008; Wiegmann *et al.,* 2008), The meanings of marginal land and its application domains vary across regions, countries and organizations by emphasizing their different management goals (Fargione*et al.,* 2008; Tang, Xie, & Geng, 2010; United States Department of Agriculture - Natural Resources Conservation Services (USDA-NRCS, 2010).

Early concepts of marginal land emerged in the discipline of agricultural economics, and can be traced back to the 19th century. Ricardo (1817) mentioned the idea of marginal lands in his land rent theory. Different marginal cost of lands would cause fluctuations in total production cost by shifting labor and capital, suggesting the farming trend between marginal lands and higher quality lands. The theory became the foundation of the marginal productivity theory. Hollander (1895) defined marginal lands as the poorest lands utilized above the margin of rent-paying land. Later, the concept of marginal land was systemically discussed by Peterson and Galbraith (1932) who examined the major variables associated with marginal lands, and proposed to dynamically determine locations of marginal lands. The three terms, physical marginal lands, production marginal lands, and economic marginal land were used under different backgrounds and concerns. In Europe, marginal lands have been defined as the land uses at the margin of economic viability (Strijker, 2005). Schroers (2006) defined more clearly an economically marginal land as "an area where a cost-effective production is not possible, under given site conditions, cultivation techniques, agricultural policies as well as macro-economic and legal conditions".

Table 1: Land capability classification (LCC) derived from USDA-NRCS (2010)

Class	Description
1	Slight limitations that restrict their use
2	Moderate limitations that restrict the choice of plants or that require moderate conservation practices
3	Severe limitations that restrict the choice of plants or that require special conservation practices, or both
4	Very severe limitations that restrict the choice of plants or that require very careful management, or both
5	Little or no erosion but have other limitations, impractical to remove, that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat
6	Severe limitations that make them generally unsuitable for cultivation and that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat
7	Very severe limitations that make them unsuitable for cultivation and that restrict their use mainly to grazing, forestland, or wildlife habitat
8	Miscellaneous areas have limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, watershed, or aesthetic purposes

Source: USDA-NRCS, 2010

Dynamic Characteristics of Marginal Lands

Many marginal lands are dynamic because of land use changes and social-economic impacts. Marginal lands are a transitional state of land resources, and very sensitive to natural processes and varied managements (see Figure 2.2). Poor management of productive lands could cause land degradation. Marginal land can be enhanced or restored to productive lands by improving land functions. Another major driving force affecting the value of marginal lands is the market mechanism determined by socio-economic drivers. With the change in demand, the margin of land cultivation will advance or recede (Plyzos and Minetos, 2009). The decrease of land rent and increases of market

demands change marginal profits and breakeven prices, and may finally lead to conversion of marginal lands into production. Places of economic paradox were employed to describe the dynamics and variability of marginal lands (Pollard, 1997) summarized the trend of marginal land in Europe from the Middle Ages, and indicated that marginal lands have been significantly subject to economic development and food demands. Marginal land in Europe has been declining as a result of increasing labour costs and intensification of agriculture (Strijker, 2005). Certainly, policies, incentives and regulations are among driving variables causing land use change (Strijker, 2005; Perlack, 2007; James, Swinton, & Thelen, 2010). All these driving variables obviously push farmers to reclaim or abandon marginal lands because of changing breakeven prices. Hence, marginal lands may not remain marginal, depending specific circumstances. Transitional characteristics of marginal lands would be critical for describing marginal land dynamics, and should be fully considered when marginal lands are assessed and managed.

