

Spatio-Temporal Dynamics of Urban Landuse in Satellite town of Bwari Area Council, Abuja, Nigeria

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ABSTRACT

Urbanization as a demographic indicator describes the concentration of population in urban areas, economic transformation and social modernization. This paper assessed Spatio – Temporal dynamics of urban land use in Bwari Area Council, Abuja, Nigeria. The objectives are to examine the spatio- temporal changes in the growth of the satellite towns (1988 – 2020) and analyzed the dynamics of urban land use within the selected time periods. Four multi-date Landsat imageries; TM of 1988 and 1999, ETM+ of 2009 and OLI of 2020 of 30m resolution were utilized to generate data and to identify changes that occurred over time and space. The results of the classified land sat imageries indicates that land use distribution in the three satellite towns of Kubwa – Dutse Alhaji, Mpape and Dawaki exhibited more concentration of built up areas on progressive basis as compared to other land use categories. The built up areas which is a signpost to urbanization increased between 1988 and 2020 from 9.33 % in 1988 to 30.63 % in 2020, 6.78 % in 1988 to 44.20 % in 2020 and 19.23 % in 1988 to 52.93 % in 2020 for Mpape, Dawaki and Kubwa-Dutse Alhaji respectively. The simulated land use analysis for the year 2040 in Kubwa- Dutse Alhaji shows a spontaneous increase in the built-up area from 8.34 km² accounting for 33.02% in 2020 to 17.96 km² representing 79.12% in 2040. This indicate an increment of 9.62 km² representing 15.83%. Dawaki for the year 2040, indicate increase in the built-up areas from 6.42 km² about 44.20 % in 2020 to 9.53 km² representing 65.70 % in 2040. It means there will be an increment of 3.11 km² representing 21.15 %. And at Mpape for the year 2040 it illustrates spontaneous increase in the built-up areas from 15.70 km² which was about 30.63 % land use category in 2020 to 29.36 km² representing 57.36 % in 2040. This shows an increase of 13.66 km² representing 26.73 %. Conclusively, spatio-temporal changes in land use across the study locations indicates increase in built up areas which consumed and converted other land use types particularly forest covers which decreased from 14.23 % in 1988 to 3.66 % in 2020, 29.93 % in 1988 to 3.56 % in 2020 and 11.26 % in 1988 to 1.08 % in 2020 for Mpape, Dawaki and Kubwa-Dutse Alhaji respectively due to population increase and continuous urbanization. It is therefore recommended that human activities (both individual and government) that speed up land use conversion be reduce, restricted or regulated. Also continuous monitoring of the land use by regulatory authorities should be strengthen to avoid or reduce environmental degradation and ensure sustainability..

Keywords: Urbanization, Land use, Conversion, Concentration, Built-up, Dynamics

1. INTRODUCTION

Nuissl and Siedentop (2021) described urbanization as increase in the urban (as

compared to rural) population and an urban workforce. The visible outcome of land use change in the wake of urbanisation is the spatial

expansion of built-up areas which implies a significant alteration of land cover features, accompanied by changes in the urban spatial structure and the urban form.

Land use is a general term for the human modification of earth's terrestrial surface. Though humans have been modifying land to obtain food and other essentials for thousands of years, current rates, extents and intensities of land use are far greater than ever in history, driving unprecedented changes in ecosystems and environmental processes at local, regional and global scale (Tsegaye, 2021). Due to world population boom and advancement in science and technology, the natural resources are overexploited for the sake of economic activities with high severity in developing countries. Agricultural expansion into the forest land, timber logging, charcoal production and fire wood harvesting are the major drivers of deforestation in Africa (Muhati *et al.*, 2018).

Gordon and David (2014) pointed that the problem with applying the term urbanization to simultaneous changes along these different dimensions is that they do not occur together and the very notion that there is a clear rural/urban distinction in economic activities or cultural norms is difficult to maintain. Thus, the shift in population from rural to urban settlements involves a shift to denser settlement patterns; whereas the shift from rural to urban land use is increasingly the result of shifts to less dense urban settlement patterns.

