International Review of Social Sciences and Humanities
Vol. 2, No. 2 (2012), pp. 68-76
www.irssh.com
ISSN 2248-9010 (Online), ISSN 2250-0715 (Print)

The Effects of Urban Sprawl on Peripheral Agricultural Lands in Calabar, Nigeria

Atu, Joy Eko
(Corresponding author)
Department of Geography and Environmental Sciences
University of Calabar, Nigeria
e-mail: jo.ekat@yahoo.com

Offiong Raphael Ayama
Department of Geography and Environmental Sciences
University of Calabar, Nigeria
e-mail: raphyxx@yahoo.com

Eni, Devalsam Imoke
Department of Geography and Environmental Sciences
University of Calabar, Nigeria
e-mail: devimoke@yahoo.com

Eja, Eja Iwara
Cross River State University (CRUTECH)
e-mail: Ejako2007@yahoo.com

Esien, Obia E.
Cross River State University (CRUTECH)
e-mail: obysien@yahoo.com

(Received: 11-10-11/ Accepted: 23-12-11)

Abstract

The main objective of the paper is to examine the effects of urban sprawl on peripheral agricultural lands in Calabar, Nigeria. The study assessed the influence of sprawl on farm sizes and densities in peripheral lands. Five sprawl areas were purposively chosen for the study. The areas were classified into agricultural lands within sprawl and agricultural lands outside sprawl. Thus, the research compared the sizes and proximity of 10 farmlands within sprawl and 10 farmlands outside sprawl and the diversity of crops between the farms. The mean numbers of the variables, the Shannon Weiner diversity index was used to determine the sprawl diversity of the sprawl formations and the paired samples student t-test was employed for the data analysis. Significant variation in the sizes and densities of farms between agricultural lands within sprawl and agricultural lands outside sprawl were observed. Maximum farm densities of 2.6m were obtained in agricultural lands outside sprawl and agricultural lands within sprawl had maximum densities of 0.1m. The study has implication for the sustainability of farmlands in peripheral land and recommends the integration of agricultural lands into urban land use planning for efficient management and protection of the dwindling farm space.

Keywords: Sprawl, Nigeria, agricultural, peripheral, lands.

1. Background

Urban sprawl is one of the foremost threat facing agricultural lands in Nigeria. Sprawl occurs in ever-widening bands surrounding large urban centres. Often times sprawl emanates from disconnected developments and single family homes that are established outside urban areas well beyond city limits, but usually within commuting distance to the urban core. Sprawl in Nigeria consist of informal housing developments on the urban periphery, on land that is mostly privately owned, sold in single small plots and, in the case of Calabar, also on marginal lands along rivers and seashore. These newly developed areas have been called "peri urban areas" (Imhoff, 2000) and the "intermetropolitan periphery" (Berry 1990). The "exurban areas" beyond the suburbs are sometimes called "fringe" developments (Daniel 1999) and "extended places" (Bureau of the Census 2000). For the purpose of this paper, all of these areas are referred to as sprawl. Recently, in Calabar, 2000-2010, there is an increase in residential estates on the urban periphery, developed by government, the private sector for their workers or by property developers for sale. The consequences of burgeoning urban growth for peripheral agricultural lands are enormous. More peripheral agricultural lands are converted to sprawl development while the remaining peripheral lands are worked more intensively to feed the immediate needs of the large urban population leading to loss and degradation of farm space. Although all cities in Nigeria are experiencing sprawl, Calabar's case is exceptional because of the scale and type of development on some of the city's most agriculturally productive land. In the past decade, the city's built up area burst outward in an explosion of sprawl that consumed former agricultural land at a break-neck pace. Thousands of hectares of agricultural land are covered by concrete and asphalt as new roads are created and existing ones are extended. Over 5,200.09 hectares of the former agricultural land at Ekorinim, Esuk Utan, Edim-Otop, Anantigha, and Ikot Efanga have been converted to low density residential, commercial and industrial uses as these areas are merged with the urban areas. This development is consequent on the growth of the population of Calabar. For instance in 1991, the population of Calabar was 328, 876, with a density of less than a thousand person per square kilometer. In 2006, it was 375, 196. At present, the population of Calabar is estimated to be over 399, 761 (National population Commission 2010) while the population density is above 1,237 persons per square kilometer (Cross River State Economic Blueprint 2007-2008).

