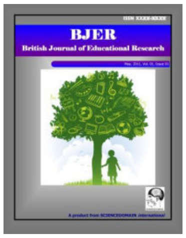

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Analytical Approach to Examining Drivers of Residential Land Use Development in Lokoja, Nigeria

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Case Study

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ABSTRACT

Aim: To analyse the statistical relationship between residential land-use development and socio-economic and bio-physical variables.
Study design: Case study.
Place and Duration of Study: Lokoja in Kogi State of Nigeria ,which lies within latitude 7º45´N and 7º51´N and longitude 6º41´E and 6º45´E of Greenwich meridian, February 2010 and May 2011
Methodology: The two sets of data source used in the study were questionnaire responses to get information on the socio-economic background of the people, and the satellite images to access information on the physical characteristic of the area. 996 questionnaires were returned out of the 1000 distributed to 10 neighborhoods zones in the town. The Arc View 9.2 was utilized with the help of its geo-processing extension to analyse the land sat image of Lokoja recorded in September 2010. This landsat thematic mapper (ETM+) satellite image of 2010 was used to derive different landuse types, it was rectified terrain corrected and geo-referenced to local UTM zone. The land sat image was processed using ERDAS imaging 8.6 software. Logistic Regression Analysis (LRA) was used analyze the selected factors of landuse determinants and factors of land use change , in this case emphasis is on bio-physical and socio-economic factors . The logit model is used to relate the probabilities and the locational characteristics of a particular land use. This is done by finding the coefficient (ß) of the logit model. A logistic regression procedure is used with actual landuse as dependent variable. The SPSS statistical package is then used to regress land use upon the change factors.
Results: The result shows that proximity to infrastructure is significant at a probability level of 1%, the significant Chi Square value (55.4 df 14, P < 100) and high correct classification

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percentage of 78%, which is indicative of the perfect fit of the model in explaining the relationship between independent and dependent variable. The R square of Nagelkerke also indicates 38.2% of the total variance in the dependent variable (residential development) was explained with independent variables. The variable elevation shows a significantly negative relationship which implies that residential land development will decrease as elevation increases i.e. one unit increase in elevation will cause the odds of residential development to decrease by a factor of 0.480. Also the Logit result shows that road condition has a significantly negative relationship with residential development , indicating that the higher the density of roads the less the probability of residential land development in the city, where the increase in one unit road presence causes the odds of residential land use development to decrease by a factor of 0.840, this is however contrary to the initial assumption .The result also shows a significant negative relationship between residential land development and population density, which implies the lower the population density the higher the probability of residential land development, the decrease of one unit population density causes the odds of residential area development to increase by a factor of 0.926. However the result did not indicate any significant relationship between drainage, education, land price, proximity to water and soil type or flood potential.

Conclusion: The findings indicated that elevation variables and nearness to infrastructure has a positive significance in residential land development which is supported by previous assumptions. The result did not indicate significant relationship with the soil type, and most physical variables. The inclusion of socioeconomic variables made a difference in the total variation which is indicative of its strength as a strong predictor of residential land development as compared to biophysical variables. The result could be utilized to generate spatially explicit explanation to study residential land use change.

Keywords: Residential land use; biophysical; socio-economic factor; Logistic regression;

1. INTRODUCTION

Lokoja, the study area has been going through rapid growth since change in status to a state capital in 1991, also due to its geographical location as a confluence town and bridge town between the northern and southern Nigeria. It now represents area of break of bulk point. since commencement of the dredging of the river Niger which in anticipation will enable goods to be transported through the inland water way from southern seas .Also the recent siting of a federal university which will make the city a university town, have all led to the swelling of the town's population which subsequently has led to scramble for residential lands and consequently scarcity of housing. These consequently have led to haphazard development in areas hitherto unfavorable to residential location, which is tending towards unsustainable development and destruction ecological balance.

Most studies carried out on rapid urban development have been carried out in other countries to explain factors of urban land use change to predict and determine how residential land can be sustainably managed. Bliss et al. (1996) in their study suggested a correlation between natural resources and Afro-American shaped by resource dependency. Veldkamp et al. (2001) and Gyawali et al. (2004) suggested biophysical variables are better predictors of landuse change than socio-economic variables. Wallace and Knight (1996) attempted to address the spatial detection of residential urban expansion by considering the relationship between natural resources, people and poverty; Leslie (2000) also analysed this relationship and found that spatially explicit explanation for the cause of poverty. Alabi (2009) in his study found that residential areas are now sited on areas which were once prime agricultural lands, wet lands and areas of physical constraints due to scarcity of land. Gyawali et al. (2008) summarized these literature , by agreeing with Rindfuss et al. (2003), that there is a need for “level of analysis at fine scale”, in order to understand the factors in a better way that shape the residential landuse development in the city. This study therefore attempts to analyse the relationship between biophysical and socio-economic factors that influences residential land use development.