In Nigeria, available studies show that urban population has been growing at an alarming rate of about 47 percent as at 2003 (UN, 2004; Ajala, 2005). Unfortunately, cities in African countries grow without incorporating element of physical planning. Adediran, (2007) opined that Nigeria did not have regulatory standard to guide planning of building and development. Jiboye (2005) made it known that the forces of urbanization and industrialization have brought about changes in production activities, thus resulting in explosive demographic changes with growth rates ranging between 6% and 12% per annum. The explosive rates of growth in the study area have not only progressively complicated and exacerbated inter-related problems of human settlements and the environment, but have also greatly accelerated poverty. The demand for infrastructure, basic services and housing in expanding urban centers is on the increase. This study therefore examine spatio-temporal changes in the growth of the satellite towns of Bwari Area Council, Abuja, Nigeria with a analyzing dynamics of urban land use changes within the selected time periods.

2. MATERIALS AND METHODS

2.1 Study Area

Bwari is a town in Abuja the Federal Capital Territory of Nigeria located within $9^{\circ} 10'55''$ and $9^{\circ} 26'15''$ N and $6^{\circ} 13'45''$ and $7^{\circ} 42'30''$ E as shown in Figure 1. It covers a total of about 2,300 square kilometers, and lies in the north –

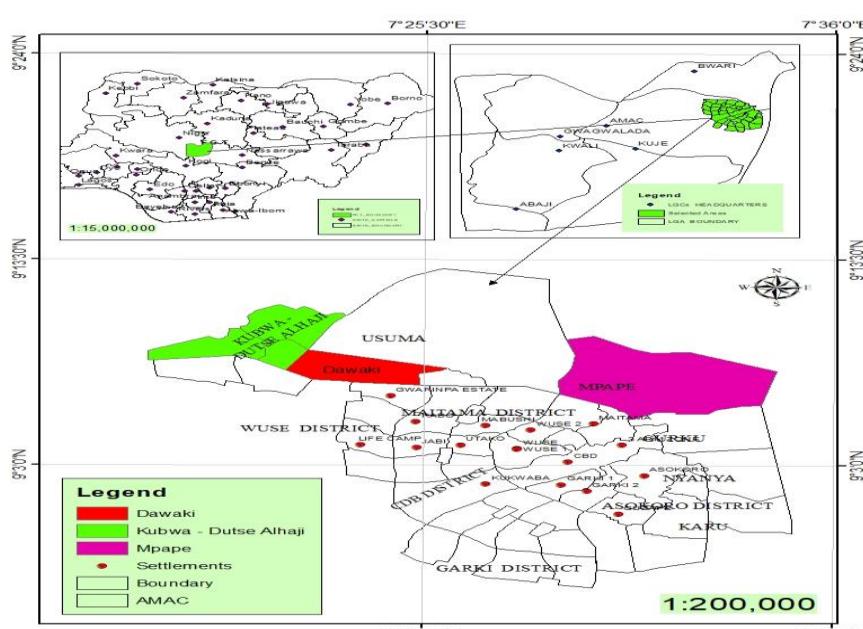


Figure 1: The Study Area Bwari Area Council, FCT, Nigeria

Source: Pedas Concept, Minna, 2021

eastern part of the Federal Capital Territory (FCDA, 2004). The Bwari area features an interesting terrain, which combines rounded hills and bunches of rock outcrops divided by river valleys, as well as gentle rolling plains. It falls within the Abuja hills and dissected zone of the Jema'a Platform. Generally viewing the study area, the hilly areas are found towards the eastern part, posing constraint to physical development while the plains occupy the central and western areas. The study area is the highest part of the FCT with several peaks that are about 760 meters above sea level (Balogun, 2001).

