ASSESSMENT AND PREDICTION OF THE EFFECT OF URBANIZATION ON GREENERY IN 9TH MILE CORNER NGWO, ENUGU STATE, NIGERIA, USING REMOTE SENSING.

[(1)] **Chukwudi Emmanuel Ekpete-Edeh** *and* [(2)] **Victor Chukwuemeka Nnam**

(1) Department of Geoinformatics and Surveying, University of Nigeria Enugu Campus (UNEC), Enugu State Nigeria. chukwudimails@gmail.com
(2) Department of Surveying and Geoinformatics, Enugu State University of Science and Technology (ESUT) Enugu Nigeria. victor.nnam@esut.edu.ng

ABSTRACT

Urban greenery provides a wide range of ecosystem functions including habitat for native species and recreation for residents; It protects us from the adverse greenhouse effects of climate changes. This study applied remote sensing in assessing the effect of urbanization on greenery in 9th Mile Corner Ngwo, Enugu state, Nigeria. The multi-date Landsat Tm, ETm+ and (OLI TIRS) were openly sourced from United State Geological Survey website. The time series images were from Landsat path 188, row 56. The Normalized Difference Vegetation Index (NDVI) was applied herein in order to extract the greenery from the remotely sensed data. The NDVI value of the study area for 1989, 1999, 2009 and 2019 were reclassified using ArcGis 10.1; during the classification, the two major classes that were identified are Vegetation area and Non vegetation area. Regression analysis was applied to predict the trend of greenery depletion in the study area. The results show that in 1989, 1999, 2009 and 2019, the percentages of greenery within the study area are 94.4%, 91.43%, 90.50%, and 82.67% respectively, while the prediction shows that in 2029 and 2039, the percentage of greenery in the study area will be 75.82% and 65.00% respectively. Consequent upon the statistical analyses of the empirical results, the trend is an evidence of the inference that the greenery within the study area has been depleted and will be dwindling in the course of time due to urbanization and industrialization. If greenery will be so depleted as predicted in this study, it will bring about the consequent negative effects of climate change, therefore, it is strongly recommended that the state government as well as the local planning authority should implement strong development control measures and encourage reforestation within the study area in order to avert the impending danger.

Keywords: Urbanization, Greenery, Landsat TM, ETM+, Remote sensing, NDVI.

ASSESSMENT AND PREDICTION OF THE EFFECT OF URBANIZATION ON GREENERY IN 9TH MILE CORNER NGWO, ENUGU STATE, NIGERIA, USING REMOTE SENSING.

[1] **Chukwudi Emmanuel Ekpete-Edeh** *and* [2] **Victor Chukwuemeka Nnam**

(1) Department of Geoinformatics and Surveying, University of Nigeria Enugu Campus (UNEC), Enugu State Nigeria. chukwudimails@gmail.com
(2) Department of Surveying and Geoinformatics, Enugu State University of Science and Technology (ESUT) Enugu Nigeria. victor.nnam@esut.edu.ng

Keywords: Urbanization, Greenery, Landsat TM, ETM+, Remote sensing, NDVI.

