World Academics Journal of Management
Research Paper
Vol.10, Issue.3, pp.09-15, September (2022)
E-ISSN: 2321-905X

Spatial and Temporal Appraisal of Urban Agriculture in Abuja Metropolis using Biophysical and Socioeconomic Indicators

Thomas U. Omali[1*], Gabriel O. Agada[2], Kebiru Umoru[3], Joseph Obera[4]

[1]National Biotechnology Development Agency (NABDA), Nigeria
[2]Dept. of Agric. Economics, University of Nigeria, Nsukka, Nigeria
[2]National Authority on Chemical and Biological Weapon Conventions, Nigeria
[3]National Centre for Remote Sensing, Jos, Nigeria
[4]Seed and Mech Hubs Limited, Abuja, Nigeria

[*]Corresponding Author: t.omali@yahoo.com, Tel.: +234-08099806705

Available online at: www.isroset.org

Received: 01/Aug/2022, Accepted: 03/Sept/ 2022, Online: 30/Sept/2022

Abstract— Urban farming is a food production strategy that has existed since ancient times to secure supplementary food supplies, particularly for the urban populace. The increasing demand for sustenance and jobs among urban dwellers attracts many metropolitan residents towards urban farming for food, income and other household necessities. Nevertheless, enough recognition has not been given to urban agriculture in developing nations, especially at the policy level. Improving urban agronomic activities requires frequent monitoring in space and time. Thus, this research is focused on spatiotemporal appraisal of urban agriculture in Abuja Metropolitan area with an emphasis on crop area. We used time-series satellite data from the Landsat sensor for the classification of LULC over Abuja Municipal Area Council. We also used questionnaires to gather socioeconomic data about the location of the study. The outcomes from the study indicate an increase in urban agricultural practice in Abuja Municipal Area Council of the FCT, Abuja-Nigeria.

Keywords—Crop area, farming, food security, satellite data, urbanization

I. Introduction

More than half of the world's populace resides within towns, and over 60 % is likely to dwell in the cities by 2050 [1, 2]. The most proliferation of urban dwellers will soon arise in low- and middle-income nations. For instance, half of Africans will probably reside in the cities by 2030 [3]. The main ecological consequence of the rapid urban population rise in Africa is the expansion of its urban land. Metropolitan land in Africa is projected to rise by approximately 600 % from 2000 to 2030[4]. In the same manner, urban residents in Nigeria have rapidly increased in the past 5 decades. The most rapid urban population growth in Nigeria is occurring in the Federal Capital Territory (FCT) Abuja, which is the eighth most populous metropolis in the country with a population of 776,298. United Nations record suggests that FCT population rose by 139.7 per cent from 2000 to 2010, which indicate that it the fastest developing urban center globally. Unfortunately, this level of population growth and urban expansion has its corresponding challenges.

The main socio-economic problems of urban expansion in Nigeria are associated with increasing food insecurity, and famine [5]. For example, Ravallion, et al. [6] show that 25 % of the poor in developing countries lives in cities with little access to food. The highly populated areas normally generate more demand for food, especially in the slums, where a huge percentage of people's earnings is spent on food [7]. Consequently, there has been a considerable susceptibility to food supply shock in the municipal areas of the Nigeria [8].

The growing urban expansion, which is inevitable, requires new tactics that can support the delivery of fresh, local food for towns. Also, urban farming has become a more essential public issue driven by universal necessities such as global warming [9]. It equally contributes to economic prospects, as it widens the food diversity while providing employment prospects and creating some income through sales of surplus produce [10]. Urban agriculture (UA) in Sub-Saharan Africa (SSA) is now seen as one possible element in solving the problem of future food supply. In Nigeria, urban agriculture is necessary for filling the gap of food demand and supply and affording income for other households' needs [11]. Furthermore, urban farming activities have proven to aid climate change adaptation by greening the urban area and enhancing the city climate, while encouraging the creative recycling of municipal organic waste and decreasing the city energy footprint [12].

Regardless of its significance, UA is yet to expand in the developing nations [13] due to several setbacks. Of course, recent reviews present the features and challenges of UA in various cities around the globe [e.g., 14–19]. Likewise, this study focuses on a spatially explicit assessment of the current extent of urban farming in FCT Abuja using a consistent methodology.

Five sections are used to prepare this study. In section I, the introduction of the study is presented. Review of related literature is conducted in section II. The study methodology is explained in section III. Section IV describes results and discussion, and Section VI concludes the study with future scope.

