SPATIAL ANALYSIS OF AGRICULTURAL LANDUSE CHANGE IN ASABA, SOUTHERN NIGERIA

[1]Enaruvbe, G. O. and [2]Atedhor, G. O.

[1]Department of Geoinformation Science, Regional Centre for Training in Aerospace Surveys (RECTAS), Obafemi Awolowo University, Ile-Ife, Nigeria

[2]Department of Geography and Regional Planning, University of Benin, Benin City, Nigeria

Correspondence: enaruvbe@gmail.com; goatedhor@gmail.com; Mobile: 07055579003; 08136446117

(Received: ; Accepted:)

ABSTRACT

This paper examines agricultural land use change because of urban encroachment into the agricultural landscape. It analyses the pattern and rate of land use change in Asaba between 1987 and 2013, and determines the impact of the observed changes on agricultural land use. Three time point multi-temporal remote sensing images are analysed using hybrid unsupervised/supervised image classification techniques to identify four dominant land cover classes in the study area. The average rate of change is also determined by computing the difference in areal extent of a land cover in the initial and final time points. The results show that cultivation and settlement increased by 1.4% and 1.5% respectively while forest and water decreased by 0.7% and 1.2% respectively in the first interval, 1987-2002. In the second interval, however, cultivation increased by 0.5% while settlement, forest and water decreased by 0.2%, 0.1% and 1% respectively. In spite of an average overall increase observed for cultivation and settlement, the results show a reduction in total area cultivated in the second interval while forest and water also declined by 0.4% and 1.1% respectively. The study concludes that urban encroachment into rural landscape should be controlled and sustainable rural development strategies to minimise rural-urban migration be implemented so as to curb the loss of interest in agriculture. Agro-business ventures should also be promoted among the youths.

Keywords: Agriculture; Food Security; Urban Expansion; Remote Sensing; GIS; Nigeria

INTRODUCTION

Agriculture is an important economic activity in many parts of the world, especially in developing countries of sub-Saharan Africa and Asia (Naab *et et al.*,2013; Rounsevell *et al.*, 2003). In Nigeria, agriculture is the mainstay of a large proportion of the population, with over 70% of rural dwellers engaged in agricultural activities. In spite of this, successive administrations in Nigeria have continued to neglect the agricultural sector of the economy. The neglect of the agricultural sector is evident in the dearth of reliable and up-to-date information on agricultural land use, which is an important requirement in the sustainable planning and management of agricultural resources (Adeniyi, 1986). The lack of relevant information, has also resulted in poor agricultural practices and management, leading to a decline in agricultural production and a concomitant increase in the prices of food items(Rilwani and Gbakeji, 2009). This situation is capable of aggravating food crisis in the country.

The neglect of the agricultural sector is worsened by rapid environmental change, occasioned by a rapid population growth rate and rural-urban infrastructure inequality. The rapid rate of environmental change has been of interest to environmental managers and scientists because of its negative implications (Biro *et al.*, 2013; Otieno and Anyah, 2012; Salemi *et al.*, 2013; Turner II *et al.*, 2007; Yeshaneh *et al.*, 2013; Zhang and Xu, 2014) which include loss of biological diversity, tropical deforestation, soil erosion and degradation and climate change (Atu *et al.*, 2013; Etter *et al.*, 2006; Huang *et al.*, 2013; Ogbuene, 2010; Ogunowo and Oderinde, 2012).

Rapid urban growth and development has been noted as an important driver of environmental change resulting from population growth, especially in developing countries (Abebe, 2013; Bhatta, 2010; Cohen, 2004; de Jong *et al.*, 2000). This has been associated with several environmental, social and economic consequences, including climate change, depletion of agricultural resources and deforestation ((Bhatta, 2010; Dutta, 2012; Enaruvbe and Ige-Olumide, 2014; Ikhuoria, 1984; Manandhar *et al.*, 2010; Rilwani and

Gbakeji, 2009).

The creation of Delta State and the subsequent siting of the capital in Asaba, resulted in the rapid urbanization of the city. The expansion and growth of Asaba have impacted the socio-economic and environmental landscape of the area, leading to the conversion of farmland and other environmental resources to urban use. Various studies in Nigeria have examined several aspects of environmental change, particularly land cover dynamics (Adeniyi and Omojola, 1999; Akinyemi, 2013; Braimoh and Onishi, 2007; Chigbu *et al*., 2011; Enaruvbe and Ige-Olumide, 2014; Fabiyi, 2006; Mahmud and Achide, 2012; Tokula and Ejaro, 2013), while recent and up-to-date studies on the effects of rapid environmental change on agricultural resources appear limited. This study is therefore aimed at analysing agricultural land use change in Asaba over the last three decades using geoinformation technologies. The specific objectives of the study are to analyse the pattern and rate of land use change in and around Asaba using remote sensing data, and determine the impact of the observed changes on agricultural land use in the area.