Bwari is one of the six Area Councils in Abuja. It comprises of 66 satellite towns with Kubwa, Bwari, Dutse and Mpape as the main towns. Bwari is one of the area councils with significant increase in urban sprawl in line with the government policy of changing the face of the capital city. According to the National Population Commission (2010), a total of 50,109 housing units exist with 40,335 of them built with cement in line with the housing policy. Of the 50109 households enumerated by the NPC, 105,593 of them use fuel wood for cooking. The government in other to fulfills its mandate for mass housing scheme has also removed large expanses covered by trees and other forms of vegetation.

2.2 Data Used

Four multi-date Landsat imageries; TM of 1988 and 1999, ETM+ of 2009 and OLI of 2020 of 30 meter resolution obtained from Global Land Cover Facility (GLCF) were utilized to generate data and to identify changes that occurred over time and space. This was

achieved using maximum likelihood classification scheme with five (5) land use classes (water body, built-up, agriculture, bare surface and grassland), calculation of the area in hectare of the resulting land use types for each study year and subsequently comparing the results.

2.3 Data Analysis

The comparison of the land use statistics helped in identifying the percentage change, trend and rate of change through the study periods. To achieve this, the first task was the development of a table that showed the area in hectare and the percentage change from each year measured against each land use type. Percentage change to determine the trend of change was calculated by the value of the preceding year and multiplied by 100. The equation is given as:

$$(Trend)\% \text{ change} = \frac{\text{Observed change} \times 100}{\text{Value of the preceding year}} \quad (1)$$

In obtaining rate of change, the percentage change was divided by 100 and multiplied by the total number of years 1988– 2020 of the study period.

The extent of land use change was analyzed by subtracting the reference year (2020) from the base year. It is represented mathematically as:

$$E_T = B - A \quad (2)$$

A= the base year (1988)

B=the reference year (2020)

E_T =total extent of forest land

3. RESULTS AND DISCUSSION

Figure 2 show the decadal land use distribution Pattern for Mpape 1988, 1999, 2009 and 2020. It indicates a drastic increase in built up areas

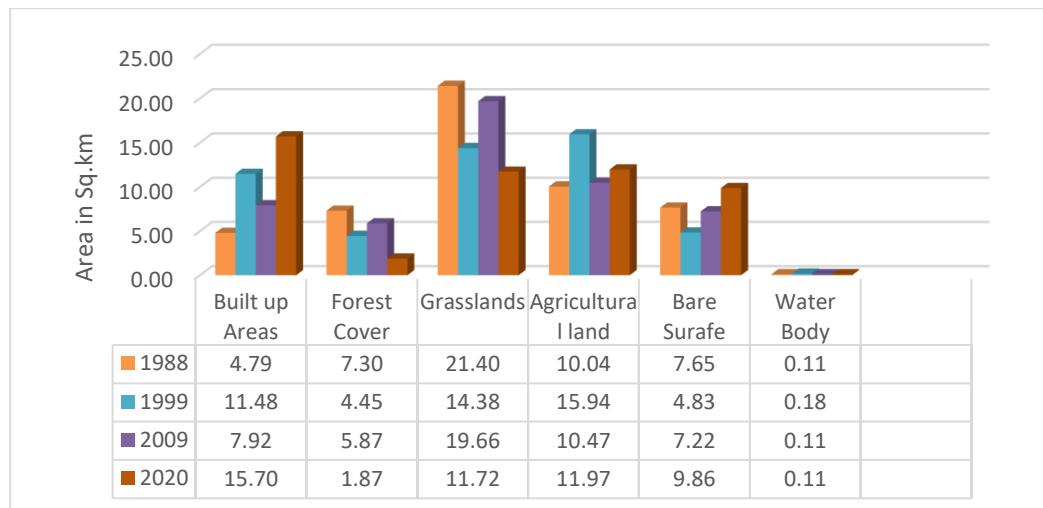


Figure 2: Decadal land use distribution Pattern for Mpape (1988, 1999, 2009, 2020)

accounting for an increase of 4.79 km² in 1988 to 15.70 km² in 2020. The built up expands towards the center due to continuous influx of people as urbanization intensified. This is followed by agricultural land area; which increased from 10.04 km² in 1988 to 11.97 km² in 2020. The large proportion of cultivated land area indicates that most of the marginal dry and wetlands have been converted to agricultural land. However, there was a decrease in other land use categories and these are attributable to its conversion to built up areas and agricultural land use categories.