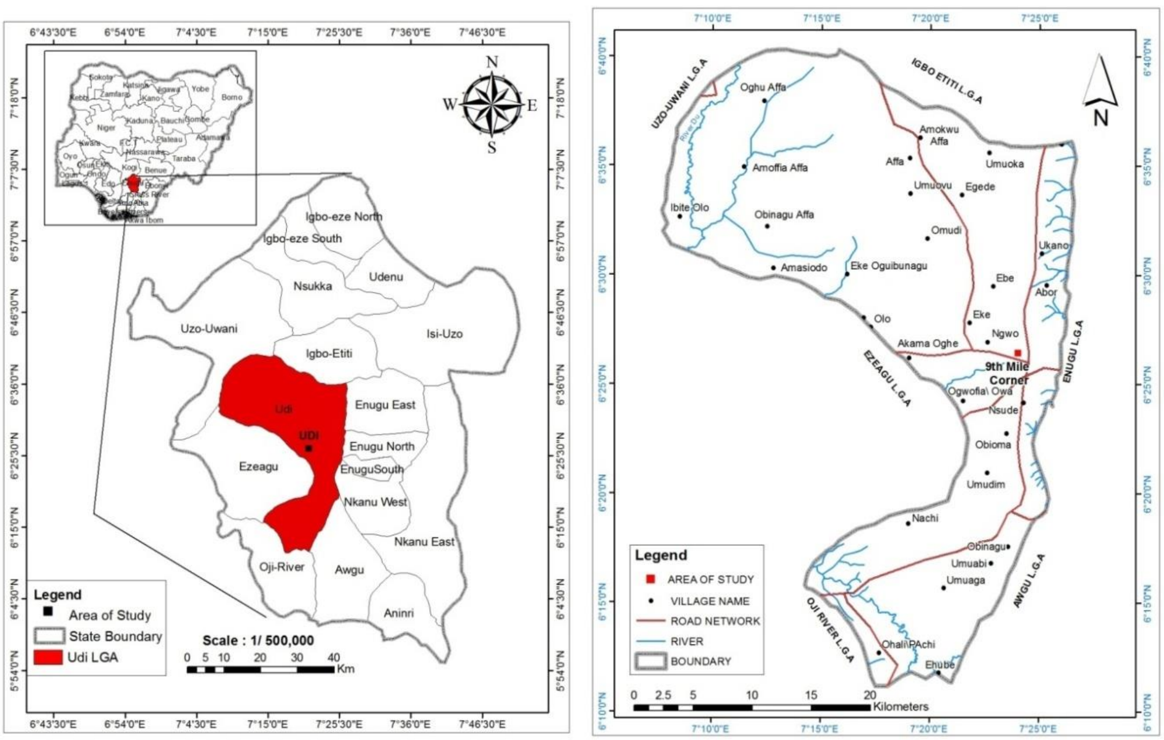
1.0 Introduction

Rapid urbanization has generated great pressure on natural resources, as the human population increases and more people are moving to urban areas, human activities are having a profound effect on ecosystems and greenery. Land use changes, fragmentation, and loss of habitat associated with urbanization have direct effects on biodiversity and ecosystem productivity (Michelle, Arlington, 2018). The challenge of vegetation degradation is the increasing urban population, particularly that the poor is becoming more critical in the urban areas of less developed countries, where an exposure expansion of the urban population due to a high population growth rate and massive rural-urban drift has compounded the vegetation degradation situation (Aliyu And Amadu, 2017). Vegetation represents one of the most frequent types of green area in cities (Cvejić and al. 2015). Urban greenery provide a wide range of ecosystem functions including habitat for native species and recreation for residents (Bolund and Hunhammer,1999, Croci and al. 2008). Both forests and orchards in cities can serve as refugia for rare and threatened specialist species and thus can be of high conservation value (Godefroid and al. 2007, Horák and al. 2018). Urban growth is the rate of growth of an urban population. The 9th Mile Corner is one of the fastest growing settlements in Enugu State. The 2006 population census put its population at 25,000 people (NPC, 2006). From its beginning as a transit camp for travelers between the eastern and the northern regions of Nigeria in the early 1930, it has developed into a sprawling industrial settlement locating important industries like the Nigerian Brewery Plc Plant, AMA Brewery Plant, Seven-Up Bottling Company Production

Plant, Nigeria Bottling Company (NBC) Plant and other associated concerns (Onwe, 2004). This study applied remote sensing in monitoring and predicting the effect of urbanization on greenery in 9th Mile corner, Ngwo Enugu State, Nigeria.

2.0 Study area

The 9th Mile area is located in Ngwo community, Udi Local Government Area of Enugu State, Nigeria and geographically situated between latitude 6° 30'N, longitude 7° 30'E (Fig 2.1a). It is bounded in the East by Enugu Urban, in the west by Ezeagu, in the North-East by Igbo-Etiti and North-West by Uzo-Uwani, in South-East by Awgu and South-West by Oji-River (Figure 2.1b). It has developed into a sprawling industrial settlement hosting important industries.



a b

Figure 2.1: *Map of the study area*

Figure 2.1a: *Geographical location of Udi Local Government Area in Enugu State.*

Figure 2.1b: *Map of Udi L.G.A showing the Geographical location of study area.*

3.0 Methodology

3.1 Method of data Collection

The methodology adopted in this study involved data acquisition and data processing (See work flow below). The Landsat satellite data were openly sourced from United State Geological Survey (USGS). The Landsat 5 Thematic Mapper (TM) of 1989, the Landsat 7 ETM^+ (Enhanced Thematic Mapper) of 1999 and 2009, the Landsat 8 Operational Land Imager and Thermal Infrared Sensor (OLI TIRS) of 2019. Obtaining images at near anniversary dates is considered important for change detection studies (Jensen, 2007). As the Landsat satellite imagery pass over the earth, the area can be identified by path and row Combination (Ayse, 2012). The time series images were from Landsat path 188, row 56.

