# The effect of poorly controlled physical development on urban food production in Ibadan, Nigeria

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## Abstract

*Urban expansion, mainly occasioned by poorly controlled physical development, continues to pose severe threats to sustainable food production. While studies have concentrated more on food production in the hinterlands of Nigeria, there is a dearth of information on empirical investigations into urban food supply. This study, therefore, examined the effect of poorly controlled physical development on urban food production in Ibadan. An ecological footprint model was used to provide its theoretical anchor, while a longitudinal survey was the research design of choice. Both primary and secondary data were sourced. Geographical and remote sensing methods of analysis were used, with the primary focus being on Ibadan City and the dairy farm that has been converted to non-agricultural uses. This research revealed that Ibadan's total urban area increased from 70.3584 ha in 1986 to 411.8877 ha in 2019. This expansion was accompanied by the loss of agricultural land, the depletion of water bodies, and agricultural land conversion. Validation of the research findings revealed a relatively high accuracy in terms of the Kappa value of 0.72 and an overall classification accuracy of 79.17% for 1986, of 0.84 and 88.33% for 2000, and of 0.91 and 92.5% for 2019. This study recommends that farmers should be trained on soilless farming practices such as aeroponics and hydroponics which both require relatively small portions of land to produce food.*

***Key words:*** *Urban agriculture, Urban expansion, and Food security*

## 1. Introduction/statement of problems

Urban sprawl, mainly facilitated by poorly controlled physical development, continues to pose severe threats to sustainable development. Among many other negative impacts (Otokiti et al., 2020), this phenomenon compromises the ability of the ecosystem to provide basic ecosystem services (Olajide et al., 2020), increases the risk of urban flooding (Ibrahim, et al., 2020), and increasingly depletes agricultural lands. Moreover, The United Nations Department of Economic

and Social Affairs/Population Division (UNDESA/PD, 2013) projected a 60% increase in the world's urban population by 2050. This amounts to an additional 2.5 billion people to the existing urban population, with Asia and Africa expected to house 90% of the population increase. According to Nweke et al. (2002), meeting the needs of this proliferating urban population is expected to be a great challenge, particularly in relation to urban food production and other human fundamental needs, especially in sub-Saharan Africa (SSA), where the agricultural sector is largely characterized by dwindling resources, a lack of incentive for many farmers, problems of land ownership, and increasing poverty levels among these countries (Olawepo, 2012).

Urban and peri-urban (hinterland) agriculture (UPA) has remained one of the main approaches used to deal with these problems, This sector has been given the primary responsibility of providing for the needs of the urban and peri-urban residents in terms of food, employment, better nutritional status, and improved well-being (Lynch et al., 2002; De Bon et al., 2010). UPA has also been associated with erosion prevention and flood control, thereby minimizing the risk of environmental degradation in these areas (Salau and Attah, 2012).

Apart from being widely practised in many developed countries, including Hong Kong (People and Planet, 2005), London (Garnett, 2000), China, and Singapore (Yeung, 1985), UPA is also widely practised in developing countries such as Kenya (Freeman, 1991), Uganda (Maxwell and Zziwa, 1992), and Togo (Equziabher et al.,1994), and ahost of others have also followed the same path.

However, despite the varying degrees of success recorded, UPA still remains largely uncoordinated and unregulated in many developing countries (Cohen and Garrett, 2010). (The situation is no different with regard to Ibadan, the largest city in West Africa.) In fact, the rapid expansion of cities, coupled with population increase, impairs the ability of UPA to deliver as a potential food security solution and to provide other associated benefits. For instance, in Tamale, Ghana, about 60% of new urban development has taken place on agricultural lands on the urban periphery (Naab et al., 2013), while between 1991 and 2019, about 22.7sq. km of the total agricultural land in Offa, Nigeria was converted to non-agricultural uses (Otokiti et al., 2020). The competition for scarce resources is further exacerbated by the unprecedented rapid expansion of cities with a severe impact on food production.