Figure 3 is the classified land use classes of Dawaki. It indicates that the built up areas progressively increased from 0.98 km² in 1988 to 6.42 km² in 2020. The built up areas is closely followed by grassland area which increased from 4.60 km² (31.67%) in 1988 to 4.50 km² (30.91%) in 1999. However, there

land area which increased from 3.42 km² in 1988 to 6.87 km² in 1999 and subsequently decreased to 1.72 Km² in 2020. Similarly, forest cover also witnesses a decrease from 2.84 km² in 1988 to 1.88 km² in 1999. The decrease may be attributed to increased land development activities in the area. Furthermore, bare surface moved up 3.45 Km² to 4.49 km² in 2020 due primarily to expanse road network and other open field. The built up areas which is a signpost to urbanization increased between 1988 and 2020 from 9.33 % in 1988 to 30.63 % in 2020, 6.78 % in 1988 to 44.20 % in 2020 and 19.23 % in 1988 to 52.93 % in 2020 for Mpape, Dawaki and Kubwa-Dutse Alhaji respectively.

The effect of urbanization on the land use to the year 2040 on the three locations were also analysed so as to identify which of the study locations is worst affected by the changes that occurred. The results of the validation of the

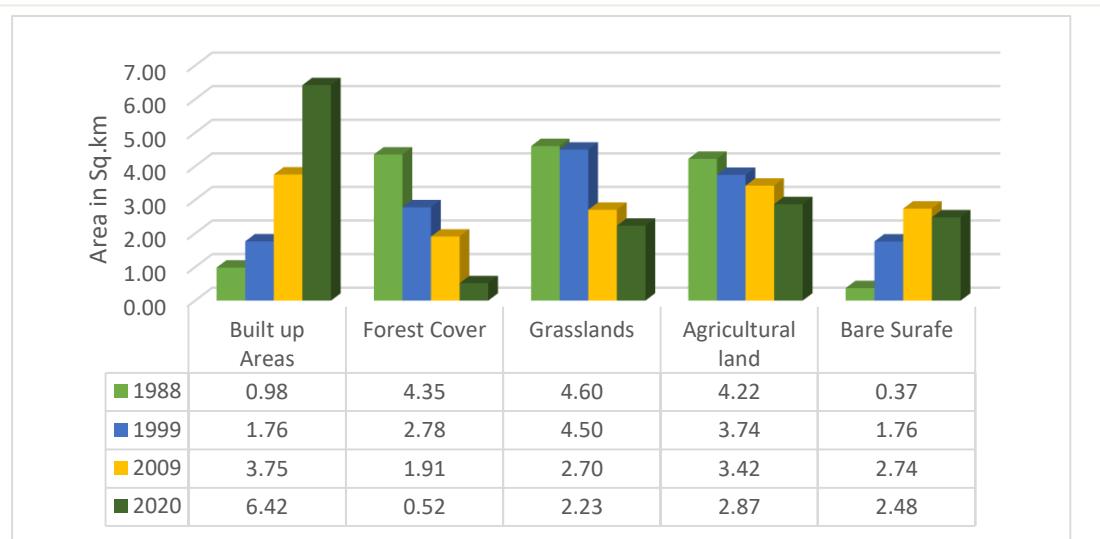


Figure 3: Land use distribution for Dawaki (1988, 1999, 2009 and 2020)

was a decrease in agricultural land area as the results indicate that grassland areas decreased from 4.22 km² (29.05%) in 1988 to 3.74 km² (25.74%) in 1999. This may be attributed to conversion to built up areas, agricultural land on other land uses and land cover categories. Furthermore, bare surface also witnesses an increase from 0.37 km² (2.56%) in 1988 to 1.76 km² (12.11%) in 1999. The areal extent of these classes reveals that the dominant class is the built-up areas.