Study Area

The study area covers most parts of four Local Government Areas in Delta State: Oshimili North, Oshimili South, Aniocha North and Aniocha South. The population of the area, according to the 2006 national population census data, is approximately 241,289. Figure 1 shows the location of the study area which lies in the bank of the Niger River and geographically defined by longitude 6°24' and 6°45'E and latitude 6°17' and 6°2'N, with an areal extent of about 773km^2. The proximity of the study area to Onitsha, a major commercial city, in the neighbouring Anambra State, and the fact that Asaba has been the administrative headquarters of Oshimili South Local Government Area, promoted trade and commerce in Asaba prior to the creation of Delta State. The majority of rural dwellers in the area is engage in peasant farming and other agricultural activities. The creation of the State, however, has boosted the administrative and commercial status of Asaba, attracting industries and increasing trade and commerce in the area.

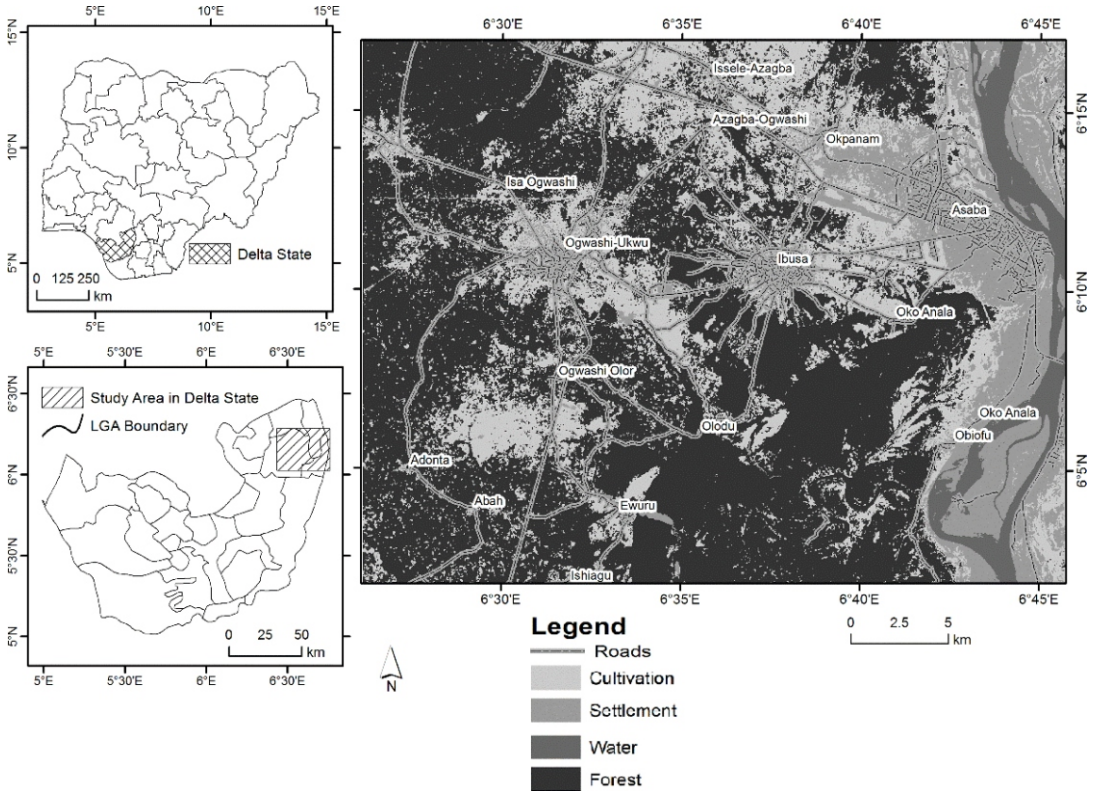

Figure 1: Location Map of the Study Area

MATERIALS AND METHODS

Landsat Thematic Mapper (TM) image of 21 December 1987, Enhanced Thematic Mapper plus (ETM^{+}) image of 30 December 2002 and Operational Land Imager (OLI) image of 20 December 2013 were obtained from the United States Geological Survey (USGS) website. The images were pre-processed to correct them for spectral variation resulting from sensor differences before the study area was extracted from each dataset. False colour composite (FCC) was created using near-infrared, red and green Bands of each of the images (Akinyemi, 2013). The selection of Band combination was done to enhance our ability to clearly distinguish vegetation types from urban land use. The pattern of environmental change was determined using the method proposed by Pontius Jr et al. (2004)andAldwaik and Pontius (2012). This method has been applied in several studies in determining the intensity of environmental changes (Braimoh, 2006; Huang *et al.*, 2012;Pontius Jr *et al.*, 2013)..

A combination of image composite, unsupervised image classification, and field survey were used for image analysis. Each of the three Landsat images was first separated into 30 clusters, using the CLUSTER module in Idrisi software, and each cluster was assigned to one of the four dominant land cover categories (Huang, 2012) identified in the study area from field survey. The land cover categories are cultivation, settlement, forest and water. Cultivation includes cultivated and fallow farmland, settlement includes built-up areas and bare-surfaces, forest includes secondary vegetation, matured plantation and dense tropical forest, while water is composed of streams, rivers and sand deposits along the Niger River.