Meanwhile, compared with other forms of land use, agricultural land use in urban centres has a low economic value. By implication, agricultural land is often priced out of the urban land use system (Amponsah et al., 2015). Furthermore, , the work of Wahab et al (2018) on access to urban agricultural land in Ibadan shows that the barriers to extending urban farmland that were

identified by farmers included finance, the lack of land in the urban area, and neglect of the farming and land tenure system. Also, in peri-urban areas, uncontrolled urbanization is continuously altering and depleting the innately rustic landscape associated with these areas (Pastur et al., 2012; Recanatesi et al., 2016; Otokiti et al., 2019). Since urban areas rely largely on food production services provided by the surrounding peri-urban agricultural area (Overbeek, 2009; Opitz et al., 2016; Salvati et al., 2016), it is important to know that about 54% of the food crops sold in the city are produced in the peri-urban areas (Abumere and Oluwasola, 2001). Furthermore, UPA provides more than 80% of the vegetables sold in the city, creating incomes ranging from US $330 to more than US $3,000 annually for the vegetable producers, input suppliers and vegetable traders (FAO, 2012). However, sporadic urban development has negatively impaired urban food production in the metropolis.

In most developing nations, where the activities around town planning have been poorly controlled or unregulated, the impact of uncoordinated urbanisation on food production is even greater. Meanwhile, several spatio-temporal dynamics studies with respect to agricultural land loss and food production have been carried out in Nigeria. For instance, Otokiti et al. (2020) assesed the spatio-temporal dynamics of agricultural land loss in the Offa Local Government Area, while Lasisi et al. (2017) assessed city expansion and agricultural land loss within the peri-urban area of Osun State. Despite the aforementioned studies on spatio-temporal dynamics as they affect agriculture in terms of land loss and food production, the extent to which uncontrollable physical planning has affected urban agricultural land use has not been given adequate attention in the literature. This study is, therefore, designed to investigate the effect of poorly controlled physical development on urban food production in Ibadan, Nigeria, with particular focus on the period 1986 - 2019 as the basis for the analysis of the available data. As observed by Duvernoya et al. (2017), such data are required so as to provide up-to-date information on the current sustainable land management strategies and urban food production.

## 2. Materials and Method

### 2.1. Study Area

Ibadan is one of the metropolitan regions that has experienced the highest population growth in Nigeria over the past three decades. It is located between latitudes $7^0$0’0”N and $7^0$45’0”N and longitudes $3^0$30’0”E and $4^0$10’0”E, while “Kolapo Ishola”, a subregion of Ibadan which also forms a portion of the study, lies between latitudes $7^0$24’50”N and $7^0$35’50”N and longitude $3^0$56’30”E and $3^0$58’30”E. Six of the total of 11 Local Government Areas that constitute Ibadan (Figure 1) are classified as peri-urban settlements, while the remaining five are classified as

urban metropolitan settlements. The proportions of the areas dedicated to urban and peri-urban land use amount to 15% and 85% of the total land area respectively (Adelekan et al., 2014). Accordingly, the built-up area has expanded sporadically into a peri-urban area, making it the largest metropolitan region in Nigeria. For instance, between 1986 and 2019, the built-up areas in Akinyele and Egbeda LGA (both peri-urban areas) increased by 86.4sq. km and 33.8 sq. km in terms of land area coverage (Otokiti et al., 2019), thereby depleting the agricultural landscape in the peri-urban areas.