II. RELATED WORK

The FAO stated in the 1990s that approximately 800 million people worldwide were practicing agriculture and forestry in and near cities. Since then, there is a growth of urban residents in less developed countries from 2 billion to more than 2.7 billion [19]. Accordingly, the population of urban and peri-urban farmers is growing [20], which has attracted a substantial research effort.

Weerakoon [21] analyzed the suitability for urban agriculture. He advanced a method to integrate stakeholders' perceptions into a spatial analysis by incorporating GIS and Multi-Criteria Assessment. The driving factors affecting the urban agriculture was also studied using a simple regression model.

Ola [22] evaluated the influence of urban planning on urban agriculture and its input to the improvement of the resilience of the city to food shock in Ilorin, Nigeria. Results of the study indicate that UA is responsible for the following percentage requirement of various produce: meat/fish/egg (16.9 %), yam/cassava/potato (4.5 %), vegetable (0.58 %), fruit (0.6 %), and grain (0.5 %).

Feola, Sahakian, and Binder [23] carried out a study on the challenges and ways forward for the sustainable evaluation of UA. The study show that specific technique for assessment of UA that is flexible for use in different context is lacking.

Clerino and Fargue-Lelièvre [24] identified the purposes and conditions for intra-urban farms relying on various stakeholders' participation. They found that policy-makers are more dedicated to external sustainability of the projects.

Ngahdiman, Terano, Mohamed and Sharifuddin [25] investigated the goal of urban residents towards active UA. The results demonstrate that respondents have positive perceptions of UA.

Aubry and Manouchehri [36] studied urban agriculture and health with emphasis on the risks. They concluded that UA influences pollution associated to farming techniques.

III. METHODOLOGY

3.1 Study Area

The study area - Abuja Municipal Area Council (AMAC) lies between latitudes 8˚37'41" and 9˚9'15" N and longitudes 7˚03'55" and 7˚34' 00" E (see figure 1). It records a yearly rainfall of nearly 1,650mm. It is also composed of hot, humid, and tropical climatic conditions and it falls within the guinea savanna ecological zone with its main vegetation being categorized into grass, woodland, and shrub [27].

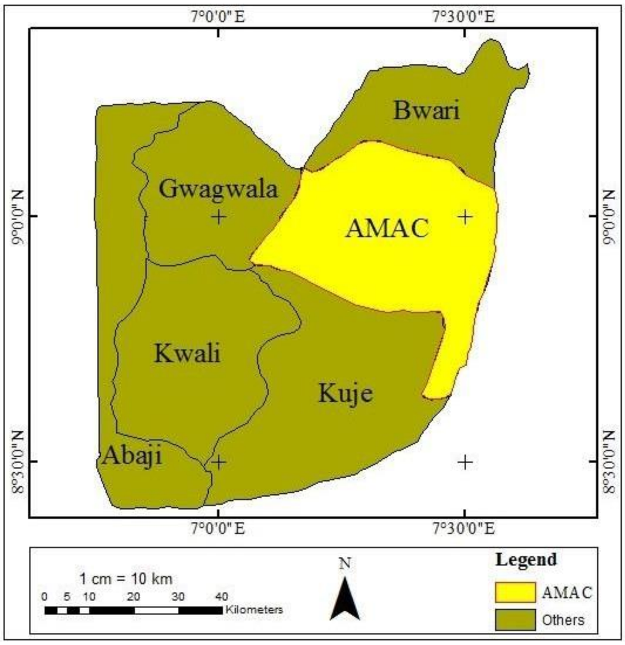

Figure 1. Map of FCT, Abuja displaying the area councils with the study area in yellow (source: Omali [27])

3.2 Data Collection

3.2.1 Satellite Imagery

The Landsat data covering the study area were acquired from the Archive of USGS for 1987, 2001, and 2020. All the data were projected using UTM with WGS84 datum and Zone 32N.

3.2.2 Socioeconomic Data

The collection of socioeconomic data was through well-structured questionnaire. Questions in the questionnaire were designed to elicit information on the research questions under investigation. The data was classified into two broad areas related to: (i) demography and (ii) agricultural activities. Trained enumerators under the researchers' supervision were used to collect the data .

3.3 Method

3.3.1 Satellite Image Pre-processing

Satellite data pre-processing was used to eliminate atmospheric noises and to ensure that multi-temporal images were in the same radiometric scale [28]. The digital number (DN) values were converted to spectral radiance; the spectral radiance were converted to apparent reflectance; and the atmospheric effects due to absorption and scattering were eliminated [29].

3.3.2 Development of Classification System and LULC Classification

The aim of feature grouping is to organize all the image pixels into different LULC. This is because diverse LULC component shows a typical blend of their basic reflectance [30]. Before attempting a classification, it is important to define the LULC classes considering the purpose of the study. Based on the Anderson's classification [31], the present study area is divided into six LULC classes (see table 1).