This change in population size and density implies pressure on agricultural lands because adaptation to rapidly increasing urban population and services result in three distinct mechanisms usually occurring in sequential steps. The first is the increasing concentration, congestion, and extension of settlements to flood prone areas and slopes within existing city limits. The second is the emergence of satellite settlements focused functionally on existing urban centres, and the third is the incorporation of outlying rural lands and settlements. The third mechanism is the sprawl process dominant in Calabar (Nwafor, 2006). A reconnaissance survey of the study sites shows that roads have been expanded and new ones created into previous agricultural lands. Statistics from the State's Ministry of Works show that from 2000 to 2010, a total of 290.8km of new roads have been constructed while over 302.60km is billed for construction in the next eight years. Housing development to accommodate the demands of the increasing population is also taking large portions of agricultural lands. Available data on land use statistics from the Ministry of Lands and Surveys, Department of Town Planning Calabar indicate that urban land uses have changed dramatically in the last two decades. From 1991-2010, over 4,772 hectares of peripheral agricultural lands have been approved for conversion to residential uses by the relevant authorities, 607 hectares approved for commercial uses, and over 90 hectares of agricultural land have given way to industrial uses. These expansions into peripheral agricultural lands reduce the spatial extent of agricultural land and fragment them leading to reduced and smaller patch sizes of less than 1hectare. Agricultural adaptation to urban expansion leads to new forms of farm practice vis a vis crop types and farm management practice. Alterations in crop types will definitely affects agro diversity of farm areas

1.1 Purpose

The study specifically examine the effects of urban sprawl on agricultural lands, assessed the spatial relationship between urban sprawl and agricultural lands, project the spatial loss of agricultural lands in Calabar by 2015 and suggested sustainable methods of integrating agricultural lands into urban systems. In view of the stated objectives, two key research questions of the study are:

1. Is there a difference in farm size and density of agricultural lands within sprawl from agricultural lands outside sprawl?
2. Is there a difference in agro diversity amongst the sprawl formations?

1.2. Literature

The conversion of agricultural lands to urban development is a phenomenon currently affecting countries as their population grows. Although urban sprawl may not threaten overall agricultural productivity of a country it does result in the alterations and declines in local agricultural activities and to the loss of agricultural land as highlighted by the literature. Organisation for Economic Co-operation and Development, OECD (1979) has documented the loss of peripheral agricultural land to sprawl in some European countries such as Netherlands and Norway which respectively lost 4.3 percent and 1.6 percent of their land annually to sprawl. Also the United States of America and Canada lose 4,800sqkm of prime cropland annually to roads, buildings, reservoirs and other non-agricultural uses. Lopez et. al., (2001) in a study on, 'Urban Expansion and the Loss of Prime Agricultural Lands in Puerto Rico', shows that between 1977 and 1994 the urban area of Puerto Rico increased from 11.3 percent to 27.4 percent. They therefore concluded that if the pattern of encroachment by urban growth into farmlands continues Puerto Rico's potential for production in the future will be dimmed.

Humphrey (1985) observed that urban sprawl has transformed the landscape of Singapore and elevated the economy to almost a developed country status over the past decade. Correspondingly, in the face of this rapid urban and industrial growth, agriculture has to make significant adjustments. The first was the loss of agricultural land. During the 1960s approximately 250 hectares were required annually for public housing and industrial development, often at the cost of fertile agricultural land. Singapore, Japan, Indonesia, Thailand and recently Malaysia exhibited this trend. The implication of this is the importation of food as Asian countries lost their diversified food production capabilities. This according to (Pernia, 1983) is a reflection of a country's loss of comparative advantage in diversified farming practices as a country losses its fertile land to urban sprawl and heads up the economic ladder. The same trend was found in a study carried out by Yoveva, et al (2000) in the city of Sofia, where land use is shown to be in a state of transition. The peri urban villages to the south of Sofia (Dragalevixi, Simeonovo and Pancharevo) are no longer areas of agricultural production as the agricultural land has been turned into housing complexes. For example the cities of Darvenitza and Mladost were built on prior agricultural land.