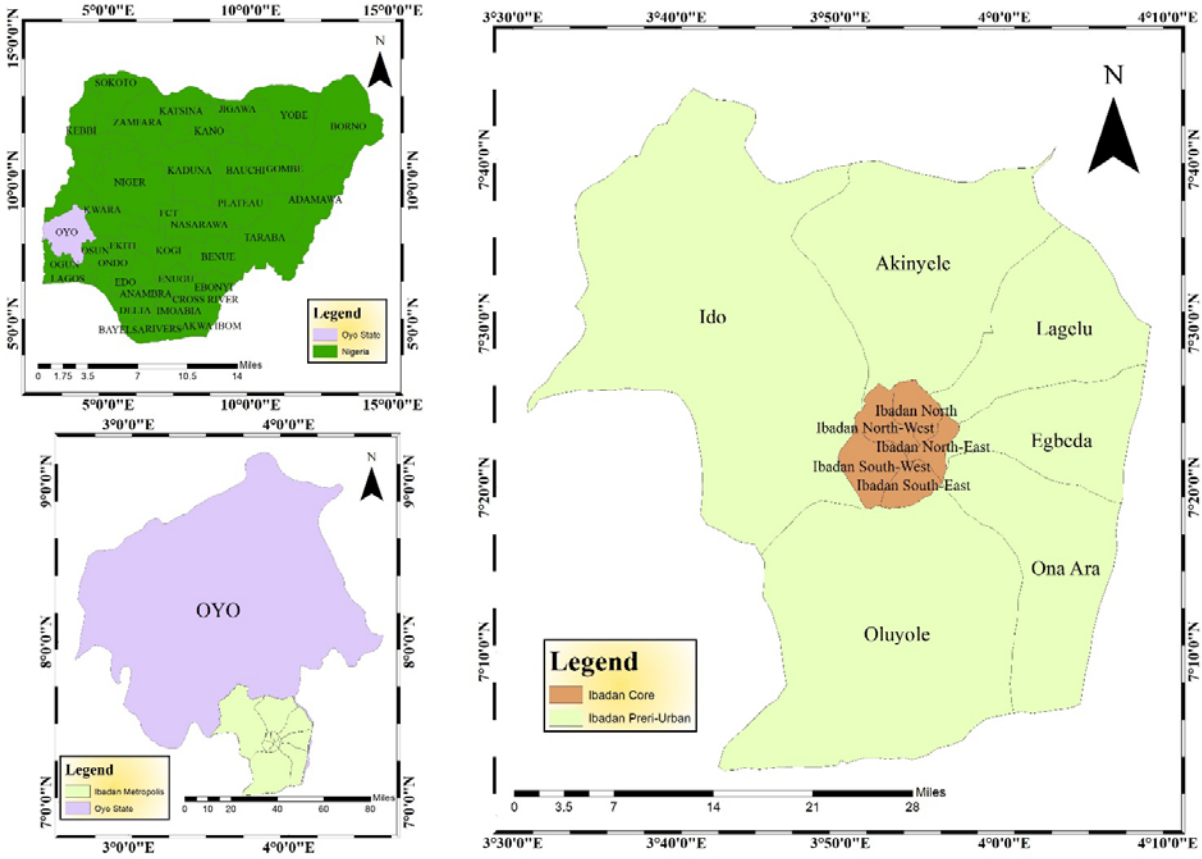


Figure 1: Ibadan City Region in the Context of Oyo State and Nigeria

Source: Ministry of Surveys, Abuja (Digitized by Authors, 2020)

The present rapid urbanization and proliferating population trends in Ibadan, started in 1952 after the city was designated as the regional and administrative headquarters of the old Western Region of Nigeria (Adelekan, 2010). It currently ranks second as the most populated city (approximately 2.6 million) after Lagos in Nigeria's southwest region, with approximately 2,889 people per square kilometer (National Population Commission, 2006). As mentioned previously, part of the study area, namely "Kolapo Ishola", was designated to support Ibadan in terms of the

production of dairy farm produce, but this has changed because of urban development. Currently, the area is dominated by residential land use. Thus, by focusing on Ibadan *vis à vis* Kolapo Ishola, this study investigates the implications of poorly controlled physical development on urban food production.

## 3. Methodology

A longitudinal survey research design was adopted for the study, for which both primary and secondary data were sourced. A purposive multi-stage sampling technique was used to select the urban areas of Ibadan. At first, a reconnaissance survey was conducted to familiarize the researcher with the areas earmarked for agricultural practice that have over recent years acted as a source of food production to the urban dwellers. As a result, the present area of Kolapo Ishola Estate, also named Carlton Gate Estate, an area originally designated as dairy farmland, was selected. This was followed by the delineation of its boundary. The level of encroachment of urban land use *vis à vis* Ibadan into Kolapo Ishola was estimated using Landsat images for the years 1986, 2000, and 2019 (Table 1). (The reason for the irregular time period captured by the study is premised on the images available as at the time of the study. The reason for this could be traceable to the poor data management system in Nigeria.) These images were acquired from the United States Geological Survey's Earth Explorer website (USGS Earth Explorer, 2019) and classification of the images into different land cover classes was carried out in ArcMap using the Maximum Likelihood Algorithm.

The results of the supervised classification covering three decades (1986-2019) were subdivided into two time intervals for Ibadan and Kolapo Ishola, respectively. The first was 1986-2000, while the second was 2000-2019. The land cover types within the study area were classified into four themes, namely, built-up land, rock outcrops and bare land, vegetation, and water bodies. The land area coverage of each land cover class was presented in hectares. This was done in order to investigate the extent of the poorly controlled physical development in the area and how it has altered the area over the study period.