Ground information was obtained within each land cover category as accurately as is possible using a combination of field survey. Some locations could not be accessed due to physical and/or social barriers and were determined using high resolution google-earth image, existing land use maps and authors' familiarity with the study area. A total of five hundred and eighty sample locations were determined within all the categories. These include two hundred and one locations in forest, sixty-seven in water, one hundred and twenty-two in cultivation, and one hundred and ninety locations in settlement category.

The overall accuracy of each of the land use/land cover maps was generated from the confusion matrix derived from data obtained from the land use/land cover maps derived from the image analysis. The accuracy assessment is the simplest and most often used statistical measure of classification accuracy of remote sensing data. It is computed by dividing the total correctly classified pixels by the total number of pixels in the confusion matrix (Congalton, 1991; Foody, 2004; Liu *et al.*, 2007).

The rate of environmental change was determined by computing the percent average rate of change using equation (1) thus:

$$\left[\frac{\left(\frac{d}{t_1}\right) * 100}{y_2 - y_1}\right] \quad (1)$$

Where d is the difference in the value of area covered by a land cover category at the initial time point and final time point while t_1 is the value of the area covered by a land cover category in the initial time point and y_1 and y_2 are base year and final year respectively.

RESULTS AND DISCUSSION

Average Rate and Pattern of Environmental Change

Figures 2 (*a* - *c*) show the land cover categories of the study area in 1987, 2002 and 2013 respectively. The Figures reveal that Asaba has enjoyed rapid growth and development over the years at the expense of agricultural land and forest around the city. Many of the surrounding villages, such as Okpanam, Ibusa, OkoAnala and Obiofu have been adsorbed into Asaba in the process of urban growth. Farmland around these villages are also being taken up by urban development. The forest in the southeastern part of the area, adjoining River Niger, is observed to have suffer consistent degradation as it is exploited for timber and timber products which are in increasing demand

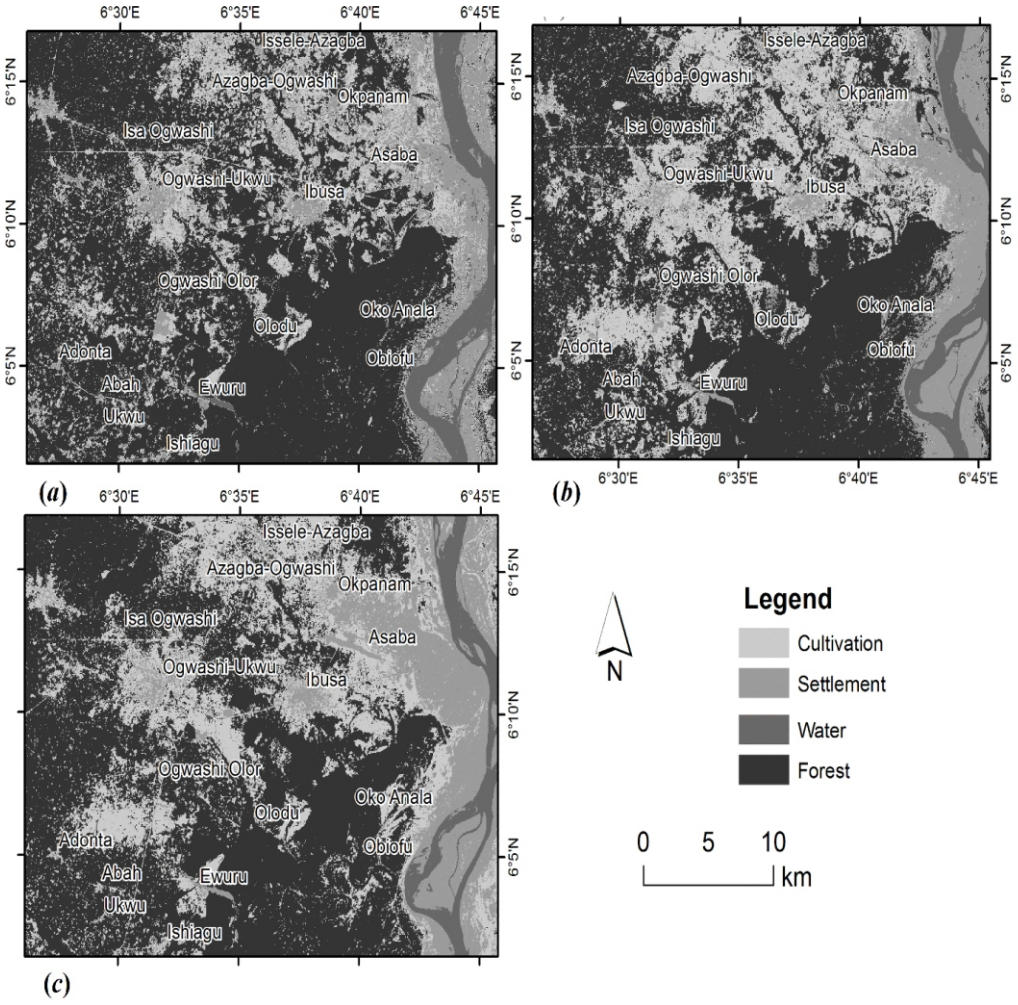

Figure 2: (a)Land Cover Categories, 1987; (b)Land Cover Categories, 2002; (c)Land Cover Categories, 2013