Table 1. Land covers classification system used for this study

S/No.	Land use/cover	Description
1	Water body	Area covered by main river, reservoir, etc.
2	Built-up	Area of human habitation and development covering buildings, transport and communication infrastructures, and utilities, etc.
3	Bare land	Area of exposed soil with very little or without vegetation coverage.
4	Agricultural Land	Area for farming.
5	Sparse Vegetation	Area of scanty growth of vegetation.
6	Thick Vegetation	A dense growth of bushes or trees.

The classification of satellite data was done to generate particular information on the extent and spatiotemporal trend in LULC of the study area. We employed the supervised classification based on maximum likelihood.

3.3.3 Classification Accuracy Assessment

The last stage of LULC classification in the present study involved the accuracy assessment in line with Manisha, Chitra and Umrikar [32]. The contingency table was used to represent the classification accuracy as recommended by many researchers (e.g., [33, 34]). Also, descriptive statistics comprising overall accuracy, user's and producer's accuracies, and kappa coefficients were used to summarize the information and to obtaining accuracy measures.

3.3.4 LULC Change Analysis

The multi-temporal imageries were used to monitor LULC change in the study area. With the statistics generated from this satellite data, the trend (T) of change and annual rate (R) of change in the LULC of the study area were determined using the equations (1) and (2) respectively

$$T = \frac{\text{Observed Change}}{\text{Sum of Change}} \text{X} \frac{100}{1} \quad (1)$$

$$R = \frac{\%\ \text{Change}}{100} \text{X} \frac{\text{No. of Years}}{1} \quad (2)$$

3.3.5 Socioeconomic Data Processing

Percentages were computed for each socioeconomic variable investigated in the study using the following equation:

$$\% = \frac{\text{No. of Respondents}}{\text{Total No. of Respondents}} \text{X} \frac{100}{1} \quad (3)$$

IV. RESULTS AND DISCUSSION

4.1 LULC Classification Results

Common approaches using Landsat multispectral images were followed to create a consistent time-series LULC maps of Abuja Municipal Area Council covering the period 1987, 2001, and 2020 (Figures 2, 3, and 4). A total of 6 LULC classes were mapped, showing unique spectral characteristics on multiple dates, and over a near-continuous time interval [35].