3.2 Data processing

In order to analyze the change pattern of the impact of urbanization on greenery in the study area between 1989 and 2019, the vegetation index was calculated using Remote Sensing techniques. The unsupervised classification was adopted, using the Normalized Difference Vegetation Index (NDVI). This was facilitated by the use of the Red and Near-Infrared bands of Landsat imagery which makes a clear-cut distinction between vegetation and other features. The satellite imagery were geometrically corrected by defining the same reference system WGS 84 UTM zone 32N, and the resample of all the imagery in 30m resolution. The Polygon shapefile defined in ArcGis 10.1 were used to clip out the Area of Interest Using the upper and lower coordinate of the study area. The radiometric correction was the conversion of the digital number of the bands involved (Red and Near Infrared (NIR)) to Reflectance and computation of NDVI Different method were applied based on the Landsat sensors. The ArcGIS 10.1 modeler was used to design the diagram model and execute the data processing (Figure 3.1).

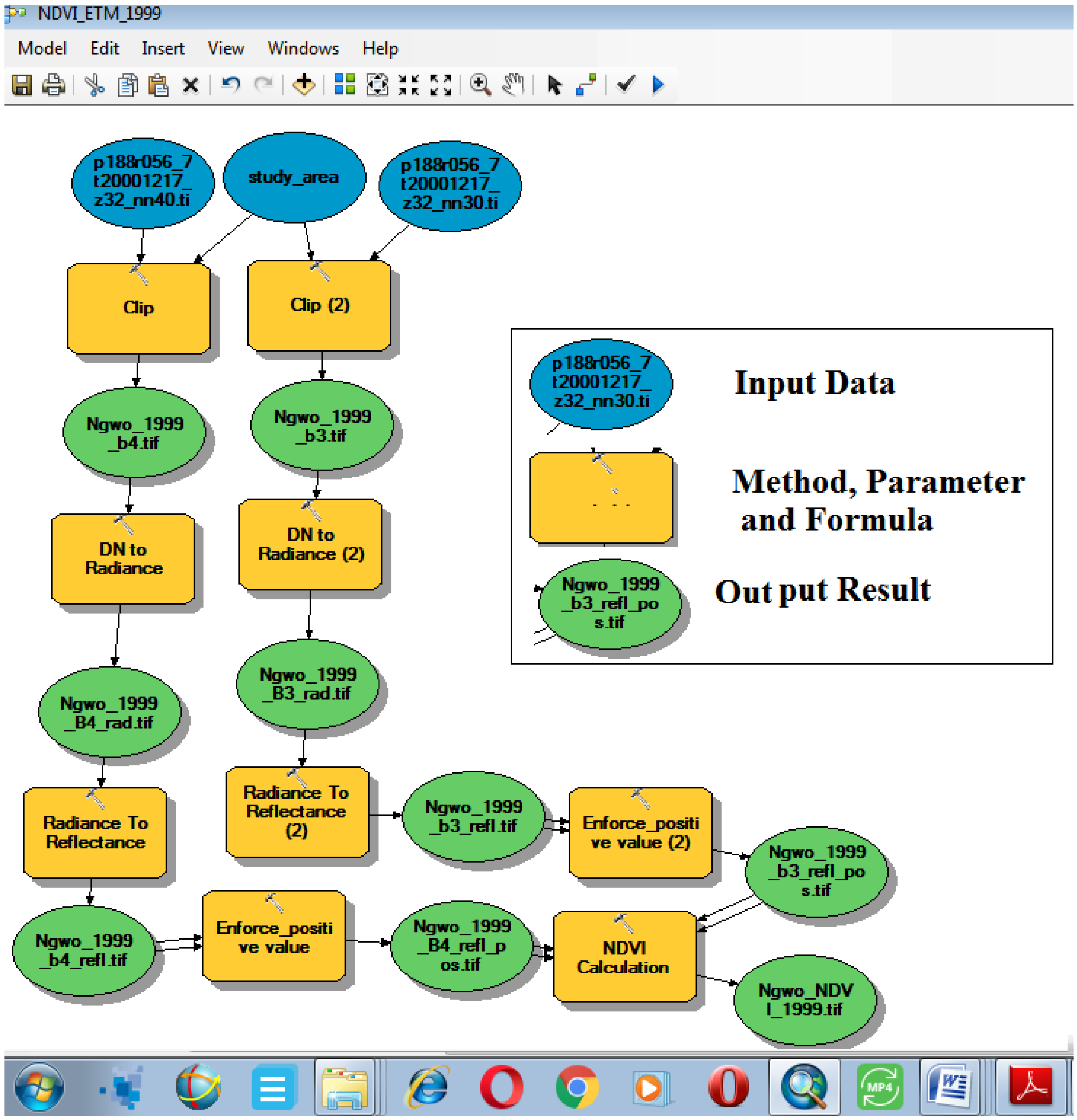


Figure 3.1: *ArcGIS Modeler for NDVI computation.*

3.2.1 Conversion of Landsat Tm and ETM$^+$ to Reflectance

The Band 3 and 4 of Landsat TM and ETM$^+$ were used in conversion of Landsat image Digital Number (DN) to reflectance. The reflectance is defined as the fraction of incoming radiation that is reflected back to the surface. The image was first converted to radiance and later the radiance was converted to reflectance. The equation Eq (1) was used for conversion of DN to Radiance whole, the equation Eq (2) was used to convert the Radiance to reflectance.

<u>Convert DN data to radiance data Formula adopted by (Huang, C., B. Wylie, L. Yang, C. Homer, and G. Zylstra, 2002):</u>

$$\mathbf{L_\lambda = (\mathit{Gain} * \mathit{DN}) + Bias_\lambda} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{Eq(1)}$$

Where:

$\mathbf{L_\lambda}$ is the cell value as radiance; **DN** is the cell value digital number; **Gain** is the gain value for a specific band; while **Bias** is the bias value for a specific band

i. **<u>Convert radiance data to reflectance data Formula adopted by (Chander, G., B. L. Markham, and D. L. Helder, 2009):</u>**