Figure 3 shows the average percentage change of land cover categories in the study area. It indicates a temporal variation in the average rate of environmental change in the study area. Figure 3 also shows that in the first interval, 1987-2002, the average rate of change was 1.4%, 1.5%, -0.7% and -1.2% for cultivation, settlement, forest and water, respectively. This indicates that while cultivation and settlement increased, forest and water decreased in the interval. In the second interval, however, the average rate of change reduced. Cultivation increased at 0.5%, while settlement, forest and water reduced by 0.2%, 0.1% and 1% respectively. The overall rate of change between 1987 and 2013, however shows that there has been a decline in the average rate of environmental change in the study area. It is observed that the overall average rate is 1.2%, 0.8%, -0.4% and -1.1% for cultivation, settlement, forest and water respectively. This shows a decline in the average rate of environmental change during the second interval. The decline can be attributed to increasing rates of urbanization and declining interest in agricultural activities. Similarly, government policies, such the 1978 Land Use Act, which vest all land rights on the government, and the quest for urban infrastructure development, rapid urban encroachment into prime agricultural land, land price and poor rural development, may also have deprived the local farmers access to land for cultivation. Figures 2 and 4 indicate that Asaba is growing along the major road arteries such as the Benin-Asaba expressway and the Asaba-Okpanam road, in the northwestern direction. Saleh and Rawashdeh (2007)reported that urban expansion occurred mainly along major roads in three Jordianian cities: Amman, Ma'daba and Irbid, between 1918 and 2002.

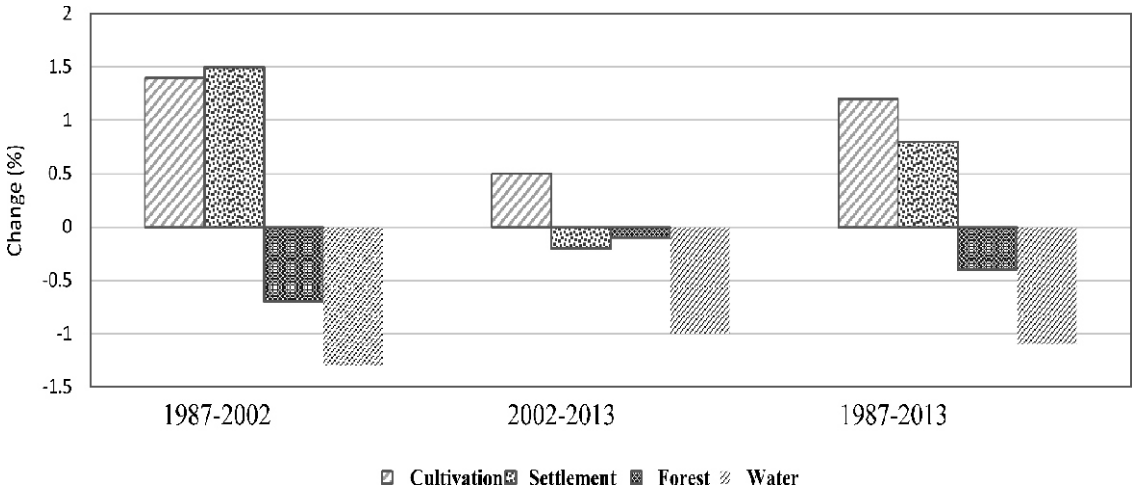

Figure 3: Average Rate and Pattern of Land Cover Change (%)

Tables 1 (*a* – *c*)show the classification accuracy assessment of the three maps derived from the classification process. The Table reveals that the maps derived from the classification of 1987, 2002 and 2013images have error margins of 11.3%, 7.6% and 2.1% respectively. Overall, the classification error is below 15% in all cases. This can be considered good agreement and adequate for determining the spatial and temporal pattern of environmental change.

Table 1 (*a*): Classification Accuracy Assessment, 1987

	Reference total (pixel)	Classified total (pixel)	Number correct (pixel)	Number wrong (pixel)	Producer's accuracy	User's accuracy
Cultivation	1106	2206	736	370	67%	33%
Settlement	1563	1825	1102	461	71%	60%
Forest	14794	13747	13206	1588	89%	96%
Water	6797	6482	6467	330	95%	100%
Total	24260	24260	21511	2749		

Overall accuracy = 88.7%

Table 1 (*b*): Classification Accuracy Assessment, 2002

	Reference total (pixel)	Classified total (pixel)	Number correct (pixel)	Number wrong (pixel)	Producer's accuracy	User's accuracy
Cultivation	1106	2463	996	110	90%	40%
Settlement	1563	1388	1157	406	74%	83%
Forest	14794	13698	13554	1240	92%	99%
Water	6797	6711	6711	86	99%	100%
Total	24260	24260	22418	1842		

Overall accuracy = 92.4%

Table 1 (*c*): Classification Accuracy Assessment, 2013

	Reference total	Classified total (pixel)	Number correct (pixel)	Number wrong (pixel)	Producer's accuracy	User's accuracy
Cultivation	1106	1533	1099	7	99%	72%
Settlement	1563	1634	1554	9	99%	95%
Forest	14794	14366	14359	435	97%	100%
Water	6797	6727	6727	70	99%	100%
Total	24260	24260	23739	521		