Table 1: Data Source

| S/N | Satellite Number | Sensor Type | UTM Zone | Datum | Spatial Resolution (M) | Sources and Year |
|---|---|---|---|---|---|---|
| 1 | Landsat 5 | TM | 31N | WGS84 | 30 | USGS, 1984 |
| 2 | Landsat 7 | ETM+ | 31N | WGS84 | 30 | USGS, 2000 |
| 3 | Landsat 8 | OLI_TIRS | 31N | WGS84 | 30 | USGS, 2019 |

# 4. Results and Discussion

## 4.1. Spatio-temporal Distribution of Land-Use/Land-Cover Changes

In Ibadan, the result reveals that in the study's base year (1986), Ibadan was largely characterized by a rustic landscape vegetation. Accordingly, the vegetation land cover class amassed 2,372.38 ha., while other land-cover classes, namely rock outcrops and bare land, built-up area, and water bodies represented 753.46 ha., 70.36 ha., and 9.37 ha., respectively. The area covered by built-up land has more than tripled from 70.36 ha. in 1986 to 219.52 ha. in 2000, adversely impacting the vegetation. On the other hand, compared to its land area coverage in hectares in 1986, the area of rock outcrops and bare land had declined significantly by 2000 (Table 2).

Table 2: Urban Expansion Trend in Ibadan

Source: Authors' Lab Work

| **LULC Classes** | **1986** | | **2000** | | **2019** | |
|---|---|---|---|---|---|---|
| | **Area (ha)** | **%** | **Area (ha)** | **%** | **Area (ha)** | **%** |
| Built-up | 70.36 | 2.19 | 219.52 | 6.85 | 411.89 | 12.85 |
| Vegetation | 2372.38 | 74.01 | 2275.60 | 70.99 | 1876.71 | 58.55 |
| Water Bodies | 9.37 | 0.29 | 705.84 | 22.02 | 2.84 | 0.09 |
| Rock Outcrops and Bare land | 753.46 | 23.51 | 4.59 | 0.14 | 914.12 | 28.51 |

The sprawling development pattern escalated further in 2019, with built-up area increasing from 219.52 ha in 2000 to 411.89 ha. in 2019. For the same time period, the corresponding effect of urban expansion was pronounced in the other land cover classes delineated in the study area. For instance, the area of vegetation declined from 2275.60 ha. in 2000 to 1876.71 ha. in 2019. Similarly, the area of water bodies declined from 4.59 ha. in 2000 to 2.84 ha. in 2019. The decline in the vegetation and water bodies land cover classes could have significant impacts on sustainable urban food production since the water bodies that are naturally supposed to provide support for vegetable farming are being exploited for other urban land uses. Also, the loss of agricultural land (vegetation) to urban development could facilitate the fragmentation of farmlands and result in an appalling reduction of land area available for UPA.

Based on the general understanding that urban spawl is largely caused by poorly controlled physical development, this study presents its corresponding effect on urban food production in Ibadan. The affected study area falls within the area earmarked for dairy farming (Kolapo Ishola), which supplies Ibadan and its hinterland with dairy products. Although a portion of the

land area adjoining Kolapo Ishola was initially primarily residential, the dairy farm was eventually subdivided into residential land use zones, thereby limiting and seriously challenging the prospect of urban agricultural practice here. This fact is in concurrence with the works of Wahab et al (2018) where it was observed that in spite of the vast land area of Ibadan, there is limited access to agricultural land in the area.

At the base year (1986), Kolapo Ishola consisted of only two land cover classes, namely; bare land and vegetation (Figure 2).