On the other hand, (Brown 1985, Song and Lee 1984 and Wade 1986) have attributed the fast rate in which agricultural lands in the peripheries of Taipa, South Korea, dwindle to sprawl. Thus, the reductions of agricultural land and biodiversity in the peripheries have been attributed to sprawl. This is because sprawl encroachment into peripheral agricultural lands results in the loss of fertile land. Farmers, therefore, need to enhance the fertility of the land by adding fertilizer, changing to new farm techniques or changing to more productive crops. This change in prior farming techniques will definitely change the constitution of biodiversity that has adapted to the former farm management. Belfrage, et al. (2005) in their study on the 'effects of farm size and organic farming on the diversity of birds, pollinators and plants in a Swedish landscape' discovered that more than twice as many bird species, butterflies, herbaceous plant species and five times more bumblebees were found on the small organic compared to the large conventional farms. The authors argued that altered management practice such as monocultures and intensification of agriculture has influenced the number and demography of birds. This is in line with the findings of Beecher et al. (2002); where bird abundance in organic sites were found to be more than two times higher than non organic sites (that use fertilizer and herbicides). `

Similarly, Luoto, et al. (2003) linked agricultural production changes to landscape fragmentation and species diversity. Based on their study on 'the loss of plant species richness and habitat connectivity in grasslands associated with agricultural change in Finland', they argued that development in agricultural production drives land- use changes and thus controls the capacity of landscapes to maintain biodiversity.

2. Methodology

The total amount of peripheral land loss to urban sprawl was used in the measurement of sprawl for this study. For instance, if an urbanized area covered 10 kilometres square in 1980 and covers 18 kilometres square in 2010, the city would have sprawled 8 kilometres. The types of data acquired for the study include: data on the spatial extent of farm lands within and outside sprawl areas for 2000 and 2010, farm sizes, distance between patches (density) of agricultural lands within sprawl (ALWS and ALOS) and agricultural lands outside sprawl areas and proximity of farm lands to built- up areas.

Field observation and measurement by the researcher and two assistants was the main source of data for number and farm sizes of agricultural land and the proximity of agricultural lands to built -up areas. Data on the spatial extent of agricultural land was extracted from Landsat ETM 1980 and SPOT Image of Calabar 2005. These data sets were sourced from National Centre for Remote Sensing (NCRS) Jos, and the GIS Laboratory Department of Geography and Regional Planning, University of Calabar, Calabar. Other sources of information utilized for the study include journals, text books, dissertation on relevant study areas and the internet which were sourced for literature and theoretical framework for the study.

A reconnaissance survey of the study area was undertaken from 3rd -7th March, 2010 to determine farmlands within and outside sprawl areas. The reconnaissance survey also created opportunities for determining access points to the farms, line transect location, and obtaining permission from the farmers to use their farms for the study. Field measurement was carried out on the identified farms from May 14th - August 14th 2010.

Analysis: A four kilometers buffer zone from the CBD (Watt Market) was created as the beginning of the urban peripheral lands. A second buffer zone of four kilometers from the first buffer was created to delimit the extent of the urban peripheral agricultural land for the study. Five out of the 8 identified areas that have witnessed rapid development in the last two decades were purposively chosen to form the sampled areas. These include, Ekorinim, Esuk Utan, Edim- Otop, Anantigha and Old Parliamentary village sprawl areas. The study further classified the areas into agricultural lands within sprawl (ALWS) and agricultural lands outside sprawl (ALOS), giving a total of 10 sampled sites (5 within sprawl areas and 5 outside sprawl areas). At each of the sampled sites two farms were purposively chosen. Thus, field measurements were carried out on 20 sampled farms or plots.