Overall Accuracy = 97.9%

Impacts of Rapid Environmental Change on Agricultural Landuse

Figures 4 (*a* - *d*) show the pattern of land use conversion between 1987 and 2013. It shows that the trend in urban growth and infrastructure development, observed in Asaba is as a result of the rapid conversion of fertile agricultural land to urban development. For instance, Figures 4 (b) and (d) reveal that the newly constructed Asaba International Airport is sited on an area that was previously under cultivation. The loss of agricultural land reduces the potential for food production and aggravates food shortages resulting in food insecurity (Lopez *et al*., 2001; Naab *et al*., 2013; Njungbwen and Njungbwen, 2011). The loss of prime agricultural land to urban expansion, also leads to a reduction in per capita agricultural production and income accruing to farmers (Abbass, 1998; Bhatta, 2010; Dalil *et al*., 2013). Figure 4 also suggests that farmlands are being abandoned as the forest category is observed to gain in the second interval, from areas that were under cultivation in the first interval. Similarly, farmland preparation appears to be declining in the area, suggesting the loss of interest in farming. The reduction in agricultural land cultivation implies a decline in agricultural production which is likely to cause an increase in the price of food items. This is capable of reducing the capacity of the populace to access food and other agricultural products.

The conversion of fertile agricultural land to urban landscape and loss of interest in agricultural activities may result in labour scarcity in the rural communities, as young graduates are forced to migrate to urban areas in search of better social, economic and recreational opportunities (Ajaero and Onokala, 2013; de Jong *et al*., 2000; Lambin *et al*., 2001).Rural-urban migration further impoverishes the rural communities and increases the pressure to provide shelter and other social infrastructure and services required by urban dwellers, necessitating further expansion into urban fringes and causing the loss of more agricultural land. Land use change is non-linear in nature but is influenced by other social and biophysical system changes. It can also be attributed to feedback caused by socio-economic changes in an area(Lambin and Meyfroidt, 2010). The rapid environmental changes observed in Asaba