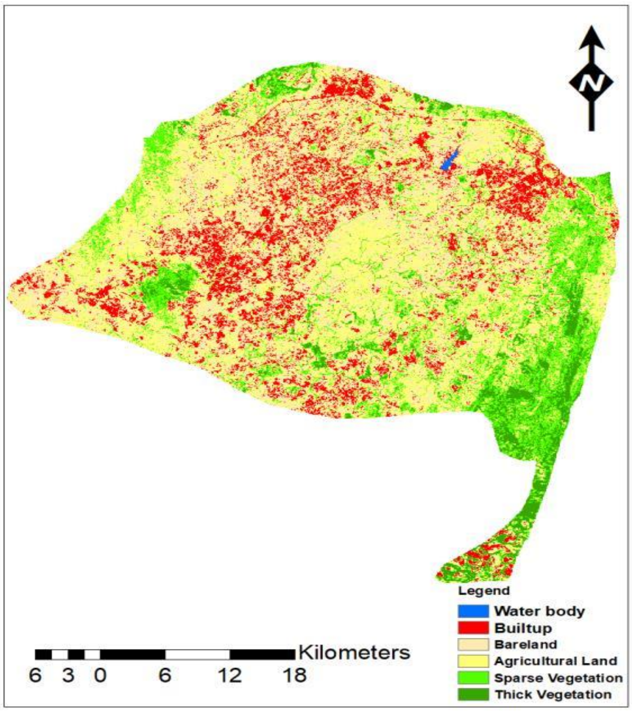

Figure 2a. LULC map of the AMAC for 1987

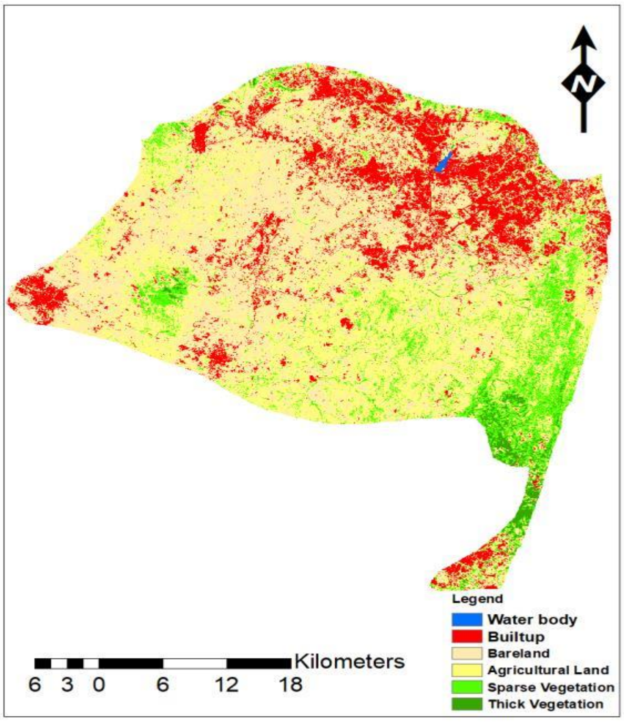

Figure 2b. LULC map of the AMAC for 2001

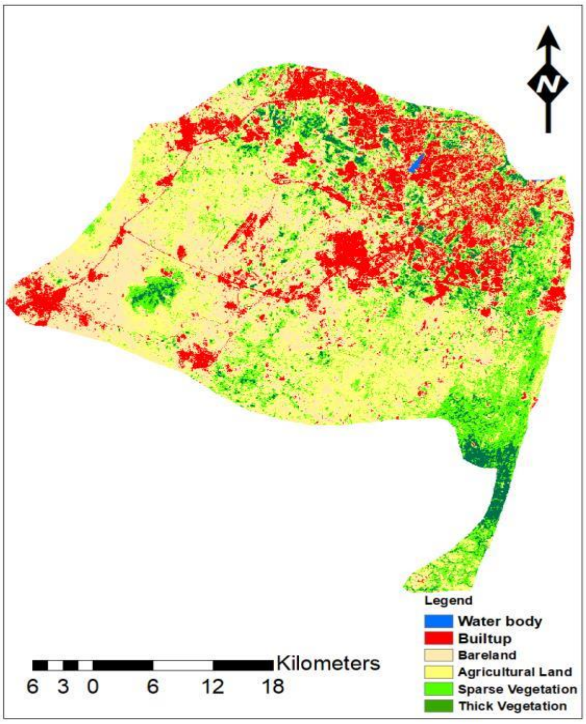

Figure 2c. LULC map of the AMAC for 2020

Also, the areal extent of each LULC class is presented in table 2. Results in table 2 revealed a flutuating trend in the waterbody as it increase from 0.07 % in 1987 to 0.09 % in 2001, and decreased to 0.08 % in 2020. There is a continual growth in builtup between 1987 and 2020. It occupies 14.05 % of the total land area in 1987, rises to 16.4 % in 2001 and 17.9 % in 2020. The bareland covers 34.33 % of the total area in 1987, rise to 41.63 % in 2001 and 30.98 % in 2020. The agricultural land covers 30.22 % of the total land area in 1987, it reduced slightly to 30.16% in 2001 and rise to 30.86 % in 2020. The Sparse vegetation covered 14.84 % of the total land in 1987 declined to 9.71 % in 2001 and rise to 14.74 % in 2020. The area of land occupied by thick vegetation declined between 1987 and 2001 but had a slight increase in 2020. It covers 6.45 % of the total area in 1987 reduced to 2.02 % in 2001 and rise to 5.40 % in 2020.

Table 2. Areal extent for each land use/cover

LU LC	1987	%	2001	%	2020	%
Water body	1.3	0.1	1.5	0.1	1.4	0.1
Built-up	229.6	14.1	267.5	16.4	292.7	17.9
Bare land	560.9	34. 3	680.1	41.6	506.2	31.0
Agric. Land	493.8	30.2	492.7	30.2	504.1	30.9
Sparse Veg.	242.5	14.8	158.7	9.7	240.8	14.7
Thick Veg.	105.4	6.5	33.0	2.0	88.3	5.4
Total	**1633.5**	**100**	**1633.5**	**100**	**1633.5**	**100**

4.1.1 Accuracy Assessment Results

Excerpt of the accuracy assessment result from the generated confusion matrices is presented in table 3. The overall classification accuracies and the Kappa coefficients of agreement presented in table suggest a very good accuracy as it corroborates earlier result (see Lekha and Kumar [36]).

Table 3. Summary of images classification accuracies

	1987	**2001**	**2020**
Overall Accuracies	80.43 %	81.97 %	80.25 %
Kappa Coefficients	0.75	0.77	0.76

4.1.2 LULC Change Analysis Results

LULC variations were computed between 1987 and 2001, and between 2001 and 2020 for the six LULC types. The excerpt of the changes in the LULC, which were computed using equation [1] is presented in table 4 while the annual rate of changes, which were computed using equation [2] is presented in table 5.