ii. $$R_\lambda = \frac{\pi * L_\lambda * d^2}{E_{sun,\lambda} * \mathrm{Sin}(\theta_{SE})} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathrm{Eq}\ (2)$$

where R_λ is the reflectance (unitless ratio),

L_λ is the radiance calculated in eq (1),

d is the earth-sun distance (in astronomical units),

$Esun_{,\lambda}$ is the band-specific radiance emitted by the sun,

θ_{SE} is the solar elevation angle

3.2.2 Conversion of Landsat 8 band to reflectance

The band 4 and 5 of Landsat 8 OLI data were converted to Top of atmospheric (TOA) planetary reflectance using reflectance rescaling coefficients provided in the product metadata file (MTL file). The following equation Eq (3) adopted by Black and Stephan (2014) is used to convert DN values to TOA reflectance for OLI data as follows:

$$\mathbf{\rho\lambda' = M\,\rho Q\,cal + A\,\rho} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{Eq\ (3)}$$

where:

$\rho\lambda'$ = TOA planetary reflectance, without correction for solar angle.

Note that $\rho\lambda'$ does not contain a correction for the sun angle.

M_ρ = Band-specific multiplicative rescaling factor from the metadata (REFLECTANCE_MULT_BAND_x, where x is the band number)

A_ρ = Band-specific additive rescaling factor from the metadata (REFLECTANCE_ADD_BAND_x, where x is the band number)

Q_{cal} = Quantized and calibrated standard product pixel values (DN)

3.2.3 Calculation of NDVI

NDVI, the normalized difference vegetation index, is a quantity used to assess the presence of live green vegetation. NDVI is computed using the formula adopted by (Zhang and al. 2003)

$$\boldsymbol{NDVI = \frac{NIR - R}{NIR + R}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. \boldsymbol{Eq\ (4)}$$

The RED (R) and Near-Infrared (NIR) stand for the spectral reflectance measurements acquired in the red and Near-Infrared (NIR) regions of electromagnetic spectrum, respectively. NDVI takes values from -1 to 1. The higher the NDVI, higher the fraction of live green vegetation present. Landsat band 4 (0.77-0.90 μm) measures the reflectance in NIR region and Band 3 (0.63-0.69 μm) measures the reflectance in the Red (R) region for Landsat TM and ETM^+ while band 4 measures the reflectance in the Red (R) and band 5 measures the reflectance in near-infrared (NIR) region in Landsat 8.