Marginal Landuse in Nigeria

The increasing level of urbanisation and the inadequacy of urban infrastructure in Nigeria have been reported by various analysts (Mabogunje, 2001; Ojo, 1978; Onibokun, 1987; Mabogunje, 2003). Nowhere is the shortage of infrastructure visible as in housing. Housing inadequacy leads to many forms of adjustments by the urban dwellers including illegal development, especially residential development on ecologically unstable land. Ecologically unstable lands consist of land which by their characteristics can be subject to disaster and which when occupied may threaten human life and environmental quality. They are seen as lands which are prone to mass failure under natural conditions and where human activities are likely to increase landslide distribution in time and space (Guthrie, 2002). They include flood plains, hill tops and slopes. As a result of their nature, such lands remain marginal. That is, they are of low quality with regard to agricultural use and unsuitable for housing development and often, they are the last land to be brought into use.

In the attempt to compensate for the deficiency in formal housing facilities, ecologically unstable land becomes attractive. First, because such lands will always attract lower cost and second, because such lands do not command caring attention from governments. The nature of such land and the weight of poverty generate interactions between urban poor and the land in form of informal housing development. To the poor urban dwellers, ,,informal housing is to a larger extent housing for the poor than informal employment is employment to the poor" (Spence *et al.,* 2009). As noted by Mabogunje (2001), it is not unexpected that part of the disabilities of the urban poor is that an increasing proportion of them are condemned to live in marginal and environmentally vulnerable location largely due to scarcity of land and the inappropriate settlement practices and policies". The disposition of the poor in using ecologically unstable land is premised around the importance of land and housing in building assets. They serve as safety elements in the urban livelihood system (Kruger, 2004). Within this context, the informal settlements emerging from the development of such lands generate more marginality. Such settlements exist because of the enterprising spirit of their inhabitants (Yapi-Diahon, 1995).

From the point of view of urban governments, such settlements are sources of urban ills and hence, governments either neglect the settlement or evict the people. Whether such settlements are in form of squatter or sprawl, the danger of slums looms high over them. Negligence means deprivation in the provision of urban basic facilities and attention may mean loss of their shelter and even livelihood activities. Similarly, informal settlements on ecologically unstable land are sources of serious environmental and health consequences. For example, Plyzos and Minetos (2009) submits that the impacts of this type of settlements ,,are great and pressuring ranging from landscape aesthetics deterioration, biotic diversity threats, desertification and forest and open land squeeze to increased vulnerability to human settlements and local water contamination". Hence, such settlements are not only seen as informal, they are also called precarious settlements (Yapi-Diahon, 1995). To some analysts, ecosystem functions are reduced by urbanization (Alberti, 2008). So, developing ecologically unstable land

may heighten the reduction of ecological functions. While both the merits of the development of ecologically unstable land and the danger they pose are recognized, the means of analysis is also important. This is the focus of this study based on Suleja, Nigeria.

RESEARCH METHODOLOGY

Data required for this research was collected from both primary and secondary sources. The primary source of data was obtained from questionnaire administration and observations. While, the secondary data comprised of remote sensing data. The land use and land cover data includes; remote sensing data (Land sat TM/ETM imageries of the study area for 1999, 2009 and 2019 with path 189 row 53. This serves as the fundamental dataset for which supervised classification was carried out with various categorizations to ascertain the different changes in the land use over time and upon which future predictions of land use change was based.

The process of data analysis for this study was divided into two phases: Land use and land cover change assessment and trend analysis that indicated the changes in land use and land cover of the study area. In assessing the land use land cover change in the study area from 1999 to 2019, image classification was carried out to map out the various land cover of the entire study area. Four major categorizations were considered which includes; Built up area, Bare Soil, Vegetation, and Surface water bodies. Image functionality in Idrisi Taiga was used to carry out the classification. Analysis of change for the next phase of the assessment involved the calculation of percentage change in the study areas that is occupied by the various land cover categorization from 1999 to 2019 which showed the trend for further analysis.

Satellite Landsat imagery of 1999, 2009 and 2019 was acquired. Quick Bird imagery of 2019 was also acquired to compliment the low resolution of Landsat. Landsat TM imagery of 1999, Landsat ETM imagery of 2009 and Landsat ETM + of 2019 (Table 1) was subjected to digital image processing which included image classification and accuracy assessment. High resolution satellite imagery of the area was used as a base map for the study, topographic contours of the area will be generated and

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overlay on the imagery, field survey was carried out to also identify the marginal landuse in the study area, the geographical coordinate of the identified marginal land was captured using GPS (See Table 2).