Table 4. LULC change values

LULC	**1987-2001**	**2001-2020**
Water body	0.2	-0.1
Built-up	37.9	25.2
Bare land	119.2	-173.9
Agric. Land	-1.1	11.4
Sparse Veg.	-83.8	82.1
Thick Veg.	-72.4	55.3

Table 4. Annual rate of change in LULCs

LULC		**1987-2001**		**2001-2020**
Water body	1000	140	500	95
Built-up	189500	26530	-126000	-23940
Bare land	596000	83440	869500	165205
Agric. Land	-5500	-770	-57000	-10830
Sparse Veg.	-419000	-58660	-410500	-77995
Thick Veg.	-361900	-50666	-276400	-52516

4.1.3 Socioeconomic Data Analysis Results

The demographic data of respondents analyzed include age, gender, marital status, household size, educational status, and primary occupation. Others, which are directly related to their farming activities include years of farming experience, land tenure, farm size, proximity to farm, and crop yield.

Table 5. Demographic features of respondents

Variables	**Frequency**	**Percentage**
Age		
<21	22	10.28
21-30	31	14.49
31-40	74	34.58
41-50	59	27.57
>50	28	13.08
Total	**214**	**100**
Sex		
Female	88	41.12
Male	126	58.88
Total	**214**	**100**

Marital Status		
Single	85	35.05
Married	112	53.27
Divorced	25	11.68
Total	**214**	**100**
Household Size		
<5	62	28.97
5-10	107	50.00
11-15	31	14.49
>15	14	6.54
Total	**214**	**100**
Educational Status		
Non-educated	43	20.09
Primary	37	17.29
Secondary	49	22.90
Tertiary	74	34.58
Non-formal	41	19.16
Total	**214**	**100**
Primary Occupation		
Trading	**28**	**13.08**
Civil servant	**75**	**35.05**
Retiree	**59**	**27.57**
Others	**52**	**24.30**
Total	**214**	**100**

The result presented in table 5 shows that the farmers cut across nearly all the age group. Also, the gender distribution of the respondents revealed that 41.12 % and 58.88 % where female and male respectively. This show an imbalance distribution, which may be connected to culture that, hinders active involvement of womenfolk in certain activities within the study area. Equally, 53.27 % of the respondents were married implying that majority of the urban farmers are married. Also, 50 % of the respondents have household of 5-10 members. The implication is that majority of the farmers has an average household size, which has a significant plus. Of course, earlier studies suggests that reasonable number in a household serves as major source of labour for agriculture (see [37,38]). The table also revealed that most of the respondents are literate. This level of literacy may be ascribed to the urban character of the study location. It is noteworthy that the educational level of a farmer increases capacity to understand different farming tactics [39]. Furthermore, 35.05 % of the respondents are civil servants. The implication is that most of the respondents are involved in a primary employment while UA is essentially supplemental. Of course, this buttresses Dennery [40] who is of the opinion that urban inhabitants who engages in employed services and also practice agriculture are do well economically as compared to their counterparts who depend only on their income and salaries.

4.1.4 Socioeconomic Data Related to Farming activities

From table 6, the respondents' years of experience in farming shows that 38.32 % and 14.95 % had less than 5 and more than 20 years farming experiences respectively. Also, the mode of land acquisition shows that 23.36 % and 3.74 % of respondents got their land by acquisition and communal respectively. Information on the Farm Size (in hectares) cultivated by the respondents in the study area show that 3.27 % cultivate more than 5 hectares while 31.31 % cultivated between 2.1-3 hectares. Reponses on the proximity of respondents to their farms shows that 10.28 % live from 5 km or more to their farms. Furthermore, 48.60 % of the respondents respond affirmatively to high crop yield.

Table 6. Data analysis related to the farming activities

Variables	Frequency	Percentage
Years of Experience		
<5	82	38.32
6-10	39	18.22
11-15	43	20.09
16-20	18	8.41
>20	32	14.95
Total	**214**	**100**
Tenure		
Rent	36	16.82
Gift	23	10.75
Leasehold	48	22.43
Govt. Allocation	37	17.29
Communal	8	3.74
Inheritance	12	5.61
Acquisition	50	23.36
Total	**214**	**100**
Farm Size (ha)		
<1	20	9.35
1.1-2	28	13.08
2.1-3	67	31.31
3.1-5	44	20.56
4.1-5	38	17.76
>5	17	3.27
Total	**214**	**100**
Proximity to Farm (km)		
<1	62	28.97
1.1-2	25	11.68
2.1-3	33	15.42
3.1-5	18	8.41
4.1-5	54	25.23
>5	22	10.28
Total	**214**	**100**
Crop Yield		
High	104	48.60
Mid	37	17.29
Low	63	28.44
Total	**214**	**100**