3.2.4 Classification of NDVI value and computation of statistic value

The NDVI value of the study area for 1989, 1999, 2009 and 2019 were reclassified using reclass tool of spatial analysis tool in ArcGis 10.1. In this process the two major classes were identified (Vegetation area and No vegetation area). The Area with forest cover including green vegetation area with heavy and light forest were classified under NDVI with high Value (value close to 1). The Area with No forest Cover including Built Up area, Water Body, Bare Land etc, were classified under NDVI with Low Value (Value Close to -1).

3.2.5 Statistical analysis

The comparison of the Land use/Land cover statistics assisted in identifying the percentage change, trend and rate of change between 1989, 1999, 2009 and 2019. The area of the Land use/Land cover was estimated in square kilometer and in percentage. The trend of change was calculated using the following equation (Eq5) adopted by (Kasanko, Barredo, Lavalle, Mccormick, Demicheli, Sagris, Brezger, 2006).

$$\boldsymbol{Trend}\ (\%) = \frac{\boldsymbol{observed\ change}}{\boldsymbol{sum\ of\ change}} * \mathbf{100} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. \ \mathbf{Eq\ (5)}$$

The regression analysis applied in this study was used to estimate the prediction of the land development in the study area. The polynomial second order trend line was the best fit for the prediction because the R square is equal to 0.946. The table 3.1 and 3.2 were the summary of the regression analysis result. The prediction equation Eq (6) and Eq (7) were derived from the regression table.

Table 3.1: *Summary of regression analysis for urban development*

Regression Statistics	
Multiple R	0.972758
R Square	0.946257
Adjusted R Square	0.838772
Standard Error	2.017128
Observations	4

ANOVA

	df	***SS***	***MS***	***F***	***Significance F***
Regression	2	71.64031	35.82016	8.803602	0.231825
Residual	1	4.068807	4.068807		
Total	3	75.70912			

	Coefficients	***Standard Error***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***	***Lower 95.0%***	***Upper 95.0%***
Intercept	47462.58	40503.24	1.171822	0.449739	-467180	562105.1	-467180	562105.1
X Variable 1	-47.7221	40.42335	-1.18056	0.447406	-561.35	465.9053	-561.35	465.9053
X Variable 2	0.011997	0.010086	1.189541	0.445027	-0.11615	0.140148	-0.11615	0.140148

The equation of prediction for urban development was derived from the regression summary Eq (6)

$$Y = 0.011997X^2 - 47.7221X + 47462.58 \quad \text{……………………………………..Eq (6)}$$

4.0 Result presentation

4.1: Evaluation of the Urban and Vegetation pattern

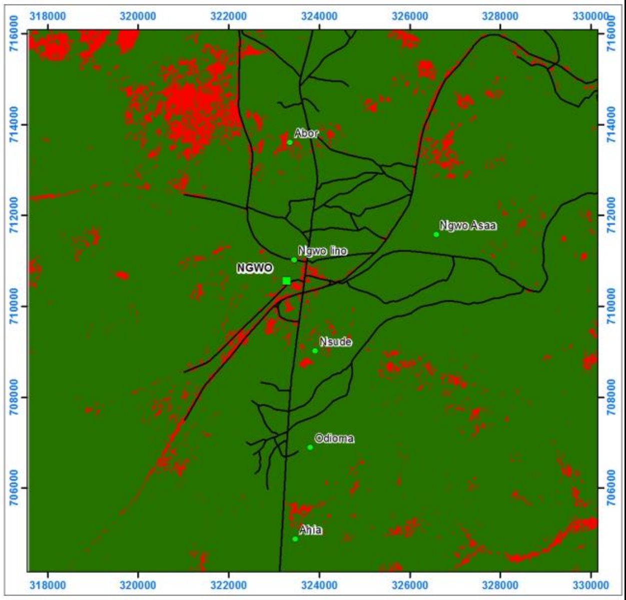
NDVI takes values from -1 to 1. The higher the NDVI, the higher the fraction of live green vegetation present (Zhang and al. 2003). The figure 4.1 below showing the NDVI of the study area from 1989, 1999, 2009 and 2019. The NDVI Value in this study indicate the Area covered with vegetation or greenery and the area with non-vegetation covered which is indicated as the Urban area (see Table 4.1). The vegetation cover includes the forest, grass land, farm land and savannah area while the non-vegetation is considered as urban development area including built up area and bare land. The analysis shows that the urban area counted for 5.54% in 1989 increased to 8.57% in 1999, the urban area kept increasing to 9.50% and 17.33% in 2009 and 2019 respectively. The NDVI result shows that the vegetation area has been decreased from 94.46% in 1989 to 91.43% in 1999. The vegetation keeps decreasing from 90.50% to 82.67 respectively in 2009 and 2019.