Field measurement of farm sizes, farm density and the distance of the farms to built- up areas within and outside sprawl areas were done by the researcher with two assistants with the aid of a metric tape. This is to determine if sprawl has an effect on farm size and density.

The delineation of sprawl in Calabar were carried out via the use of satellite imageries of Calabar of two image dates, specifically, Landsat ETM December 1980 and SPOT Image XP December 2005. The land uses were then categorized into urban (sprawl) and non urban (agricultural) land uses. The urban land uses include: the residential, commercial, industrial, transportation, communication, as well as developed portions of recreational, public, military and non productive uses. The remaining land was classified into non urban or agricultural land. The SPOT Image 2005 was overlaid on the Landsat image of ETM 1980. The new urban areas were then digitized onscreen using the 1980 urban coverage as a guide for interpreting and measuring the 2005 images. ARC GIS software was employed in the measurement of sprawl impact on agricultural land. The assumption is that areas classified as urban in 1980 will remain in urban uses in 2005. The total area of peripheral agricultural land in 1980 delineated from the Landsat ETM Image of 1980 was subtracted from the total agricultural land of 2005 delineated from the SPOT Image XP 2005 to determine the effects of urban sprawl on agricultural lands and comparing the sizes of the sampled farms between ALWS and those of ALOS. To get the rate of sprawl land gain per annum, the sprawl areas of 1980 in hectares were subtracted from the sprawl areas of 2005 and the result divided by the number of years between 1980 and 2005. The rate of agricultural land loss per annum was derived by subtracting the agricultural land in hectres of 2005 from those of 1980 and dividing the result by the number of years between 1980 and 2005.

2.1 Results and Discussion of Findings

The sprawl areas delineated for 1980 and 2005 are presented in Fig.1. From Fig.1., 2,018 hectares of peripheral agricultural lands and 658 hectares of sprawl areas were delineated for 1980. The agricultural land and sprawl areas for 2005 were 178 and 7,258 hectares. Between 1980 and 2005, urban sprawl gained over 6, 000 hectares of peripheral land while agricultural land diminished from over 2,000 hectares to 178 hectares. The difference in urban sprawl area and peripheral agricultural lands for the two periods of study 1980 and 2005 are presented in Table .1. The areal relationship between peripheral farmland loss and gain in urban space is shown in Fig.2.