V. CONCLUSION AND FUTURE SCOPE

Urban farming is characterized by numerous roles and creates range of opportunities that influences sustainable metropolitan settlements. This study demonstrates a method of appraising agricultural activities in metropolitan settlement using geospatial technology. It focuses on crop-based agricultural analysis from 1987 to 2020 within Abuja city. The results indicate that crop-based agriculture is successful in the study area. This is evidenced by the high crop yield, and the consistent expansion of agricultural land use over the three epochs investigated.

Land tenure system is of great significance in agricultural activities. The high percentage in leasehold and rent with regards to agricultural land shows high demand for agricultural land within the area of study. Unfortunately, there is no government layout specifically for farming purpose in the area. As a consequence, various land uses are modified into agricultural land use. This action has invariable effect on the city aesthetics, and the general ecosystem balance. Thus, establishing explicit policy for Urban Agriculture in Nigeria will give UA the official acknowledgment it deserves and would also co-ordinate a strong and viable farmers association.

REFERENCES

[1] United Nations, "World Population to 2300," *Department of Economic and Social Affairs, United Nations*, **New York**, **2004**.

[2] United Nations, "World urbanization prospects: The 2014 revision," *United Nations*, **New York**, **2014**.

[3] A.P. Celik, R. Zyman, R. Mahdi (eds.), "Sustainable Urbanization in the Information Age," *Department of Economic and Social Affairs Division for Public Administration and Development Management, United Nations*, ST/ESA/ PAD/SER.E/137, **New York**, **2009**.

[4] K.C. Seto, B. G¨uneralp, L.R. Hutyra, "Global Forecasts of Urban Expansion to 2030 and Direct Impacts on Biodiversity and Carbon Pools," *Proc. Natl Acad. Sci.*, Vol.**109**, pp.**16083–16088**, **2012**.

A. Metu, K. Okeyika, O. Maduka, "Achieving Sustainable Food Security in Nigeria: Challenges and Way Forward," In: *Proceedings of the 3rd International Conference on African Development Issues (ICAD, 2016)*, Otta, **Nigeria**, pp.**143-148**, **2016**.

[5] M. Ravallion, S. Chen, P. Sangraula, "New Evidence on the Urbanization of Global Poverty," *Popul. Dev. Rev.*, Vol.**33**, pp.**667–701**, **2007**.

[6] I. Matuschke, "Rapid Urbanization and Food Security: Using Food Density Maps to Identify Future Food Security Hotspots Rapid Urbanization and Food Security." *Paper for the International Association of Agricultural Economists Conference (IAAEC)*, Beijing, **China**, **2009**.

[7] H. Fudjumdjum, W.L. Filho, Y.A. Desalegn, "Assessment of Barriers to Food Security in North-Eastern Nigeria," In: W.H. Filho (ed.). *Handbook of Climate Change Resilience*. Springer International Publishing, **Switzerland**, pp.**1019-1033**, **2019**. Available from https://doi. org/10.1007/978-3-319-93336-8_99

[8] K. Bohn, A. Viljoen, "The Edible City: Envisioning the Continuous Productive Urban Landscape (CPUL)," *Field Journal*, Vol.**4**, Issue.**1**, pp.**149–161**, **2011**.

[9] A. Drescher, R. Holmer, R. Glaser, C. Richert, "Understanding Urban and Peri-urban Vegetable Production and Marketing Systems through GIS-based Community Food Mapping as Part of an Interactive Collaborative Research Environment in Southeast Asia—An outlook," In SEAVEG 2012: *High Value Vegetables in Southeast Asia: Production, Supply and Demand*, The World vegetable Center: Chiang Mai, **Thailand**, p.**272**, **2013**.

[10] R.O. Kareem, K. A. Raheem, "A Review of Urban Agriculture as a Tool for Building Food Security in Nigeria: Challenges and Policy Options," *J. Sust. Dev. Afr.*, Vol.**14**, Issue.**3**, pp.**2012**.

[11] H. De Zeeuw, "Cities, Climate Change and Urban Agriculture," *Urban Agriculture Magazine*, Vol.**25**, pp.**39–42**, **2011**.