Table 4.1: *The statistic tabular of NDVI of the study area from 1989, 1999, 2009 and 2019.*

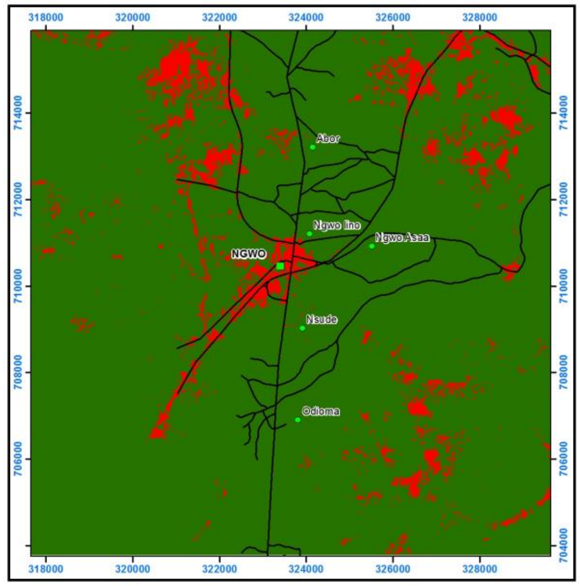
Years	**NDVI Value**	**Class**	**Count**	**Area (Km^2)**	**PCT**
1989	0.0489 - 0.1205	Non Vegetation	9792	8.81	5.54
	0.1205 - 0.3976	Vegetation	166998	150.30	94.46
	Total		**176790**	**159.11**	**100.00**
1999	0.3124 - 0.090	Non Vegetation	15157	13.64	8.57
	0.090 - 0.4874	Vegetation	161633	145.47	91.43
	Total		**176790**	**159.11**	**100.00**
2009	0.0489 - 0.1443	Non Vegetation	16790	15.11	9.50
	0.1443 - 0.3976	Vegetation	160000	144.00	90.50
	Total	Vegetation	**176790**	**159.11**	**100.00**
2019	0.0536 - 0.1304	Non Vegetation	30639	27.58	17.33
	0.1304 - 0.2774	Vegetation	146151	131.54	82.67
	Total		**176790**	**159.11**	**100.00**

Assessment and Prediction of the Effect of Urbanization on Greenery in 9th Mile Corner Ngwo, Enugu State, Nigeria, Using Remote Sensing (10283)
Chukwudi Emmanuel Ekpete-Edeh and Victor Chukwuemeka Nnam (Nigeria)

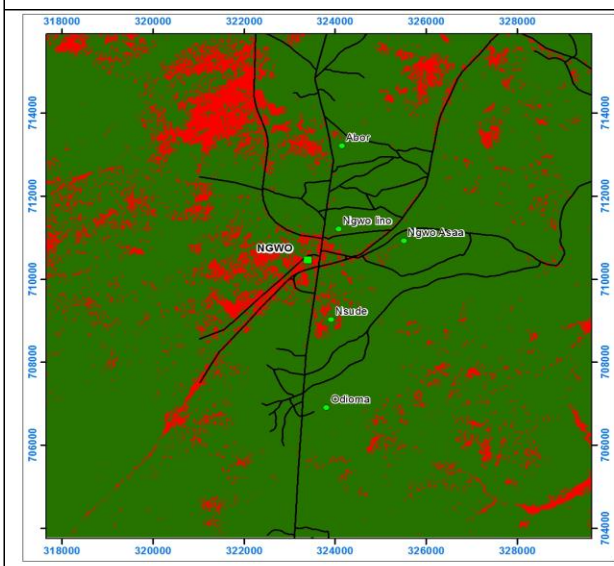
FIG Working Week 2020
Smart surveyors for land and water management
Amsterdam, the Netherlands, 10–14 May 2020