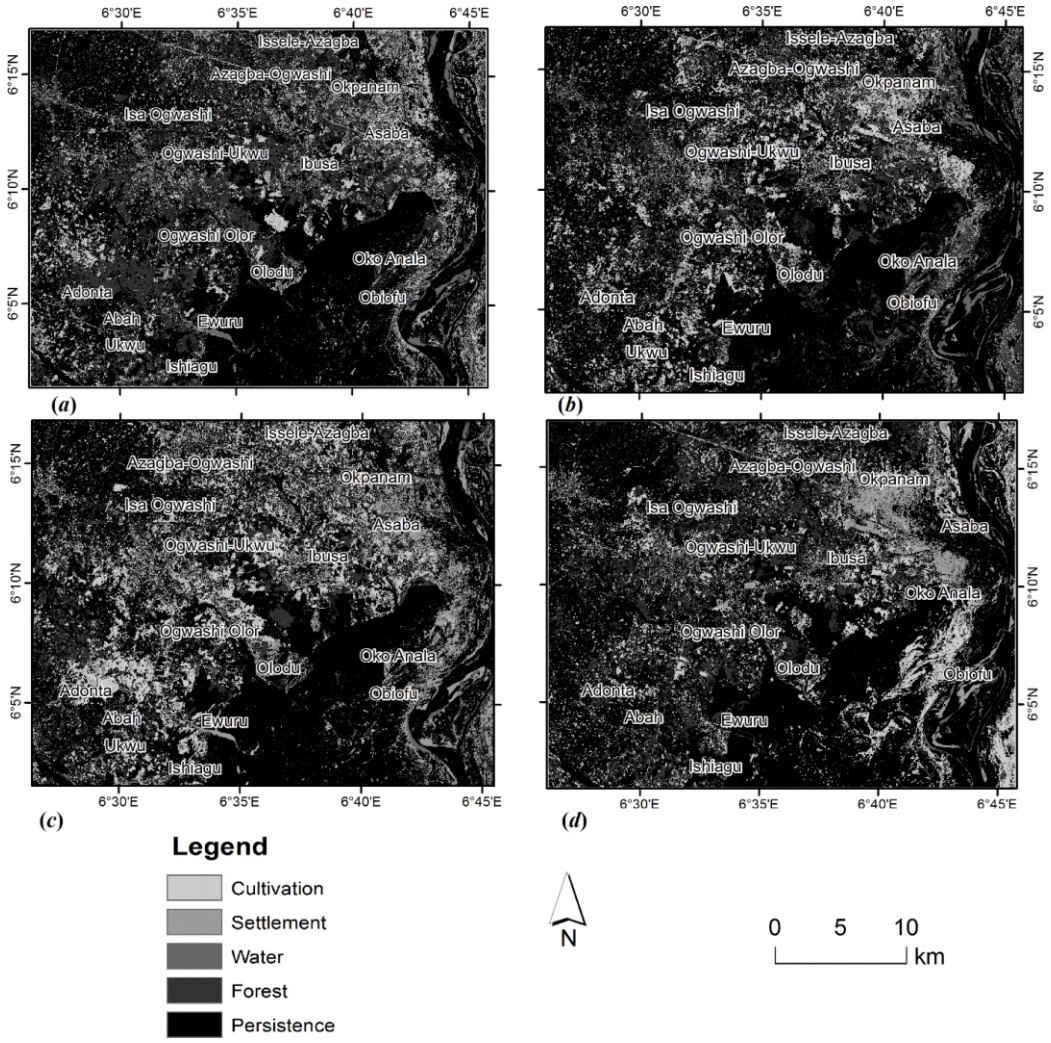

Figure 4: (*a*) Loss and Persistence, 1987-2002; (*b*) Loss and Persistence, 2002-2013; (*c*) Gain and Persistence, 1987-2002; (*d*) Gain and Persistence, 2002-2013

can be attributed to the siting of the capital in the city. This is collaborated by Ikhuoria (1999)who showed that historical land use regimes influenced the pattern of environmental change and urban growth in Ile-Ife, Nigeria. Oriye (2013), and Njungbwen and Njungbwen (2011) observed that urban expansion resulted in scarcity of farmland and reduction in agricultural production in Ado-Ekiti and Uyo respectively. Balogun *et al.* (2011), however, reported an increase in arable land in Akure, Nigeria, in spite of urban expansion while bare surface and dense forest reduced. Studies have shown that urban development is a threat to agricultural production around the world, causing a decline in net primary productivity as prime agricultural land is loss to urban growth (Heimlich and Anderson, 2001; Imhoff *et al.*, 2004;Naab *et al.*, 2013).

CONCLUSION

Environmental change is an inevitable natural process. However, rapid environmental changes, caused by anthropogenic activities, can lead to several negative consequences including deforestation, climate change and food shortages. Consequently, monitoring the rate and pattern of environmental change is an important component of environmental planning and management. This study examined the impacts of rapid environmental changes on agricultural land use in Asaba, southern Nigeria. The results reveal that urban expansion resulted in a decline in agricultural land from 1.4% between 1987 and 2002 to -0.2% between 2002 and 2013 in the study area. Overall, farming activities in the area reduced by 0.4% during the period of study. These results suggest dwindling interest in agriculture production which requires policy

intervention aimed at protecting agricultural land against urban encroachment and the provision of agricultural inputs and credit facilities to young graduates willing to venture into agro-business, while sustainable rural development strategies must be put in place.

REFERENCES

Abbass, I. M. 1998. *The emerging trends in rural-urban migration in Nigeria.* Paper presented at the Habitat-Afrique 2000: International conference and exposition, Arewa House, Kaduna, Nigeria.

Abebe, G. A. 2013. Quantifying urban growth pattern in developing countries using remote sensing and spatial metrics: a case study in Kampala, Uganda. from www.itc.nl/library/papers_2013/msc/upm/abebe.pdf. Accessed 23 March, 2014

Adeniyi, P. O. 1986. Agricultural Land use Inventory and Mapping in Nigeria: The application of Remote Sensing. In M. J. Eden & J. T. Parry (Eds.), *Remote sensing and tropical land management* (pp. 175-187): John Wiley and Sons.

Adeniyi, P. O., and Omojola, A. 1999. Land use/Land cover change evaluation in Sokoto-Rima Basin of N.W. Nigeria based on Archival Remote sensing and GIS techniques. In P. O. Adeniyi (Ed.), *Geoinformation Technology Application for Resource and Environmental Management in Africa* (pp. 143-172): AARSE.

Ajaero, C., and Onokala, P. C. 2013. The effects of rural-urban migration on rural communities of southeastern Nigeria. *International Journal of Population Research*, 1-10. doi: 10.1155/2013/610193

Akinyemi, F. O. 2013. An assessment of land-use change in the Cocoa Belt of south-west Nigeria. *International Journal of Remote Sensing,* 34(8), 2858-2875. doi: 10.1080/01431161.2012.753167

Aldwaik, S. Z., and Pontius, R. G. 2012. Intensity analysis to unify measurements of size and stationarity of land changes by interval, category, and transition. *Landscape and Urban Planning,* 106(1), 103-114.

Atu, J. E., Ayama, O. R., and Eja, E. I. 2013. Urban sprawl effects on biodiversity in peripheral agricultural lands in Calabar, Nigeria. *Journal of Environment and Earth Science, 3*(7), 219-231.

Balogun, I. A., Adeyewa, D. Z., Balogun, A. A., and Morakinyo, T. E. 2011. Analysis of urban expansion and land use change in Akure, Nigeria using remote sensing and geographic information system (GIS) techniques. *Journal of Geography and Regional Planning,* 4(9), 533-541.

Bhatta, B. 2010. Causes and consequences of urban growth and sprawl *Analysis of urban growth and sprawl from remote sensing data*. Berlin Heidelberg: Springer-Verlag.