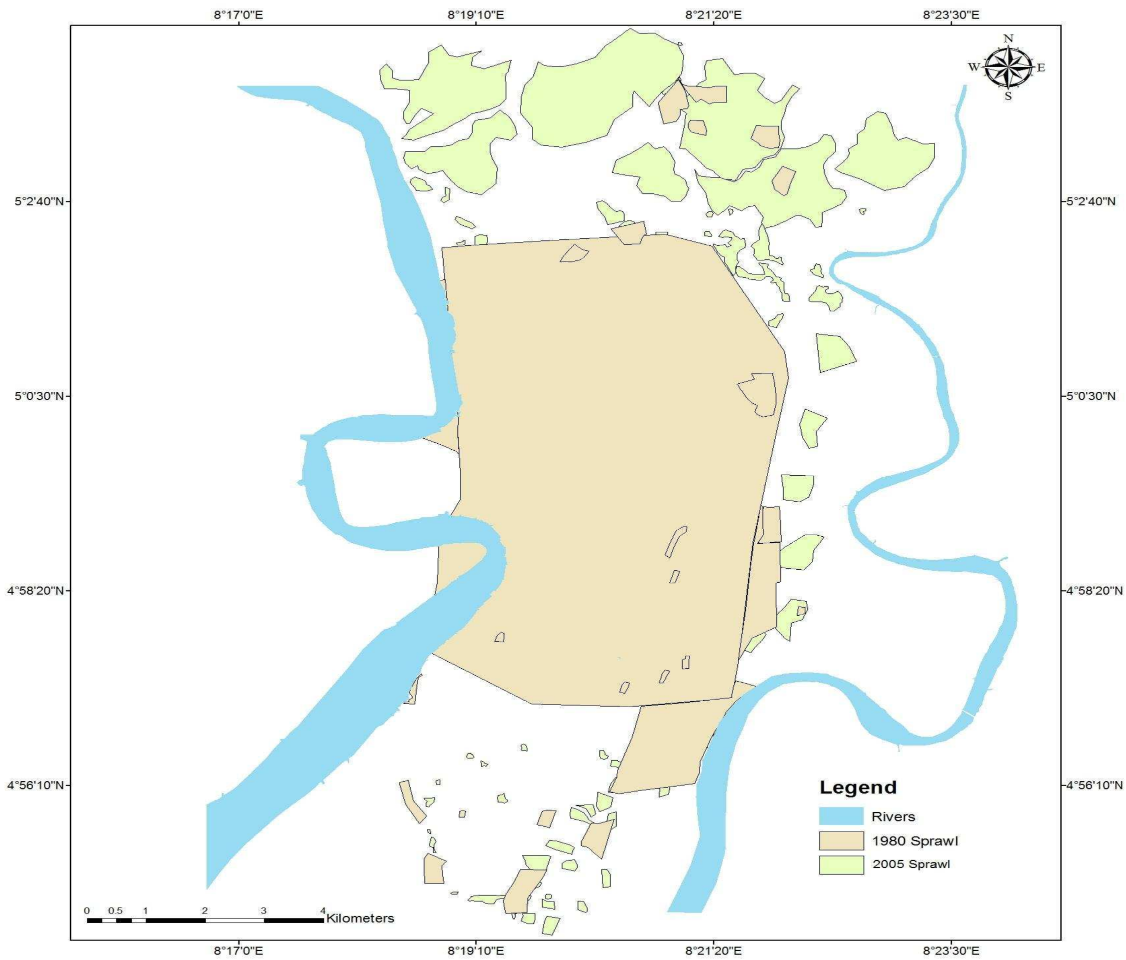

Fig. 4.1: Urban sprawl areas 1980 & 2005 delineated from overlay of Calabar Master Plan on digitized Landsat ETM image 1980 & SPOT image XP 2005.

Table1: Difference in agricultural lands and sprawl areas 1980 and 2005

Study periods	**Urban sprawl areas (ha)**	**Sprawl land gain (ha)**	**Peripheral agricultural lands in (ha)**	**Agric land loss in (ha)**
1980	658		2, 018	
2005	7,258	6,600	178	
Difference in years	25		25	- 2,168
Rate of change per annum	264		73.6	