Figure 4 is the land use distribution for Kubwa - Dutse Alhaji 1988, 1999, 2009 and 2020. There was a drastic increase in built up areas from 4.85 km² in 1988 to 13.37 km² in 2020. The built up areas is followed by agricultural

study locations on classified land use of 2020 and simulated land use of 2020 reveals the predicted maps of Kubwa- Dutse Alhaji, Mpape and Dawaki (Figure 5).

As a rule of thumb, if the Kappa index is less than or equal to 0.4, then the land use changed greatly and with poor consistency between the two images. However, if the Kappa index is 0.4–0.75, there are general consistencies and obvious changes between the two images. The Kappa values range from 0 to 1. A value of 0.61–0.80 means substantial, while 0.81–1 means almost perfect (Yousheng et al., 2011; Liping et al., 2018). The computed the Kappa index between the predicted map and the observed map of 2020 is 0.763, 0.672 and 0.65

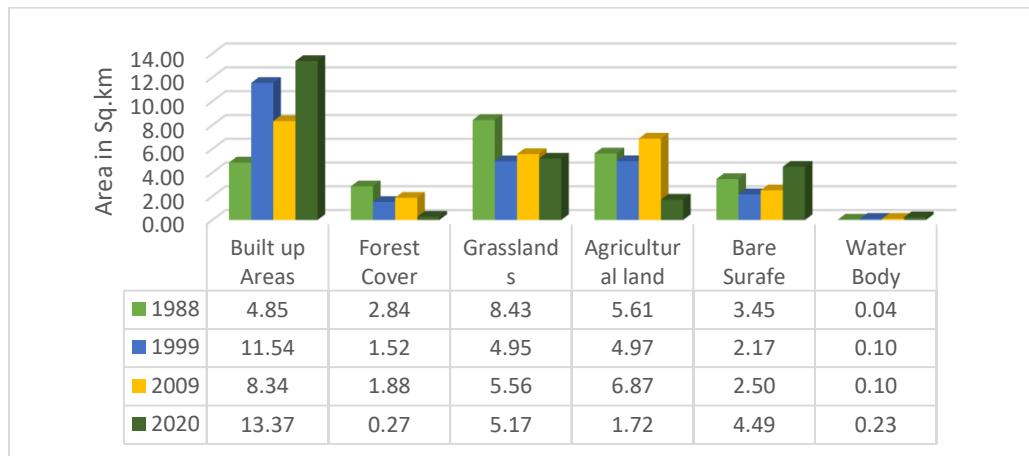


Figure 4: land use distribution for Kubwa - Dutse Alhaji (1988, 1999, 2009 and 2020)