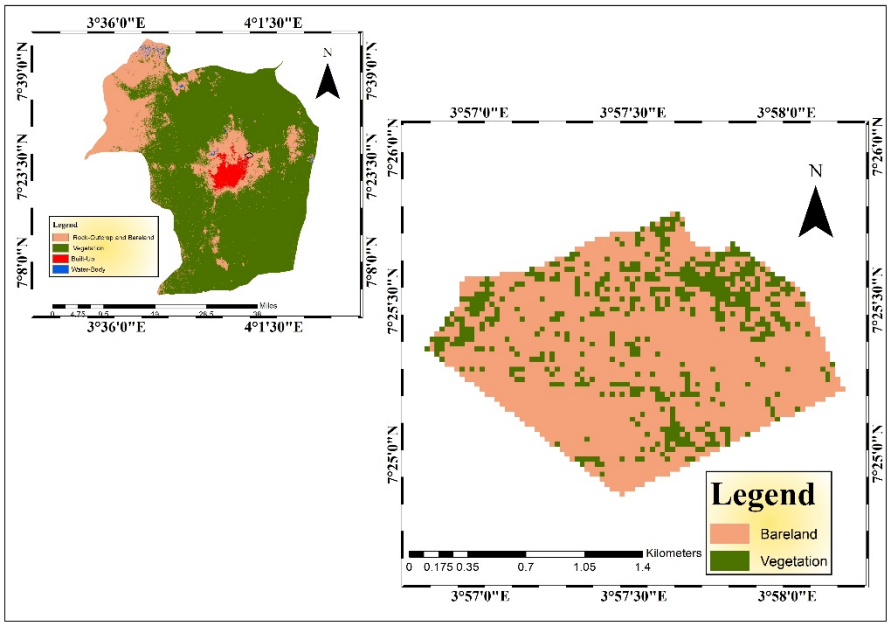


Figure 2: Land Use/Land Cover of Ibadan Metropolis and Kolapo Ishola, 1986

The total land coverage of bare land was estimated at 2.01 ha., while that of vegetation was estimated to be 0.48 ha.. By implication, no urban development was recorded at this stage. However, by 2000, the results show that built-up area (consisting of houses and other buildings) already constituted about 0.45 ha. of the total area; vegetation area coverage was estimated to be 0.60 ha.; while bare land was still the dominant land cover class in the erstwhile designated dairy farm as it constituted about 1.45 ha. of the total land area (Figure 3).

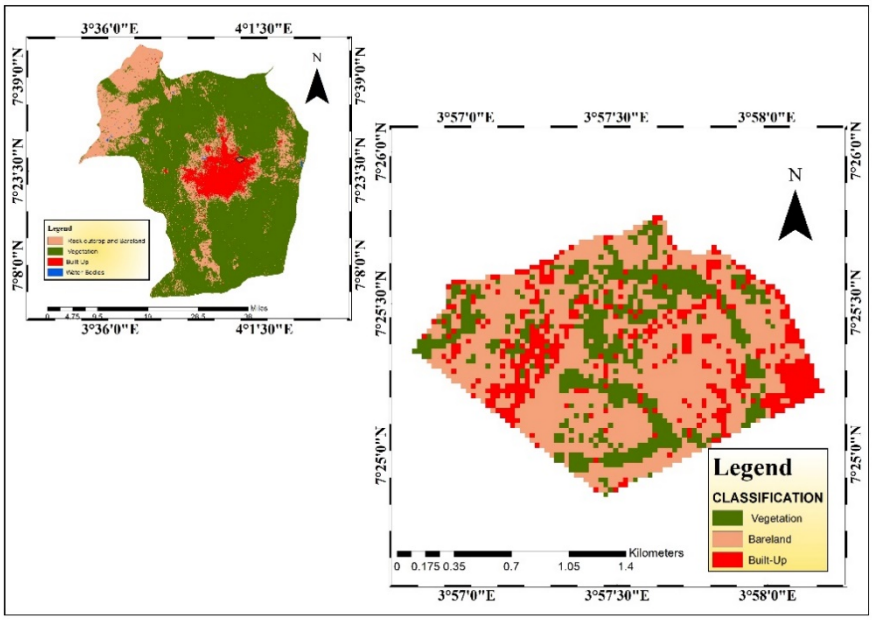


Figure 3: Land Use/Land Cover of Ibadan Metropolis and Kolapo Ishola, 2000

Finally, in 2019, built-up (1.65 ha) had become the dominant land cover class in the area at the expense of both the bare land (0.66 ha) and vegetation (0.20 ha) land cover classes (See Figure 4 and Table 3).