[12] A.L. Thebo, P. Drechsel, E.F. Lambin, "Global Assessment of Urban and Peri-urban Agriculture: Irrigated and Rainfed Croplands," *Environ. Res. Lett*., Vol.**9**, p.**114002**, **2014**. doi:10.1088/1748-9326/9/11/114002

[13] A.J. Hamilton, K. Burry, H.-F. Mok, S.F. Barker, J.R. Grove, V.G. Williamson, "Give Peas a Chance? Urban Agriculture in Developing Countries: A Review," *Agron. Sust. Dev*., Vol.**34**, pp.**45–73**, **2013**.

[14] M.A. Altieri, N. Companioni, K. Cañizares, C. Murphy, P. Rosset, M. Bourque, C.I. Nicholls, "The Greening of the 'Barrios': Urban Agriculture for Food Security in Cuba," *Agric. Human Values*, Vol.**16**, pp.**131–40**, **1999**.

[15] E. Bryld, "Potentials, Problems, and Policy Implications for Urban Agriculture in Developing Countries," *Agric Human Values*, Vol.**20**, pp.**79–86**, **2003**.

[16] H.-F. Mok, V.G. Williamson, J.R. Grove, K. Burry, S.F. Barker, A.J. Hamilton, "Strawberry Fields Forever? Urban Agriculture in Developed Countries: A Review," *Agron. Sust. Dev.*, Vol.**34**, pp.**21–43**, **2013**.

[17] F. Orsini, R. Kahane, R. Nono-Womdim, G. Gianquinto, "Urban Agriculture in the Developing World: A Review," *Agron. Sust. Dev*., Vol.**33**, pp.**695–720**, **2013**.

[18] FAO, "Growing Greener Cities in Latin America and the Caribbean:," *An FAO report on urban and peri-urban agriculture in the region.* **Rome**, **2014.** Available from http://doi.org/10.1017/CBO9781107415324.004

[19] M.D. Houessou, M. van de Louw, B.G.J.S. Sonneveld, "What Constraints the Expansion of Urban Agriculture in Benin?," *Sustainability*, Vol.**12**, pp.**5774, 2020.** doi:10.3390/su12145774

[20] R.A. Olawepo, "Food Security and Challenges of Urban Agriculture in the third World Countries," In A. Aladjadjiyan (Ed.), *Food Production - Approaches, Challenges and Tasks.* InTech., **2012**. Available from http://doi.org/10.5772/52807

[21] K.G.P.K. Weerakoon, "Suitability Analysis for Urban Agriculture Using GIS and Multi-Criteria Evaluation," *Int. J. Agric. Sci. Technol.*, Vol.**2**, Issue.**2**, **2014**. doi: 10.14355/ijast.2014.0302.03

[22] A. Ola, "Building a Food-resilient City through Urban Agriculture: The Case of Ilorin, Nigeria. *Town and Regional Planning*, Vol.**77**, pp. **89-102**, **2020**. doi: http://dx.doi.org/10.18820/2415-0495/trp77i1.7

[23] G. Feola, M. Sahakian, C.R. Binder, "Sustainability Assessment of Urban Agriculture, " In: C.R. Binder, R. Wyss, E. Massaro, (Eds.) *Sustainability Assessment of Urban Systems*. Cambridge University Press, **Cambridge**, pp.**417-437**, **2020**.

[24] P. Clerino, A. Fargue-Lelièvre, "Formalizing Objectives and Criteria for Urban Agriculture Sustainability with a Participatory Approach," *Sustainability*, Vol.12, pp.7503, **2020**. doi:10.3390/su12187503

[25] I.N. Ngahdiman, R. Terano, Z. Mohamed, J. Sharifuddin, "Factors Affecting Urban Dwellers to Practice Urban Agriculture," *Int. J. Adv. Res*, Vol.**5**, Issue.**7**, pp.**1580-1587**.

[26] C. Aubry, N. Manouchehri, "Urban Agriculture and Health: Assessing Risks and Overseeing Practices," *Field Actions Science Reports*, Special Issue. **20**, **2019**. Available from http://journals.openedition.org/factsreports/5854

[27] T.U. Omali, "Ecological Evaluation of Urban Heat Island Impacts in Abuja Municipal Area of FCT Abuja, Nigeria," *World Academic Journal of Engineering Sciences*, Vol.**7**, Issue.**1**, pp.**66-72**, **2020**.

[28] X. Chen, L. Vierling, D. Deering, "A Simple and Effective Radiometric Correction Method to Improve Landscape Change Detection across Sensors and across Time," *Remote Sens. Environ.*, Vol.**98**, Issue.**1**, pp.**63–79**, **2005**.