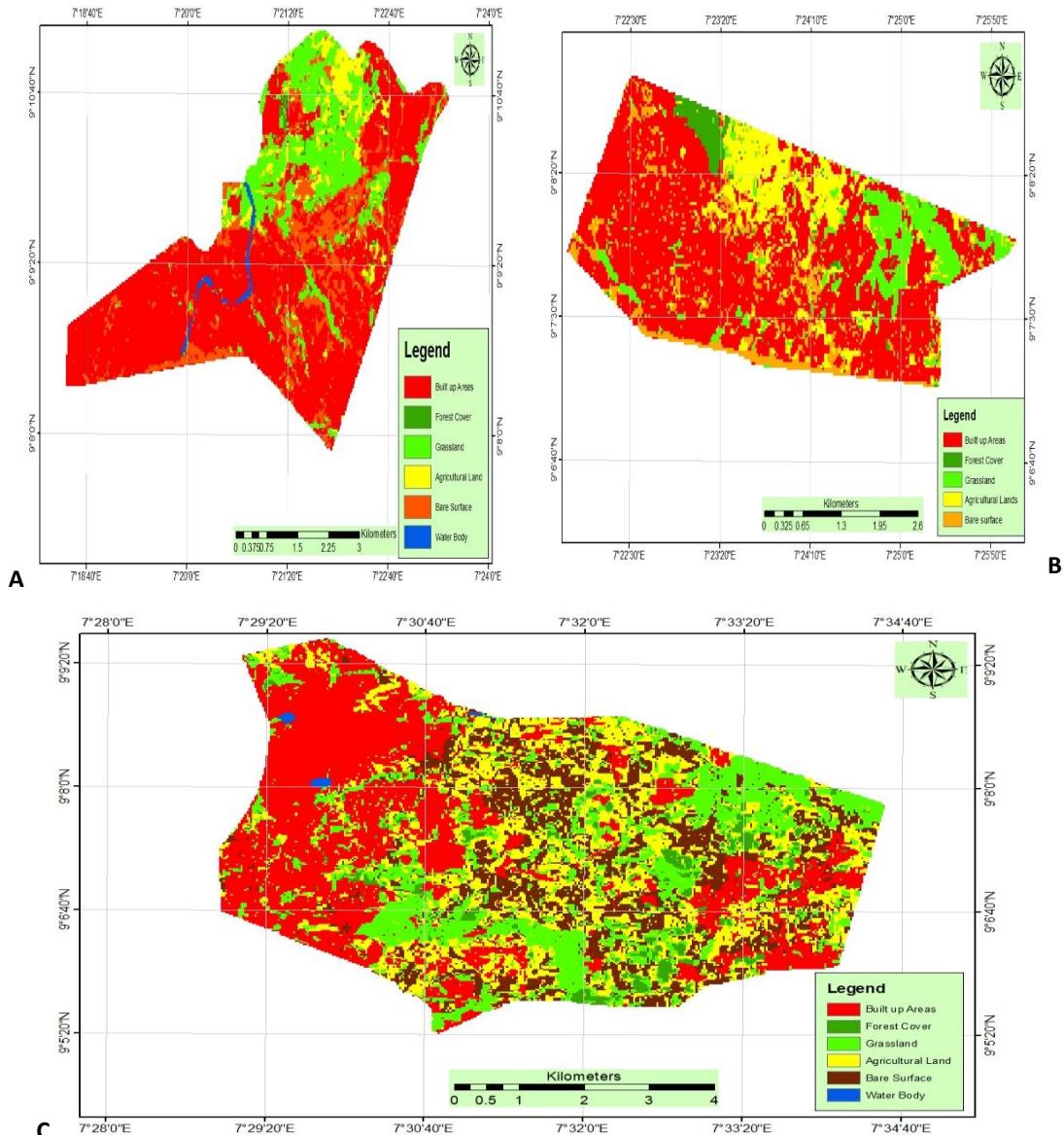


Figure 5: Year 2020 land use map for (a) Kubwa- Dutse Alhaji, (b) Mpape and (c) Dawaki (Used for Simulation into 2040)

for Kubwa- Dutse Alhaji, Mpape and Dawaki, illustrating that the results are reliable. Hence, there was high consistency between the actual

classified results and predictive results. The precision for correct predictions is relatively high; therefore, this method was used to predict

the results in 2040. The simulated land use analysis for the year 2040 in Kubwa- Dutse Alhaji shows a spontaneous increase in the built-up area from 8.34 km² accounting for 33.02% in 2020 to 17.96 km² representing 79.12% in 2040. Forest cover occupied an area of 0.27 km² which is about 1.08% in 2020 and will decrease to 0.13 km² about 0.50 % by 2040. Agricultural land which was 1.72 km² about 6.79% in 2020 will reduce to 1.64 Km² about 6.50 % in 2040 and grassland accounted for 5.17 km² about 20.48% in 2020 will also reduce further to 1.36 km² which is about 5.40% in 2040. All these reductions will be taken over by built-up areas consequent upon increasing urbanization (Figure 6). The simulated land use map of Mpape for the year 2040 as shown in