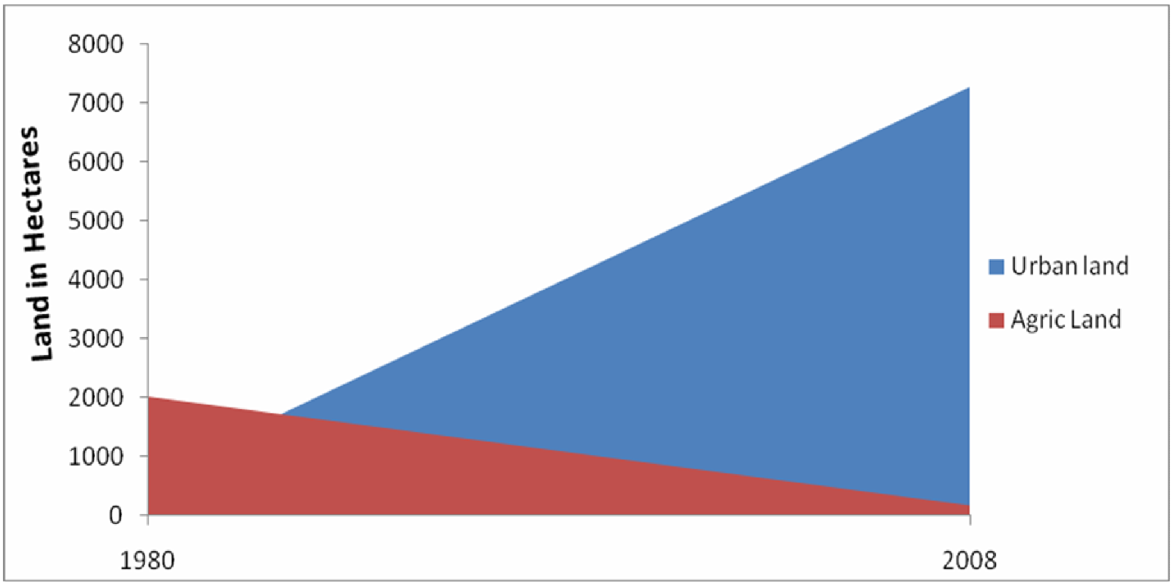

Fig.2: Areal Relationship between Urban Sprawl and Agricultural Land 1980/2005
Source: Landsat ETM 1980 and SPOT Image XP 2005

From Table1, mere sprawl extents of 658 hectares in 1980 had escalated to 7,258 hectares in 2010. This monumental rise in sprawl areas has a corresponding effect on agricultural land seen in Fig.2, where peripheral agricultural lands diminished from 2,018 hectares in 1980 to 178 hectares in 2005. This loss in farm space implies a corresponding loss in farm density. Using the urban land gain of 264 hectares per annum, a trend line forecast algorithm in Microsoft excel was used to calculate a five year moving average from 1980- 2015. The result presented in Fig.3, show that urban sprawl areas would gain about 10,000 hectares of peripheral lands by 2015, while peripheral agricultural lands are tending towards zero. The consequence of the annihilation of peripheral agricultural land is loss in farm density and the fragmentation of farmlands.

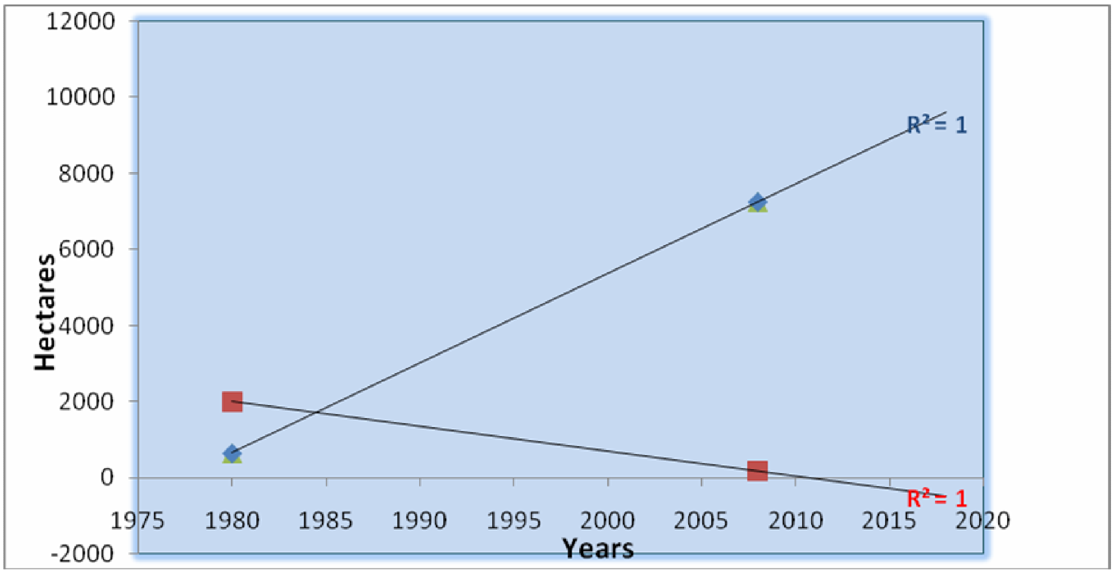

Fig. 3: The Spatio – temporal Relationship and Projection of Urban Sprawl and Agricultural Lands 1980-2015