Table 2: Remote Sensing Data used for the study

S/N	Data	Resolution	Year	Source
1	Landsat ETM	30 Metres	1999	GCLF
2	Landsat ETM +	30 Metres	2009	GCLF
3	Landsat ETM +	30 Metres	2019	GCLF
4	Quick Bird imagery	0.6 Metre	2019	INFOTERA

Source: Author's compilation, 2019

The research population was derived from National Population Commission. The areas covered 21 census enumeration areas, with the population of 18,288. Therefore, the total population of the study area was used as sample frame for this research. Sample size was calculated from the population using the National Average household size. The study projected the total population of the area using the formula PF= PP (1+r) n at the growth rate of 3.5% for 12 years up to 2019.Questionnaires response was subjected to statistical analysis using SPSS, descriptive analysis was used, result was presented in tables and figures.

RESULTS AND DISCUSSION OF FINDINGS

Marginal lands in the Study Area

The study area comprises of two settlements in Suleja Local Government Area of Niger State namely Suleja, and Maje. The marginal land is identified through satellite imagery and the characteristics of the neighbourhoods and the buildings were assessed descriptively.

In order to identify the marginal land based on their level of height, whether low land or high land, the contour level is classified into; low land: 260 – 355; moderate low land: 356 – 430; high land: 431 – 475; very high land: 476 – 550; and very very high land: 5511- 675.

Marginal land in Suleja

The surface imagery of Suleja indicating the boundary is shown in Figure 4.3, this image shows the existing development situation in the Suleja. Suleja is a linear settlement aligned along Madalla–Maje road and extended to Zuba–Kaduna road, characterised by nucleated buildings.

The overlay contour generated over the surface satellite imagery of Suleja is shown in Figure 4.4, the area at the first class 260 – 355 with green colour good for residential development has no development around it due to absent of road, the second group has development spread around the area, and the area is also gentle and good for residential development. The third class 431 – 475 contour height, which can be asserted as marginal land due to the steeply slope has residential development on it, likewise the four class 476 – 550, which is hilly also has residential development on it.