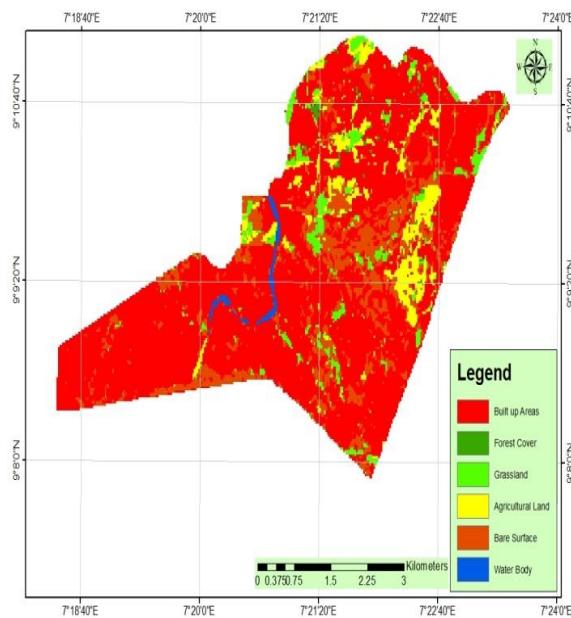


Figure 6: Simulated 2040 Land use of Kubwa – Dutse Alhaji

Figure 7 illustrates spontaneous increase in the built-up areas from 15.70 km² which was about 30.63% land use category in 2020 to 29.36 km² representing 57.36% in 2040. The grassland land cover category decreased from 5.17 km² about 20.48% in 2020 to 1.01 km² which will be 1.97% in 2040. In addition, bare surface increase from 4.49 km² about 17.79% in 2020 to 9.59 km² about 18.74% by the year 2040. These are results of continuous developmental activities such as building, road construction, mining and quarrying activities and other construction activities which expose the bear surface.

Figure 8 is the simulated land use map of Dawaki for the year 2040, the map indicate increase in the built-up areas from 6.42 km²