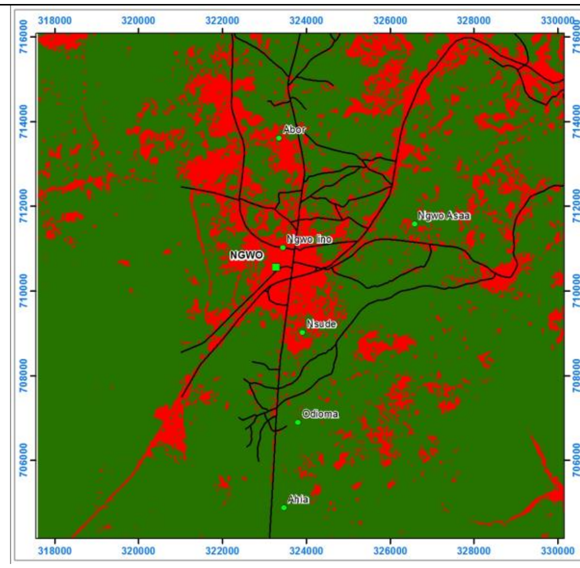
(a) : Greenery of 9th Mile in 1989



(b) : Greenery of 9th Mile in 1999



(c) : Greenery of 9th Mile in 2009



(d) : Greenery of 9th Mile in 2019

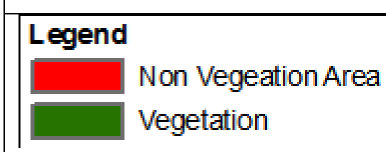


Figure 4.1: *Land use / Land cover changes of the study area from 1989, 1999, 2009 and 2019.*

4.2 Relationship between urban area and Vegetation Cover

The table 4.2 below shows that the correlation between urban area and vegetation cover from 1989 till 2019 is -1. It means there is negative relationship between the urban and vegetation. As the urban increased the vegetation decreased (see figure 4.2). The urban has increased between 1989 to 1999 at rate of 21.50% urban land consumption rate while the vegetation decreased at rate of 1.63%. Between 1999 to 2000 the rate of increment of Urban land consumption reduced to 5.11% while vegetation decreased at rate of 0.51%, from 2009 to 2019 the urban land consumption rate rise to 29.20% while vegetation decrease at 4.52%. This analysis reveal that that the urban area is developed by destroying the greenery. The urbanization incited the degradation of the greenery for the need of the population in wood, timber, habitation, hunting of animal, agriculture, industries etc.

Table 4.2: *Statistical Evaluation of Urban and Greenery Changes.*

Year	**Urban (%)**	**Greenery (%)**
1989	5.54	94.46
1999	8.57	91.43
2009	9.50	90.50
2019	17.33	82.67
Correlation	**-1**	
Trend of Urban change (1989-1999)	Trend of Urban change (1999-2000)	Trend of Urban change (2009-2019)
21.50	5.11	29.20
Trend of Greenery change (1989-1999)	Trend of Greenery change (1999-2000)	Trend of Greenery change (2009-2019)
-1.63	-0.51	-4.52

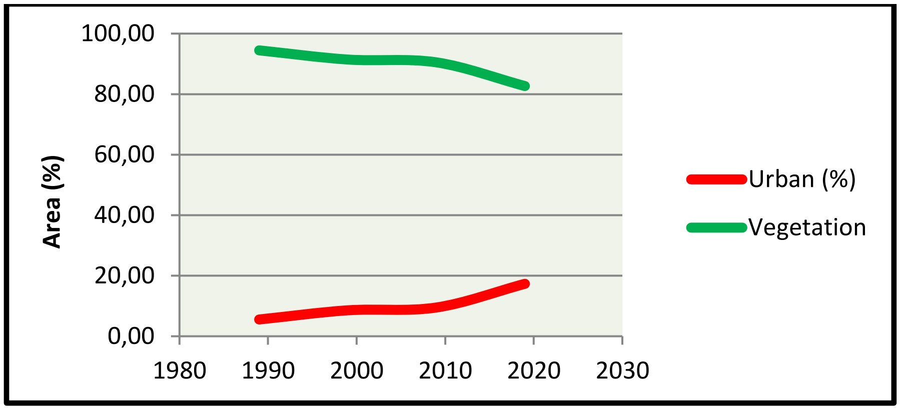
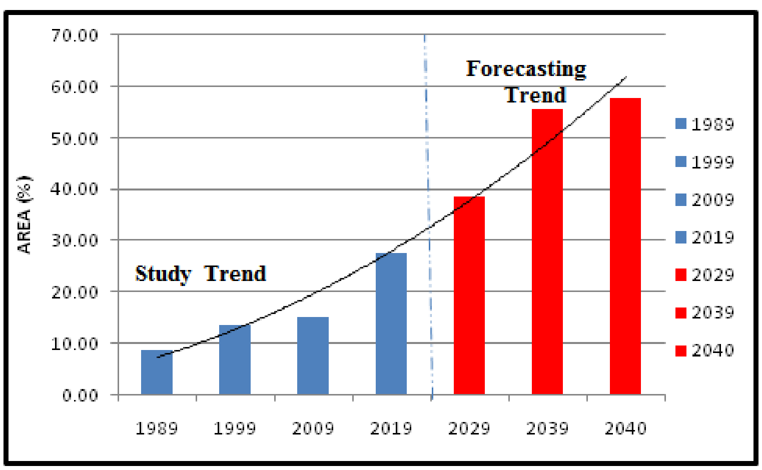