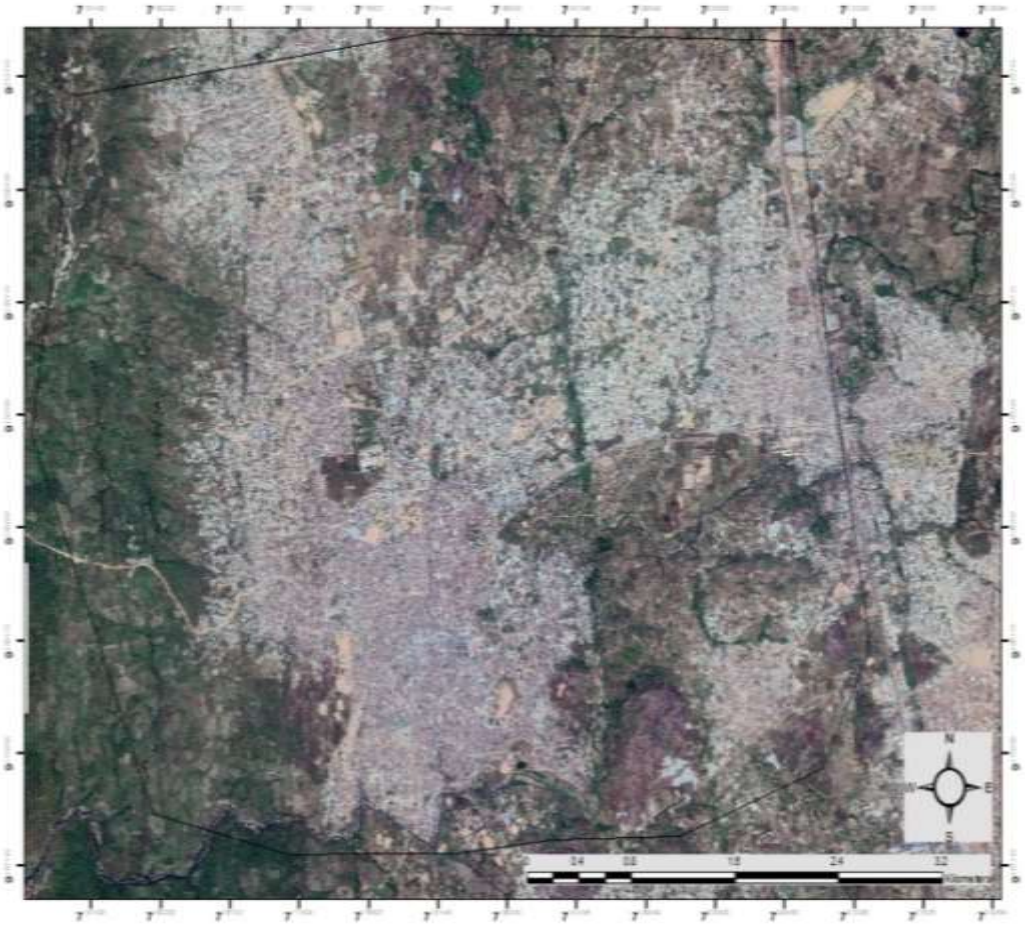

Figure 4.3: Satellite imagery of Suleja