[29] L. Cui, G. Li, H. Ren, L. He, H. Liao, N. Ouyang, Y. Zhang, "Assessment of atmospheric correction methods for Historical Landsat TM Images in the Coastal Zone: A Case Study in Jiangsu, China," *Euro. J. Remote Sens.*, Vol.**47**, pp.**701–71**6, **2014**.

[30] P. Fisher, "The Pixel: A Snare and a Delusion," *Int. J. Remote Sens.*, Vol.**18**, Issue.**15**, pp.**679–685**, **1997**.

[31] J.R. Anderson, "Land Use Classification Schemes used in selected recent geographic applications of Remote Sensing," *Photogrammetric Engineering and Remote Sensing*, Vol.**37**, Issue.**4**, pp.**379-387**, **1971**.

[32] B. Manisha, G. Chitra, N. Umrikar., "Image Classification Tool For Land Use/ Land Cover Analysis: A Comparative Study of Maximum Likelihood and Minimum Distance Method," *Int. J. Geo. Earth. Environ.*, Vol.**6**, pp.**189-96**, **2012**.

[33] H.G. Lewis, M. Brown, "A Generalized Confusion Matrix for Assessing Area Estimates from Remotely Sensed Data," *Int. J. Remote Sens.*, Vol.**22**, pp.**3223–3235**, **2001**.

[34] G.M. Foody, "Status of Land Cover Classification Accuracy Assessment," *Remote Sens. Environ.*, Vol.**80**, pp.**185–201**, **2002**.

[35] P.S. Thenkabail, M. Schull, H. Turral, "Ganges and Indus River Basin Land Use/Land Cover (LULC) and Irrigated Area Mapping using Continuous Streams of MODIS data," *Remote Sens. Environ*., Vol.**95**, pp.**317–341**, **2005**.

[36] S.L.S. Lekha, S.S. Kumar, "Classification and Mapping of Land Use Land Cover Change in Kanyakumari District with Remote Sensing and GIS Techniques," *Int J Appl Eng Res*., Vol.**13**, Issue.**1**, pp.**158–66**, **2018**. Available from: http://www.ripublication.com

[37] M.A.Y. Rahji, S.A. Fakayode, "A Multinomial Logit Analysis of Agricultural Credit Rationing by Commercial Banks in Nigeria,'' *International Research Journal of Finance and Economics*, Vol.**24**, Issue.**1**, pp.**91-92**, **2009**.

[38] S.I. Umar, M.A. Ndanitsa, S.R. Olaleye, "Adoption of Improved Rice Production Technologies Among Youth Farmers in Gbako Local Government Area, Niger State,'' *Journal of Agricultural Extension*, Vol.**13**, Issue.**1**, pp.**1-8**, **2009**.

[39] I.S. Umar, U. Mohammed, "Enhancing agricultural production through improved rice variety adoption in Niger State, Nigeria,'' In: Gambari, A.I., Okwori, R.O., Umar, I.Y., Gana, C.S. and Koroka, M.U.S. (eds) Enhancing Science and Technology Education in a Dwindling Economy. Proceedings of the 5th International Conference of School of Science and Technology Education, held at Federal University of Technology Minna, Niger State, Nigeria. 3rd – 6th October, pp.**83-88**, **2017**.

[40] P. Dennery, "Urban Agriculture in Informal Settlements: How can it contribute to poverty alleviation? ,'' Agriculture and Rural Development, Vol.**4**, Issue.**2**, pp. **46-48, 1997**.

AUTHORS PROFILE

Thomas U. Omali is a staff of the National Biotechnology Development Agency (NABDA), Nigeria. He has published several papers in both local and international journals and books. His resent research interest is in global change, crustal deformation and earthquake analysis, and spatial analysis, applied remote sensing and GIS/LIS.

Gabriel O. Agada is a Principal Inspector of Factory at the National Authority on Chemical and Biological Weapon Conventions, Office of the Secretary to government of the Federation, Nigeria. He is currently Pursuing Doctor of Philosophy in Agriculture Economics at the University of Nigeria, Nsukka. His recent research interest is in agriculture, resources, disaster risk, economics, and finance.

Kebiru Umoru is an Assistant Chief Scientific Officer at the National Remote Sensing Centre, Jos, Nigeria. He obtained Doctor of Philosophy in Geography with specialization in Environmental Resources Planning from the University of Abuja, Nigeria. His resent research interest is in EIA, land degradation, agriculture, ecology, health geography, applied remote sensing, and GIS.

Joseph Obera is a graduate of Plant Breeding and Seed Science from the University of Agriculture Makurdi. He is currently the seed business manager at the Seed and Mech Hubs Limited, Nigeria. He has worked with several seasoned seed breeders on different seed production projects. His research focus is on Agriculture and ecology.