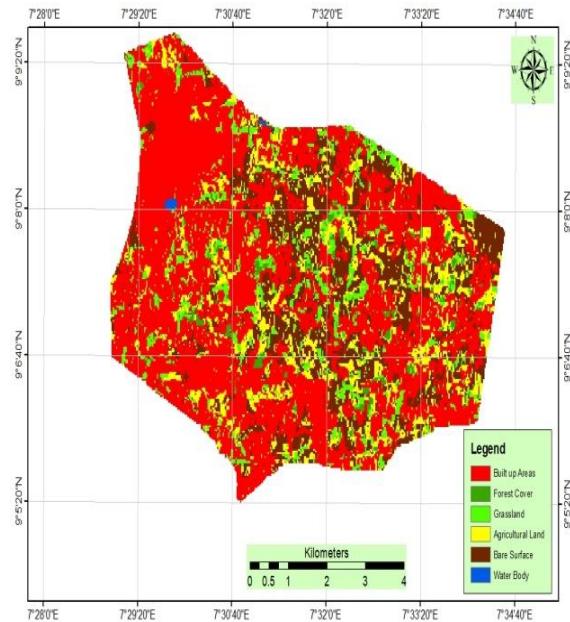


Figure 7: Simulated 2040 Land use of Mpape

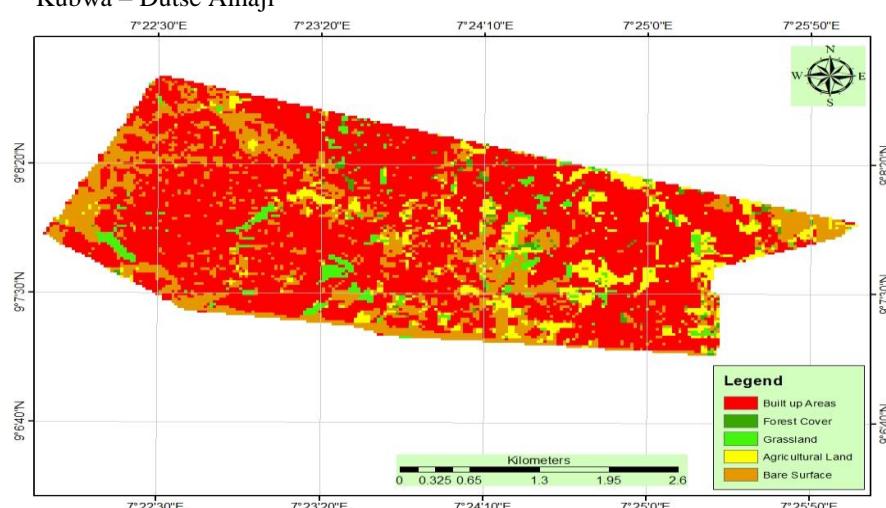


Figure 8: Simulated 2040 Land use of Dawaki

about 44.20% in 2020 to 9.53 km² representing 65.70% in 2040. The simulation of land use in the year 2040 indicates that the urban area will continue to increase sporadically due to the influx of people to the areas.

4. CONCLUSION

Land use change is a product of physical growth and socio-economic development. The changing pattern and direction of land use change in Bwari Area council of the Federal Capital Territory is majorly from agricultural and open space land use to build up for residential, public, retail and office uses. The dominant causes of these land use changes are economic and population influx factors while the significant consequences are landscape distortion, pressure on urban infrastructure and the conversion of other land use types to more of built up environment. As the study locations continue to expand, understanding the current patterns of urban growth and land use and their impact and predicting the possible future patterns of growth of these urban centres will empower the government particularly the FCDA, other stakeholders and policy makers by providing them with information and support that will prove to be essential for future planning and development decisions making. It is therefore recommended that human activities (both individual and government) that speed up land use conversion be reduce, restricted or regulated. Also continuous monitoring of the land use by regulatory authorities should be strengthen to avoid or reduce environmental degradation and ensure sustainability.

REFERENCES

Adediran, A. (2007) challenges of the new national building code presented at the continuing professional development program. By, NITP and TOPREC. Lagos, Nigeria July – August.

Ajala O.A (2005). “Environmental impact of Urbanization : The challenges of Urban governance in Nigeria”, in Fadare et al. (Eds.) proceedings of the conference on Globalization, culture and the Nigerian Built Environment. II. Ile – Ife, Nigeria.

Balogun, O. (2001). The Federal Capital of Nigeria: Geography of its Development. University Press, Ibadan

Jiboye AD (2009) The challenges of sustainable housing and urban development in Nigeria. *Journal of Environmental Research and Policies*. 4(3), 23 – 27

Liping, C., Yujun, S., & Saeed, S. (2018). Monitoring and predicting land use and land cover changes using remote sensing and GIS techniques—A case study of a hilly area, Jiangle, China. *PloS one*, 13(7), 0200493.

Muhati, G.L, Daniel, O., & Lydia, O. (2018). Past and Projected Rainfall and Temperature Trend in sub humid montane forest in Northern Kenya based on CMIPS Model Esensemle. *American Journal of Climate Change*, vol.10 (4)

NPC (National population Commission) (2010) Facts and Figures 2006 census. Retrieved.

Nuissl, H., & Siedentop, S. (2021). Urbanisation and land use change. In *Sustainable Land Management in a European Context* (pp. 75-99). Springer, Cham.

Pedas Concept (2021) GIS/Remote Sensing Laboratory, Minna

Tsegaye, N. T. (2021). Land Use and Land Cover Change Analysis Using GIS and Remote Sensing in The Case of Kersa District, Jimma Zone, Oromia Region, Ethiopia.

UN-HABITAT (2004) Urban Governance index conceptual foundation and field test report. Global Campaign on Urban governance Global Urban observers victory. August 2004

Yousheng W, Xinxiao Y, Kangning H, Qingyun L, Yousong Z, Siming S. (2011). Dynamic simulation of land use change in Jihe watershed based on CA-Markov model. *Transactions of the Chinese Society of Agricultural Engineering*. 1(2), 11- 20.