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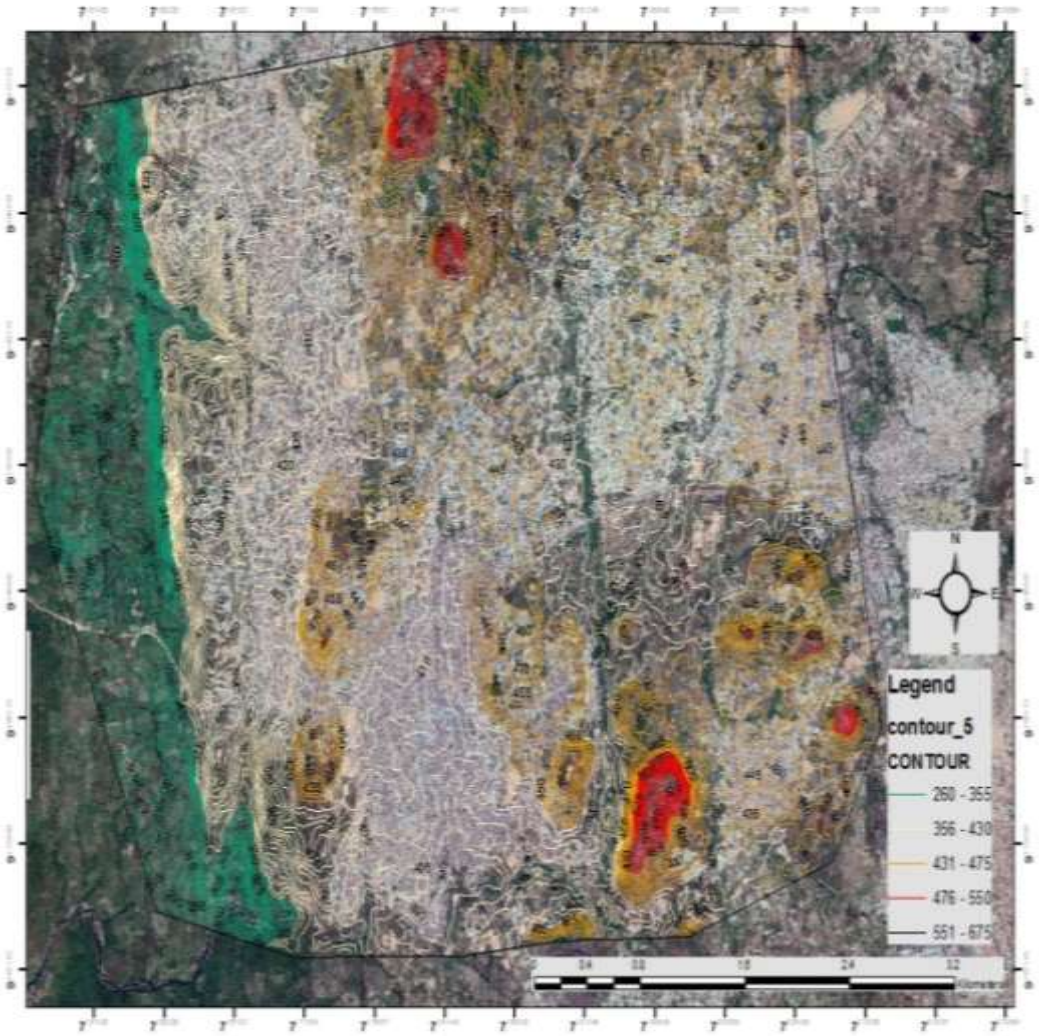