Biro, K., Pradhan, B., Buchroithner, M., and Makeschin, F. 2013. Land Use/Land Cover Change Analysis and Its Impact on Soil Properties in the Northern Part of Gadarif Region, Sudan. *Land Degradation & Development,* 24(1), 90-102. doi: 10.1002/ldr.1116

Braimoh, A. K. 2006. Random and systematic land-cover transitions in northern Ghana. *Agriculture, Ecosystems & Environment,* 113(1-4), 254-263. doi: 10.1016/j.agee.2005.10.019

Braimoh, A. K., and Onishi, T. 2007. Spatial determinants of urban land use change in Lagos, Nigeria. *Land Use Policy,* 24(2), 502-515.
doi: 10.1016/j.landusepol.2006.09.001

Chigbu, N., Igbokwe, J. I., and Orisakwe, K. U. 2011. *Analysis of landuse and landcover changes of Aba urban using medium resolution satellite imageries*. Paper presented at the FIG Working Week, 2011: Bridging the gap between cultures, Marrakech, Morocco.

Cohen, B. 2004. Urban growth in developing countries: a review of current trends and a caution regarding existing forecasts. *World Development, 32*, 23-51.

Congalton, R. G. 1991. A review of assessing the accuracy of classification of remotely sensed data. *Remote Sensing of Environment,* 37, 35-46.

Dalil, M., Yamman, U. M., and Omeiza, I. 2013. The impact of urban development on food security in peri-urban areas of Minna, Niger State, Nigeria. *International Journal of Humanities and Social Science Invention,* 2(4), 26-31.

de Jong, S. M., Bagre, A., van Teeffelen, P. B. M., and van Deursen, W. P. A. 2000. Monitoring trends in urban growth and surveying city quarters in Ouagadougou, Burkina Faso using SPOT-XS. *Geocarto International,* 15(2), 63-69.

Dutta, V. 2012. *War on the dream - how land use dynamics and peri-urban growth characteristics of a sprawling city devour the master plan and urban suitability?: A fuzzy multi-criteria decision making approach*. Paper presented at the 13th annual global development conference, Budapest, Hungary.

Enaruvbe, G. O., and Ige-Olumide, O. 2014. Geospatial analysis of land-use change processes in a densely populated coastal city: the case of Port Harcourt, south-east Nigeria. *Geocarto International*. doi:http://dx.doi.org/10.1080/10106049.2014.883435

Etter, A., McAlpine, C., Phinn, S., Pullar, D., and Possingham, H. 2006. Characterizing a tropical deforestation wave: a dynamic spatial analysis of a deforestation hotspot in the Colombian Amazon. *Global Change Biology,* 12(8), 1409-1420. doi: 10.1111/j.1365-2486.2006.01168.x

Fabiyi, O. O. 2006. Urban Land Use Change Analysis of a Traditional City from Remote Sensing Data: The Case of Ibadan Metropolitan Area, Nigeria. *Human & Social Sciences Journal,* 1(1), 42-64.

Foody, G. M. 2004. Thematic map comparison: evaluating the statistical significance of differences in classification accuracy. *Photogrammetric Engineering & Remote Sensing, 70*(5), 627-633.

Heimlich, R. E., and Anderson, W. D. 2001. Development at the urban fringe and beyond: impacts on agriculture and rural land *Agricultural Economic Report* No. 803: U.S. Department of Agriculture.

Huang, J., Li, Q., Pontius, R. G., Jr., Klemas, V., and Hong, H. 2013. Detecting the dynamic linkage between landscape characteristics and water quality in a subtropical coastal watershed, Southeast China. *Environ Manage,* 51(1), 32-44. doi: 10.1007/s00267-011-9793-2

Huang, J., Pontius, R. G., Li, Q., and Zhang, Y. 2012. Use of intensity analysis to link patterns with processes of land change from 1986 to 2007 in a coastal watershed of southeast China. *Applied Geography,* 34, 371-384. doi: 10.1016/j.apgeog.2012.01.001

Ikhuoria, I. A. 1984. Rapid urban growth and urban landuse pattern in Benin city. In P. O. Sada & A. B. Osirike (Eds.), *Case studies in migration and Urbanization in Nigeria: Perspectives in Policy Issues* (pp. 175-189). Benin City.

Ikhuoria, I. A. 1999. SPOT satellite detection and analysis of urban spatial growth regimes in a pre-colonial African city. *Geocarto International,* 14, 49-52.

Imhoff, M. L., Bounoua, L., DeFries, R., Lawrence, W. T., Stutzer, D., Tucker, C. J., and Ricketts, T. 2004. The consequences of urban land transformation on net primary productivity in the United States. *Remote Sensing of Environment,* 89, 434-443. doi: 10.1016/j.rse.2003.10.015

Lambin, E. F., and Meyfroidt, P. 2010. Land use transitions: Socio-ecological feedback versus socio-economic change. *Land Use Policy,* 27(2), 108-118. doi: 10.1016/j.landusepol.2009.09.003

Lambin, E. F., Turner, B. L., Geist, H. J., Agbola, S. B., Angelsen, A. A., Bruce, J. W., Coomes, O. T., Dirzo, R., Fischer, G., Folke, C., George, P. S., Homewood, K., Imbernon, J., Leemans, R., Li, X., Moran, E. F., Mortimore, M., Ramakrishnan, P. S., Richards, J. F., Skanes, H., Steffen, W., Stone, G. D., Svedin, U., Veldkamp, T. A., Vogel, C., and Xu, J. 2001. The causes of land-use and land-cover change: moving beyond the myths. *Global Journal of Environmental Change,* 11, 261-269.