The minimum size of ALOS was 1400M^2 and 10M^2 for ALWS (Table 2). The maximum size of ALOS was 10921M^2 and 316.8M^2. The densities of the farms were also different. The mean density of the ALOS was 1.59m and ALWS had mean densities of 0.59m. From Table 2, the mean numbers for farm size and density for agricultural lands within sprawl were 111.96m^2, 0.59m, and 6.7, respectively.

Table2: Minimum, maximum and mean numbers of farm size and farm density of ALOS and ALWS

Sampled farmlands	Farm size	Farm density	Mean size	Mean density
ALWS 1	83.2	0.6	111.9600	0.5900
ALWS 2	316.8	0.1		
ALWS 3	60	0.2		
ALWS 4	84	0.8		
ALSW 5	20	0.9		
ALWS 6	10	0.8		
ALWS 7	29	0.4		
ALWS 8	41.5	0.8		
ALWS 9	238	0.9		
ALWS 10	236.3	0.4		
ALOS 11	1953	1.7		
ALOS 12	1400	2.0		
ALOS 13	3360	1.0		
ALOS 14	2340	1.0	3542.8000	1.5900
ALOS 15	3360	1.0		
ALOS16	2340	1.0		

ALOS 17	2624	1.0		
ALOS 18	2960	2.3		
ALOS 19	10921	2.3		
ALOS 20	4800	2.6		

The result of the paired samples analysis is presented in Table 3. Pair 1 of the analysis compared the means of patch sizes of ALWS and ALOS. The result recorded a calculated t value of 4.324, while the critical t- value is 2.262 at 5 per cent level of significance when degree of freedom (df) =9 (Table 4.16). It showed that the calculated t is greater than the tabulated t. Pair two compared the means of patch density of FLWS and FLOS. The result of the analysis shows a calculated t- value of 4.26 and a critical t- value of 2.262 at 0.05 level of significance when the df =9. This implies that significant difference exists between the patch density of ALWS and ALOS. Pair three of the analysis compared the means of crop diversity of ALWS and ALOS. The result indicates that the calculated t value is 2.654 while the critical t is 2.262 at 5 per cent level of significance when df=9. Since the calculated t values were greater than the critical t values, the null hypothesis is rejected, implying that there is a significant difference in patch size, patch density and crop diversity between ALWS and ALOS.

Table 3: Results of Paired samples test of the variables

	Paired differences					df	t-tab	t-cal	p
	Mean	Std Deviations	Std mean error	95% confidence interval of difference					
				Lower	Upper				
Pair 1 PS	+3430.840	2509.17060	793.46941	-5225.793	-1635.887	9	4.324	2.262	5
Pair 2 PD	+1.00000	.74237	.23476	-1.53106	-.46894	9	4.26	2.262	5
Pair 3 CD	2.60000	3.09839	.97980	.38955	4.81654	9	2.654	2.262	5

2.3. Conclusion

The findings in this study indicate that urban sprawl has impacted negatively on agricultural lands in Calabar, Nigeria by reducing their spatial extent and density and fragmenting them into smaller sizes of less than 100metres square. Hence, the challenge in the sustainability of agricultural activities lies in the conservation and management of existing fragments in the face of very rapid urbanization. This feat can be achieved via the integration of agricultural landscapes into urban land use planning systems and agricultural lands must also be taken into consideration as crucial part of urban development.

References

[1] N. A. Beecher, R. J. Johnson, J. R. Brandle, R. M. Case and L. J. Young, Agroecology of birds in organic and non organic farmland, *Conservation Biology*, 16(6) (2002), 1620-1631.