Figure 4.4: Satellite imagery of Suleja with contour overlay

Marginal land in Maje

The surface imagery of Maje indicating the boundary is shown in Figure 4.5, this image shows the existing development situation in the Maje. Maje is a linear settlement aligned along Suleja–Paiko road, characterised by nucleated bungalow buildings.

The overlay contour generated over the surface satellite imagery of Maje is shown in Figure 4.6. Maje is located on contour class 431 – 475 and class 476 – 550 which are both high land but the contour were gentle with much gap in-between them, which makes the land flat and suitable for residential development. No marginal land is identified in Maje settlement.

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Figure 4.5: Satellite imagery of Maje

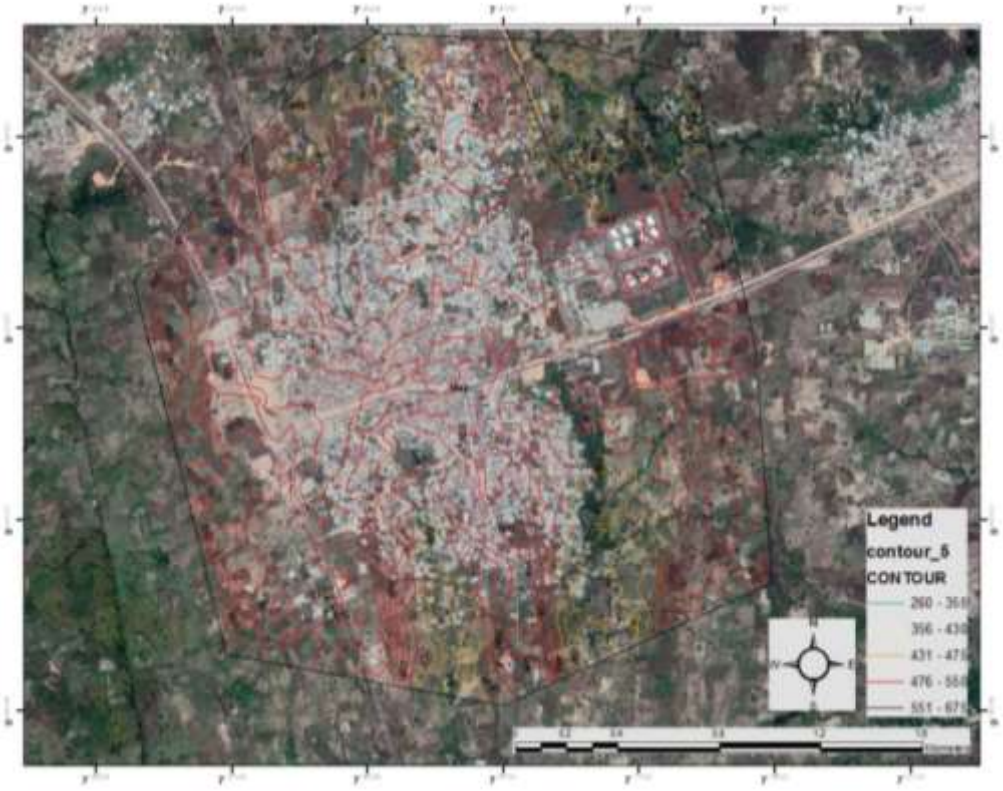

Figure 4.6: Satellite imagery of Maje with contour overlay

Spatio-Temporal Trend in Marginal Landuse from 1999 to 2019

Land use and land cover classification of 1999, 2009 and 2019 are presented in the Figures 4.7, 4.8, 4.9, 4.10. In 1999as presented in Table 4.6, water body is 1.29‰, built up area is 21.71%, vegetation is 39.87‰ and bareland is 47‰, it shows that bare land has the highest percentage. The result of 2009 land use and land cover analysis as shown in Table 4.7 indicated that waterbody decreased from 1.29‰ area cover to 0.02‰, vegetation decreased from 39.87‰ to 29.50‰ and bareland also decreased from 47.70‰ to 43.84‰, while built up area increased from 21.71‰ to 26.64‰. In 2019, the result as shown in Table 4.8 shows that bareland decreased to 39.71‰, vegetation decreased to 24.71‰, while built up area and water body increased to 0.98‰ and 34.60 respectively. The decrease in bareland, waterbody, vegetation and increase in built up area also implies encroachment into marginal land.

Table 4.6: Statistics of LULC_1999

FEATURES	AREA(hect)	PERCENTAGE_1999
WATERBODY	167.4	1.29
BUILT UP AREA	2821.32	21.71
VEGETATION	5180.94	39.87
BARELAND	6164.01	47.70
TOTAL	12994.65	100.00

Table 4.7: STATISTICS OF LULC_2009

FEATURES	AREA(hect)	PERCENTAGE_2009
WATERBODY	1.98	0.02
BUILT UP AREA	3442.64	26.64
VEGETATION	3812.32	29.50
BARELAND	5666.04	43.84
TOTAL	12923.18	100.00

Table 4.8: Statistics of LULC_2019

FEATURE	AREA(hect)	PERCENTAGE_2019
WATERBODY	114.84	0.98
BUILT UP AREA	4057.83	34.60

VEGETATION	2897.73	24.71
BARELAND	4656.88	39.71
TOTAL	11727.28	100.00

Table 4.9: Change Detection Statistics

FEATURES	LULC_1999	LULC_2009	LULC_2019
WATERBODY	1.29‰	0.02‰	0.98‰
BUILT UP	21.71‰	26.64‰	34.60‰
VEGETATION	39.87‰	29.50‰	24.71‰
BARELAND	47.70‰	43.84‰	39.71‰