1.1 Theoretical Framework

When there is competition for residential land it is usually assumed that the financially disadvantaged people that are socially marginalized and the poor are relegated to poor lands and bad terrains, they are pushed to area of constraints where there are no access roads, badland topography, poor soil quality, far from infrastructure, poor drainage condition, and flooded area. Such data is aggregated and analysed using multiple regressions such as logit to identify which variables could explain residential development and what combination of the variables generates the best fit and what proportion of the variable is accounted by socio-economic and biological characteristics. However literature has shown that low income, elevation, inefficient geography have negative effect on residential development, also that residential development is induced through favorable ecological characteristic such as favorable road network, nearness to amenities and facilities, which could in turn increase human population and attract investors (Skole and Davids , 2002; Gyawali et al., 2004).

2. MATERIALS AND METHODS

2.1 Study Area

Lokoja is located in Kogi State of Nigeria and lies within latitude 7º45´N and 7º51´N and longitude 6º41´E and 6º45´E of Greenwich meridian (figure -1). It is situated at the confluence of river Niger and river Benue and lies in the western bank of the river Niger at an altitude of 45 – 125 meters above sea level (asl) towards the north-west and at the foot of the Patti ridge, which rises to an altitude of 400m asl. It is basically made up of 11 neighborhoods (figure -2)

Before the creation of Lokoja as a state capital, the population was below 40,000 and by 1991 it increased to 43,784 (Kogi State Ministry of Budget and Planning). The 2006 census declared that over 196,643 persons inhabit Lokoja (National Population Commission, 2010). It has a heterogeneous population with various tribes from all parts of Nigeria.

2.1.1 Data sources and methodology

The two set of data source used in the study, were questionnaire responses to get information on the socio-economic background of the people, and the satellite images to access information on the physical characteristic of the area.

996 questionnaires were returned out of the 1000 distributed to 10 neighborhoods zones in the town (figure-1). The Arc View 9.2 was utilized with the help of its geo-processing extension to analyze the land sat image of Lokoja recorded in September 2010.