[2] K. Belfrage, J. Bjorklund and L. Salomonsson, The effects of farm size and organic farming on the diversity of birds, pollinators and plants in a Swedish Landscape, *AMBIO*, 34(8) (2005), 582-588.

[3] K. P. Bell and E. G. Irwin, Spatial explicit micro-level modelling of land-use change at the rural-urban interface, *Agricultural Economics*, 27 (2002), 217-232.

[4] B. J. L. Berry, Urbanization, In B. L. Turner, W. C. Clark, R. W. Dates, J. F. Richards, J. T. Mathews and W. B. Myers eds., *The Earth as Transformed by Human Action: Global and Regional Changes in the Biosphere over the Past 300 Years*, (1990), Cambridge, Cambridge University Press.

[5] R. M. Brown and D. N. Laband, Species imperilment and spatial patterns of development in the United States, *Conservation Biology*, 20 (2006), 239- 244.

[6] Bureau of the Census, *Census 2000*, Washinghton D. C.: Bureau of the Census, Congress for the New Urbanism, (1990), Charter of the new Urbanism, Available at: www.cnu.org.

[7] CR-SEEDS **(**Cross River State Economic Empowerment and Development Strategy, 2005-2007).

[8] T. Daniels, *When City and Country Collide: Managing Growth in the Metropolitan Fringe*, (1999), Washington D. C., Island Press.

[9] J. W. Humphrey, The urbanization of Singapore's rural landscape. In C. MacAndrews and L. S. China, eds, *Too Rapid Rural Development: Perception and Perspectives from South East Asia*, (1985), Ohio Press, Athens Ohio.

[10] M. L. Imhoff, The use of multi source and satellite and geospatial data to study the effects of urbanization on primary productivity in the United States**,** *Transactions in Geoscience and Remote Sensing*, 38 (2000), 2549-2556**.**

[11] E. A. Johnson and M. W. Klemens, eds, Nature in Fragments: The Legacy of Sprawl, (2005), Columbia: Columbia University Press.

[12] T. D. Lopez, A. Mitchell and J. R. Thomlinson, Urban expansion and the loss of prime agricultural lands in Puerto Rico, *Ambio: A Journal of the Human Environment*, 30(1) (2001), 49-54.

[13] M. Luoto, R. Seppo, A. Jyrki and P. Juha, Loss of plant species and habitat connectivity in grasslands associated with agricultural change in Finland, 2003.

[14] Ministry of Works, Program of Activities Presented to Cross River State Executive Council, 11^{th} March 2008.

[15] National Population Commission, *Federal Republic of Nigeria Official Gazette 24: (96)*, Federal Government of Nigeria, (2007).

[16] National Population Commission (2007), The 2006 Census for Calabar, Cross River State.

[17] J. C. Nwafor, *Environmental Impact Assessment for Sustainable Development: The Nigerian Perspective*, (2006), EDPCA Publications, Enugu, Nigeria.

[18] Organisation for Economic Co-operation and Development (OECD), *Agriculture and Biodiversity*, Developing Indicators for Policy Analysis, (1979).

[19] E. M. Pernia, *Implications of Urbanization for Food Policy Analysis in Asian Countries*, (1983), Resource System Institute East-West Centre Honolulu, Hawaii, USA.

[20] B. N. Song and T. I. Lee, Country report: Republic of Korea, *Paper presented at the Working Group Meeting on Food, Fuel and Urbanization in Asia*, Nihon University, Tokyo, 1984.

[21] I. Wade, *City food, Crop selection in Third World Cities*, (1986), San Francisco, Urban Resources System.

[22] A. Yoveva, B. Gocheva, G. Voykov, B. Borrisov and A. Spassov (2000a), Sofia: Urban agriculture in an economy in transition, In Ambo, M. E. environmental change and urban agriculture: Implication for food security in Calabar Metropolis, South Eastern Nigeria, *Unpublished PhD. Proposal Presented to the Department of Geography and Regional Planning*, University of Calabar, Calabar. January, 2008.