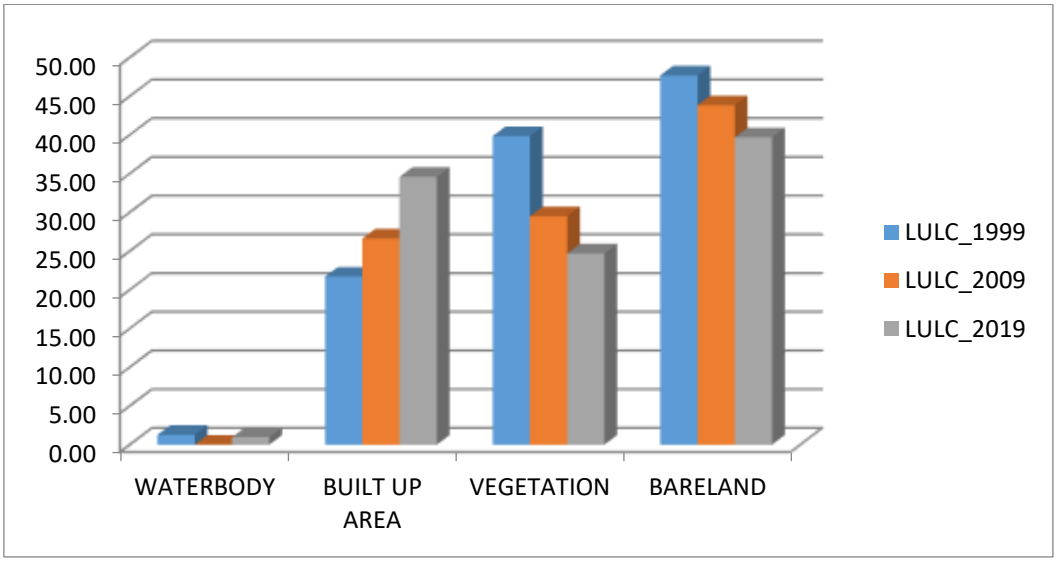

Figure 4.7: Bar chart of LULC of 1999, 2009 and 2019.

Effects of Building on Marginal Land

Environmental Effects of Building on Marginal Land

Three environmental effects of building on marginal land tested include; erosion, flood, and air pollution based on the previous encountered and level of impacts. The environmental effect of erosion based on the previous encountered as presented in Table 4.10 shows that in Suleja 87.5% agreed to erosion while 12.5% disagreed, and in Maje 93.5% agreed to erosion while 6.5% opined that there is no erosion.

The environmental effect of flood based on the previous encountered as presented in Table 4.11 shows that in Suleja 58.35% agreed to previous experienced of flood while 41.7% disagreed, and in Maje 71.0% agreed to

experienced of flood while 29.0% opined that there is no previous experienced of flood.

Plate I: Erosion sites

The environmental effect of air pollution based on the previous encountered as presented in Table 4.12 shows that in Suleja 83.3% agreed to previous experience of air pollution while 16.7% disagreed, and in Maje 77.4% agreed to experience of air pollution while 22.6% opined that there is no previous experience of air pollution.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The issue of marginal land use has sparked up interests on future land use management for several disciples and nations. Globally, marginal land plays a critical role in the production of food and bioenergy due to the growing pressure of limited land resources. However, environmental, and sustainability concerns have been widely raised over the use of marginal land. Knowledge of the extent, location, and quality of marginal lands as well as their assessment and management are limited and diverse which is the contribution of this study in bridging the existing gap.

In the years that span 1999, 2009, 2019, there has been a and a steady decrease in the size of bareland, waterbody, and vegetation, whereas there has been an increase in built up area which implies encroachment of development into marginal land. This study has been able to establish the fact that there has been increasing encroachment into marginal land

in Suleja. Erosion, flooding and air pollution are some of the effects of encroachment into marginal land in the study area with consequent environmental impact. Harbouring of rodents and reptiles, danger of building collapse; health risk; and awareness that the area is prone to erosion are the perception residents have on the dangers of development on marginal land.

Recommendations

The following recommendations are proffered based on the findings of the study:

1. Development control which is an instrument for overall environment quality control should be effectively applied by Niger State Urban Development Board (NUDB) to eliminate the dangers of development on marginal land and ensure their sustainability.
2. With the increasing population in the study area and the pressure on land resources due to its proximity to the Federal Capital, Abuja, the direction of development should be directed away from marginal lands by NUDB, Ministry of Lands, Survey and Housing and the Suleja Local Government to stop encroachment into marginal land.
3. Risk and vulnerability assessment should be carried out by Niger State Emergency Management Agency (NSEMA) to ascertain the number of people at risk to the effect of erosion, flooding and air pollution and the degree of vulnerability to these identified hazards. This will guide decisions to be taken by relevant authorities for effective management of marginal land and to mitigate impending disaster.

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