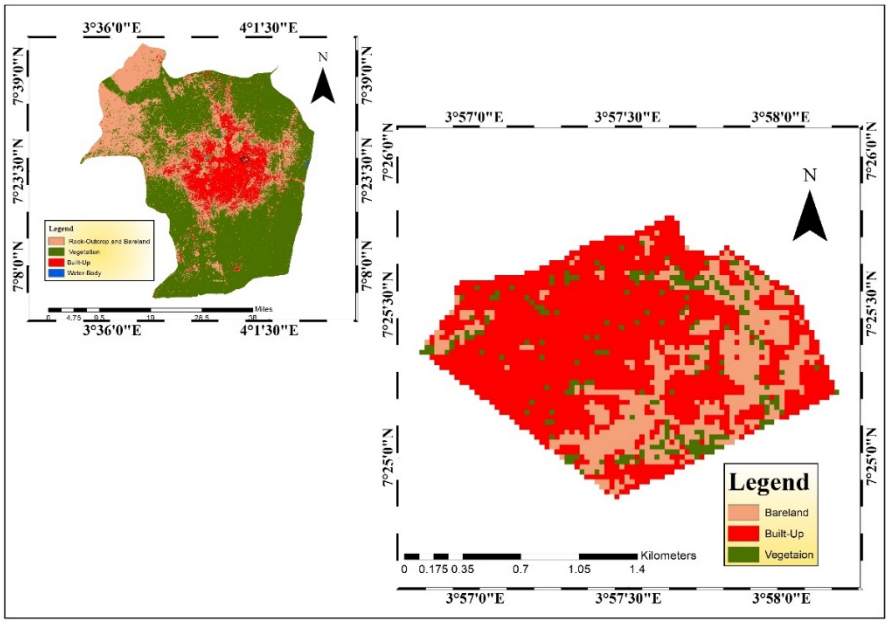


Figure 4: Land Use/Land Cover of Ibadan Metropolis and Kolapo Ishola, 2019

Table 3: Urban Expansion Trend in Kolapo Ishola

Source: Authors' Lab Work

| LULC Classes | 1986 | | 2000 | | 2019 | |
|---|---|---|---|---|---|---|
| | Area (ha.) | % | Area (ha.) | % | Area (ha.) | % |
| Built-up | - | - | 0.45 | 17.9 | 1.65 | 66.3 |
| Vegetation | 0.48 | 19.38 | 0.60 | 24.1 | 0.66 | 25.7 |
| Bare land | 2.01 | 80.62 | 1.45 | 58.0 | 0.20 | 8.0 |

This pattern is likely to continue for years to come. However, as it stands, producing dairy products for a growing population in Ibadan and its environs is further complicated as a result of the changing nature of the area, largely facilitated by poorly controlled physical development ( see figure 5)


Figure 5, The street map of Kolapo Isola estate, formerly a dairy farm, but now converted completely to residential land use

Source: Authors' Field Work

Dairy products are considered perishable. As such, dairy production close to the market is a necessity. However, investigation revealed an alteration in the use of this former agricultural

land, the dairy farm: it has been converted into a different class of urban land use, namely residential land use, and is now known as Kolapo Ishola. This has been due to the poorly controlled physical development of the built-up area, which has encroached upon the agricultural land and forced most dairy enterprises to move further away from the region. This means that the availability of dairy products in the region and accessibility to them has been severely compromised. Okolo (2006) corroborated this fact by noting that one of the most serious challenges for many urban dwellers in Nigeria is access to adequate food. This is because, both availability of and accessibility to food are often associated with food production and supply, as rightly observed by Olawepo (2012). By implication, Kolapo Ishola, an erstwhile dairy farm, has been taken over by residential land use. Thus, this former agricultural area has been stripped of its potential to support urban food production and supply. Its former potential on the basis of its comparative locational advantage in respect of its proximity to and link with urban centres, where the demand for and consumption of dairy products are high, has been taken from it. Accordingly, its potential to support the production and supply of dairy products to the urban dwellers, where the cost of distribution to consumers would be minimal, has been compromised.

Also, as a consequence, food prices are continuously being driven higher, leading to a widely low level of nutritional development, particularly in the case of the urban poor. With this, Okolo (2006) also asserted that escalating food prices, the low earning power of residents, and the high inflation rate have made the average Nigerian urban dweller vulnerable to food insecurity.

Furthermore, poor infrastructure in terms of transport facilities, the storage of dairy products, and the processing into milk powder constitute but a few issues among the major challenges being faced by farmers in Nigeria. This assertion is supported by Boroh and Nwakanma (2018), who noted that a lack of improved technology and a poor infrastructure are hampering agricultural productivity in the Ibadan urban region, and on a larger scale, in Nigeria,. Similarly, Tunde and Adeniyi (2012) stressed the importance of transport infrastructure and storage facilities to promote food production and food security.