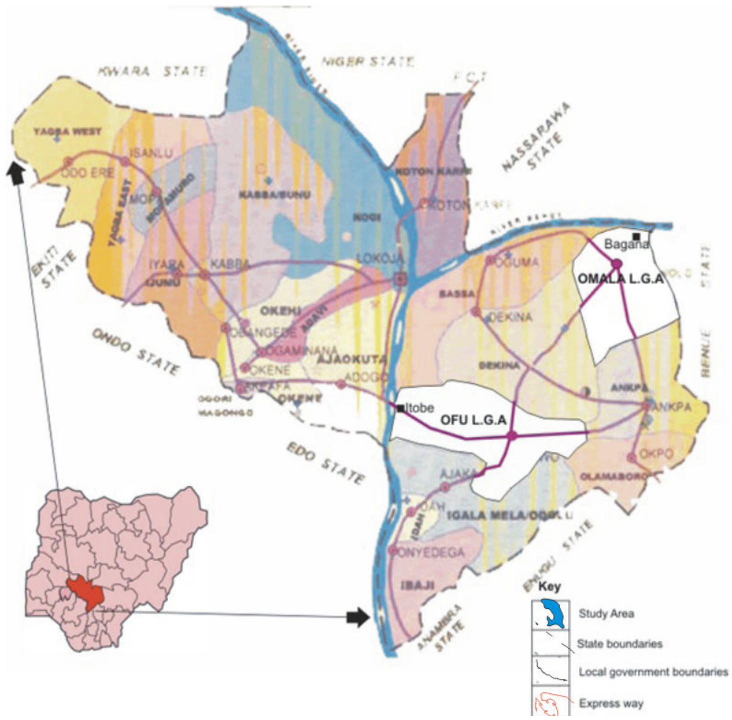

Figure 1: Kogi state showing Lokoja

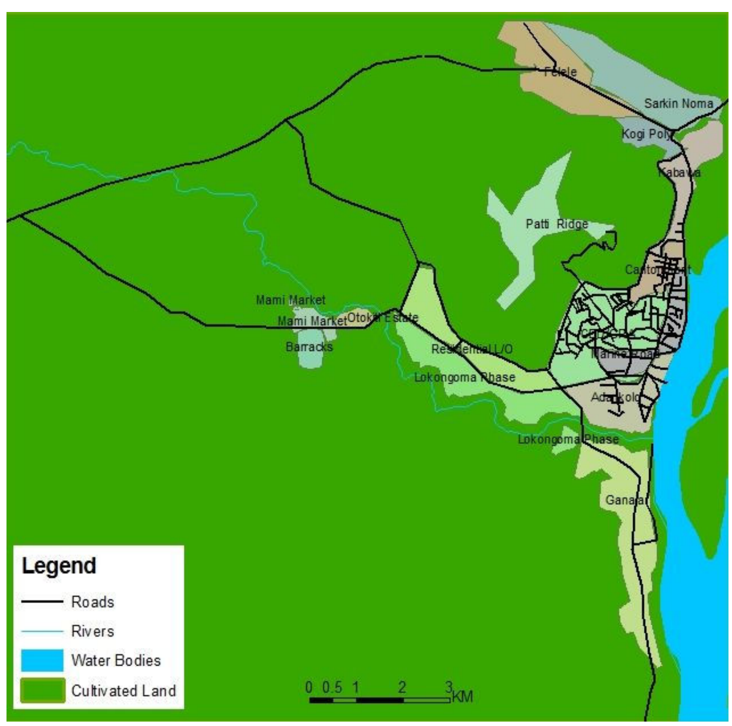

Figure 2: Showing neighborhoods in study area

This landsat thematic mapper (ETM+) satellite image of 2010 was used to derive different land use types, it was rectified terrain corrected and geo-referenced to local UTM zone. The land sat image was processed using ERDAS imaging 8.6 software.

2.1.1.1 Model specification

Logistic Regression Analysis (LRA) will be used analyze the selected factors of landuse determinants and factors of land use change , in this case emphasis is on bio-physical and socio-economic factors . The probability of converting a land parcel to residential use is defined by the logit model. The logit model is used to relate the probabilities and the locational characteristics of a particular land use. This is done by finding the coefficient (ß) of the logit model, a logistic regression procedure is used with actual land use as dependent variable. The SPSS statistical package is then used to do regression upon the landuse change factors.

This LRA technique will be used to determine if significant relationship exists between the residential land allocation (the dependent variable-Y) and bio-physical features of land, also the socio-economic conditions of the various neighborhoods in the study area. The bio-physical features includes – slope, soil type, drainage conditions, flood potential and the socio-economic includes – land prices, transportation, proximity to roads, proximity to existing infrastructure, population density, land area(density),(all these serve as the independent variables $ß_1$---- $ß_n$).

Residential land development = ßo + $ß_1$ *(Elevation) **+** $ß_2$ *(soil type) + $ß_3$ *(flood potential) **+** $ß_4$ *(drainage) + e

And/ or

Residential land development= ßo + $ß_1$ *(land prices)
+ $ß_2$ *(proximity to water source)
+ $ß_3$ *(proximity to roads)
+ $ß_4$ *(proximity to infrastructure)
+ $ß_5$ *(population density) + e

Where (ßo) is a constant and an error term (e), in these models the adjusted coefficient of determination (R^2) is a measure of the level of variation in spatial distribution of the land use type.

However not all factors selected are significantly relevant for land use change, to find the relevant factors, the stepwise regression procedure is used to select the significant factors of change from a large set of location characteristics. Variables that have no significant contribution to the explanation of the land use pattern are excluded from the final regression equation.

The table-2 below summarizes the dependent and independent variables with their relationship. This expected relationship is based on literatures. A positive relationship is expected between income and residential land development, suggesting that where income is more, development will increase and the low income residents will be relegated to areas unfavorable. Similarly a positive relationship is expected due to proximity to major roads that the closer a land parcel is to the major road the more the tendency of being converted to a residential use. However a there is a negative relationship to drainage. Since this is related to water retention capacity of land, development will tend towards area with low water retention and good run off. Also population density will have a positive development since increase density will also increase the need for residential land development.

Table 2: Expected relationship between dependent and independent variables

Independent variable	Description	Data	Expected association with Dependent variable (residential development)
Elevation		metric	-ve
Income	higher the more the development	metric	+ve
Proximity to major roads	The closer to road the more the development	metric	+ve
Proximity to water source	The closer the more the development	metric	+ve
Proximity to infrastructure	The closer the more the development	metric	+ve
Drainage condition	Water retention rate	metric	-ve
Road condition	Total road length per acre in city	metric	+ve
Population density	Increase will increase development	metric	+ve

- **LOGIT MODEL**

A binary logistic analysis was used to model the probability of the given land parcel being developed to a residential use as a function of independent variables. The dependent variables for a logistic regression analysis was given as binary (y=1, means area developed with 60% built-up and y=0 means otherwise).

The following equation adopted from Gujrati 1992, specifies the logistic relationship

L_i= 1n (P_i/1-P_i) =Z_i = ßo + Σ $ß_1$ X_i

Where L_i is the natural log of the odds of residential landuse being dominant in the city- i (→60%), this is also called the logit. While the Z_i is a linear combination of independent variables bo +b_1---- b_n **;** P_i represents the probability residential use to be dominant in the city- I, then (1-P_i) represents the probability of residential area not being dominant in the city- i (=>60%). The odds ratio {exp (b)} in a logit result, Σ $ß_1$ $X_{i,}$ represents summation of the variables (See table-3 below where effects of an independent variable on the odds for an event like residential dominance have been described).