Liu, C., Frazier, P., and Kumar, L. 2007. Comparative assessment of the measures of thematic classification accuracy. *Remote Sensing of Environment,* 107, 606-616. doi: 10.1016/j.rse.2006.10.010

Lopez, T., Aide, T. M., and Thomlinson, J. R. 2001. Urban expansion and the loss of prime agricultural lands in Puerto Rico. *Ambio,* 30(1), 49-54.

Mahmud, A., and Achide, A. S. 2012. Analysis of Land use/Land cover changes to monitor urban sprawl in Keffi-Nigeria.

Environmental Research Journal, 6(2), 129-134.

Manandhar, R., Odeh, I. O. A., and Pontius, R. G. 2010. Analysis of twenty years of categorical land transitions in the Lower Hunter of New South Wales, Australia. *Agriculture, Ecosystems & Environment,* 135(4), 336-346. doi: 10.1016/j.agee.2009.10.016

Naab, F. Z., Dinye, R. D., and Kasanga, R. K. 2013. Urbanisation and its impact on agricultural lands in growing cities in developing countries: A case study of Tamale in Ghana. *Modern Social Science Journal,* 2(2), 256-287.

Njungbwen, E., and Njungbwen, A. 2011. Urban expansion and loss of agricultural land in Uyo urban area: implications for agricultural business. *Ethiopian Journal of Environmental Studies and Management, 4*(4), 74-83. doi: 10.4314/ejesm.v4i4.9

Ogbuene, E. B. 2010. Environmental Consequences of Rainfall Variability and Deforestation in Southeastern Nigeria. *International Journal of Water and Soil Resources Research,* 1(1-3), 100-115.

Ogunowo, C. O., and Oderinde, F. O. 2012. Sustainable development and management of infrastructure for effective transformation of rural communities in Nigeria: Implications for food security. *Ozean Journal of Social Sciences,* 5(3), 87-94.

Oriye, O. 2013. Urban expansion and urban land use in Ado-Ekiti, Nigeria. *American Journal of Reserach Communication,* 2(1), 128-139.

Otieno, V. O., and Anyah, R. O. 2012. Effects of land use changes on climate in the Greater Horn of Africa. *Climate Research, 52*, 77-95.

Pontius Jr, R., Gao, Y., Giner, N., Kohyama, T., Osaki, M., and Hirose, K. 2013. Design and Interpretation of Intensity Analysis Illustrated by Land Change in Central Kalimantan, Indonesia. *Land,* 2(3), 351-369. doi: 10.3390/land2030351

Pontius Jr, R. G., Shusas, E., and McEachern, M. 2004. Detecting important categorical land changes while accounting for persistence. *Agriculture, Ecosystems & Environment,* 101(2-3), 251-268. doi: 10.1016/j.agee.2003.09.008

Rilwani, M. L., and Gbakeji, J. O. 2009. Geoinformatics in agricultural development: challenges and prospects in Nigeria. *Journal of Social Science,* 21(1), 49-57.

Rounsevell, M. D. A., Annetts, J. E., Audsley, E., Mayr, T., and Reginster, I. 2003. Modelling the spatial distribution of agricultural land use at the regional scale. *Agriculture, Ecosystems & Environment, 95*(2-3), 465-479. doi: 10.1016/s0167-8809(02)00217-7

Saleh, B., and Rawashdeh, S. A. 2007. Study of urban expansion in Jordanian city using GIS and remote sensing. *International Journal of Applied Science and Engineering,* 5(1), 41-52.

Salemi, L. F., Groppo, J. D., Trevisan, R., de Moraes, J. M., de Barros Ferraz, S. F., Villani, J. P., Duarte-Neto, P. J., and Martinelli, L. A. 2013. Land-use change in the Atlantic rainforest region: Consequences for the hydrology of small catchments. *Journal of Hydrology,* 499, 100-109. doi: 10.1016/j.jhydrol.2013.06.049

Tokula, A. E., and Ejaro, S. P. 2013. Dynamics of land use/land cover changes and its implication on food security in Anyigba, North Central Nigeria. *Conference Journal of Environmental Studies,* 7, 42-52.

Turner II, B. L., Lambin, E. F., and Reenberg, A. 2007. The emergence of land change science for global environmental change and sustainability. *Proc Natl Acad Sci U S A,* 104(52), 20666-20671. doi: 10.1073/pnas.0704119104

Yeshaneh, E., Wagner, W., Exner-Kittridge, M., Legesse, D., and Blöschl, G. 2013. Identifying Land Use/Cover Dynamics in the Koga Catchment, Ethiopia, from Multi-Scale Data, and Implications for Environmental Change. *ISPRS International Journal of Geo-Information,* 2(2), 302-323. doi: 10.3390/ijgi2020302

Zhang, Y., and Xu, B. 2014. Spatiotemporal analysis of land use/cover changes in Nanchang area, China. *International Journal of Digital Earth*, 1-22. doi: 10.1080/17538947.2014.894145