The results of the land cover analysis carried out in Ibadan show that the study area is under great pressure in terms of agricultural land depletion and decreased water availability, both of which emanate from the poorly controlled physical development of the area, weak attention given to UPA by policy makers in the region (IWMI/RUAF, 2007), the proliferation of informal settlements on the periphery (Agbola et al., 2014), and a lack of strategic planning to guide against the conversion of agricultural land in both urban and peri-urban areas to urban-oriented land uses. This poses a significant challenge to urban and peri-urban food production (Satterthwaite et al., 2010 and FAO, 2011).

## 4.2. Validation

Validation was carried out to test whether the classification was correct or otherwise. It was based on the accuracy of the classification itself and the Kappa result. The classification accuracy is based on percentages while the Kappa result ranges from -1 to 1. Values of ≤ 0 indicate no agreement, 0.01-0.20 as none to slight, 0.21-0.40 as fair, 0.41-0.60 as moderate, 0.61-0.80 as substantial, and 0.81-1.00 as almost perfect agreement. The results presented an average Kappa value of 0.72 and an overall classification accuracy of 79.17% for 1986 (Table 4), 0.84 and 88.33% for 2000 (Table 5), and 0.91 and 92.5% for 2019 (Table 6). These highly accurate results, relatively speaking, indicate that the method is adequate for mapping urban expansion in Ibadan.

Table 4: Validation of land-use/land-cover (LULC) classes in 1986

| **Class** | **Built-up** | **Vegetation** | **Bare land/ Rock outcrops** | **Waterbodies** | **Total** |
|---|---|---|---|---|---|
| Built-up | 73.33 | 0 | 26.67 | 0 | 100 |
| Vegetation | 0 | 93.33 | 6.67 | 0 | 100 |
| Bare land/Rock-outcrops | 0 | 6.67 | 80 | 13.33 | 100 |
| Water bodies | 0 | 0 | 30 | 70 | 100 |
| Total | 73.33 | 100 | 143.34 | 83.33 | 400 |
| Overall Classification Accuracy = 79.17% | | | Overall Kappa Coefficient = 0.72 | | |

Table 5: Validation of land-use/land-cover (LULC) classes in 2000

| Class | Built-up | Vegetation | Bare-land/Rock-outcrops | Water bodies | Total |
|---|---|---|---|---|---|
| Built-up | 80 | 0 | 0 | 20 | 100 |
| Vegetation | 0 | 100 | 0 | 0 | 100 |
| Bare-land/Rock-outcrops | 0 | 6.67 | 93.33 | 0 | 100 |
| Water bodies | 10 | 0 | 10 | 80 | 100 |
| Total | 90 | 106.67 | 103.33 | 100 | 400 |
| Overall Classification Accuracy = 88.33% | | | | Overall Kappa Coefficient = 0.84 | |

Table 6: Validation of land-use/land-cover (LULC) classes in 2019

| Class | Built-up | Vegetation | Bare-land/ Rockoutcrops | Water bodies | Total |
|---|---|---|---|---|---|
| Built-up | 85 | 5 | 10 | 0 | 100 |
| Vegetation | 0 | 95 | 5 | 0 | 100 |
| Bare land/ Rock outcrops | 0 | 0 | 100 | 0 | 100 |
| Water bodies | 0 | 0 | 10 | 90 | 100 |
| Total | 85 | 100 | 125 | 90 | 400 |
| Overall Classification Accuracy = 92.5% | | | Overall Kappa Coefficient = 0.91 | | |

## 5. Conclusion and Recommendation

This study concludes that poorly controlled physical development has undermined the potential of UPA in its role as an area supporting food production . This has been necessary in the light of the need to supply housing to the growing population of Ibadan. Without the required strategic land use planning that should be implemented in tandem with the burgeoning population and housing issues, pressure has been placed on urban food production, particularly in respect of the conversion of agricultural lands to urban-oriented uses. In the light of the conversion of Kolapo Ishola to a residential land use class, this study recommends that new dairy farms with adequate infrastructures should be provided within and around the city of Ibadan so that these farming enterprises can then be in a position to enjoy comparative locational advantages in terms of their proximity to the city. This study also recommends that UPA should be appropriately equipped in order to respond to the needs of the urban dwellers for food accessibility and availability. The study recommends that the UPA should be integrated into the Ibadan development plan and that farmers should be trained in soilless farming practices such as aeroponics and hydroponics, both of which require relatively small portions of land on which to produce food, which in turn could help to deal with the growing trend in agricultural land conversion.

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