3. RESULTS AND DISCUSSION

The table -3 below shows the result of the logistic analysis, the result shows that proximity to infrastructure is significant at a probability level of 1 %, the significant Chi Square value (55.4 df 14, P < 100) and high correct classification percentage of 78%, is indicative of the perfect fit of the model in explaining the relationship between independent and dependent variable as shown in the table -3.

The R square of Nagelkerke which also indicates 38.2% of the total variance in the dependent variable (residential development) was explained with independent variables. The variable elevation shows a significantly negative relationship which implies that residential land development will decrease as elevation increases i.e. one unit increase in elevation will cause the odds of residential development to decrease by a factor of 0.480. Also the logit result shows that road condition has a significantly negative relationship with residential development, indicating that the higher the density of roads the less the probability of residential land development in the city, where the increase in one unit road presence causes the odds of residential land-use development to decrease by a factor of 0.840, this is however contrary to the initial assumption on table 2. The result also shows a significant negative relationship between residential land development and population density, which implies the lower the population density the higher the probability of residential land development, the decrease of one unit population density causes the odds of residential area development to increase by a factor of 0.926. However the result did not indicate any significant relationship between drainage, education, land price, proximity to water, soil type or flood potential.

Table 3: Result of the Logit Analysis

Variables	B	S.E.	Wald	Sig	Exp(B)
Soil type	-3.097	.242	164.419	.159	.045
Elevation	-.734	.520	1.987	.005	.480
Road condition	.687	.538	1.096	.003	.840
drainage	.550	.621	.784	.376	1.733
Flood potential	-.310	.442	.490	.484	.734
education	.300	.197	2.317	.128	1.350
Monthly income	.548	.114	22.979	.000	1.730
Proximity to major road	-.036	.247	.022	.883	.964
Proximity to water source	.126	.203	.386	.534	1.135
Proximity to infrastructure**	-.747	.251	8.869	.003	.474
Population density	-.077	.303	.065	.799	.926
Land price	-.830	.148	31.283	.000	.436
Constant	4.999	1.107	20.398	.002	148.291
Chi-Square value	55.4				
Nagelkerke R square	0.382				
Correct classification (%)	78				

***significant at 1% level*

3.1 Comparison of Influence of Socio-Economic and Bio-Physical Variables

The table 4 below shows a comparison of the differences in the logit result between the biophysical variables and socio-economic variables and both types of variables combined. The table shows that the inclusion of socio-economic variables had a significant effect on the model by its slight reduction in strength (the Chi-Square value decreased from 42.21 to 27.0). The inclusion of socio-economic variable also caused a reduction in the Nagelkerke R value from 30.2% to 20.2%. also the percentage of correctly classified cases changed from 75.8% to 65.5%, this indicates that addition of the socio-economic variables were very significant in the' combined variable' model. It means the socioeconomic variables did make a strong additional contribution, however in the combined variable significant variables of Elevation and road were retained; this result indicates that the role of socio-economic variables is strong in explaining the variation of residential land use development in the city.

Table 4: Comparison of the Logit result

Parameters	Bio-physical	Socio-economic	Socio-economic and Biophysical variables
Variables used*	5	7	12
Chi-Square value	42.21	20.6	27.0
-2 log likelihood value	178.5	199.9	193.4
Cox &Snail R square	0.218	0.113	0.146
Nagelkerke R square	0.302	0.197	0.202
Correct classification	75.8	69.2	65.5
Significant variables at 1% level	Elevation, Road condition	Proximity to infrastructure,	

**education, proximity to roads, proximity to water source, proximity to infrastructure, income, population density*

4. CONCLUSION

The analysis identified areas of urban residential development, in ten selected neighborhoods of the study area by using remote sensing technique in combination with the use of questionnaire. It was however a bit difficult to separate the area of mixed uses (residential and commercial) from purely residential, however only the originally approved use of the development was considered.

The availability of the module-extension in the in the Arc View was used to acquire and manipulate data effectively. The result showed that residential land use was the dominant, followed by commercial uses. The study analyzed the relationship between residential land use and socio-economic, with biophysical variables through the logit model. The findings indicated that elevation variables and nearness to infrastructure has a positive significance in residential land development which supported by previous assumptions on the table 2. The result did not indicate significant relationship with the soil type, and most physical variables. The inclusion of socioeconomic variables made a difference in the total variation which is indicative of its strength as a strong predictor of residential land development as compared to biophysical variables alone. The result could be utilized to generate spatially explicit explanation to study residential land use change.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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