Figure 4.2: *Graph showing the correlation between Urban Area and Greenery/Vegetation.*

4.3 Prediction of urban development

The table below indicates that the Urban area will continue expanding from 27.58Km^2 (17.33%) in 2019 to 38.47 Km^2 (24.18%) in 2029. It will continue increasing to 55.68Km^2 (35%) in 2039 and 57.62km^2 (36.21%) in 2040 (figure 4.3) . This prediction is subjected to the same condition of development currently observed during our study.

Table 4.3: *Prediction of urban development in the study area*



Year	Area (Km2)	Area (%)
1989	8.81	5.54
1999	13.64	8.57
2009	15.11	9.50
2019	27.58	17.33
2029	38.47	24.18
2039	55.68	35.00
2040	57.62	36.21

Figure 4.3: *Prediction of Urban area development in the Study area*

5.0 Conclusion

In Conclusion, Remote Sensing has been an important tool for monitoring urban greenery (Guido 2017). The Normalized Difference Vegetation Index (NDVI) is a quantity used to assess the presence of live green vegetation in this study.

Empirical facts from the results of the study revealed that while urban area in the study were increasing within the study period of 1989, 1999, 2009 and 2019, the greenery of the area has been dwindling till date; it is therefore predicted that the urban area will continue to increase while the greenery will continue on the downwards trend if policies are not changed.

Following the results presented above, it is inferred that one of the contributing factors to the above trend is the teeming population of young Rural-urban migrants, a result which led to increased demand for residential use of land and also progressive deforestation. Another dominantly contributing factor is industrialization, in the study area we sited many industries such as Nigerian Brewery Plc Plant, AMA Brewery Plant, Seven-Up Bottling Company Production Plant, Nigeria Bottling Company (NBC) Plant and then the proposed Free-Trade Zone. Illegal cutting of timbers in commercial quantities and random harvesting of firewood are also contributory in the gradual depletion of the greenery of the study area.

6.0 Recommendation

Further to the above results, the following are strongly recommended;

1. An awareness campaign should be launched in the study area and its environs towards the protection and conservation of green spaces from further depletion.
2. The Master plan of Enugu Urban is getting out-dated. There is need for Government to review and update the plan in order to incorporate policies that protect greenery.
3. The government should encourage the reforestation in the study area by making legislations that encourage Planting of Trees as part of urban development.
4. The Government should discourage further development of industries outside the proposed free trade-zone and design the free trade-zone to incorporate more industries. This move will help and control deforestation in the area.
5. Strict development control enforcement measures must be put in place by local planning Authorities in order to curb and mitigate the factors that deplete greenery in the area.

Reference

Ahmed, Y.A. (2010) “Trend and Pattern of Urban Crime in South Western Nigeria” Unpublished Ph.D. Thesis, University of Ilorin, Nigeria.

Aliyu A. And Amadu L. 2017: Urbanization, Cities, and Health: The Challenges to Nigeria – A Review, Annals of African medicine, Ann Afri Med. 2017 Oct-Dec; 16(4): 149–158. doi:10.4103/aam.aam_1_17,PMCID, PMC5676403, PMID: 29063897.

Aluko, O.E. (2010) “The Impact of Urbanization on Housing Development: The Lagos Experience, Nigeria” Ethiopian Journal of Environmental Studies and Management Vol. 3, No. 3

Black, A., & Stephen, H. (2014). Relating temperature trends to the normalized difference vegetation index in Las Vegas. GIScience and Remote Sensing, 51, 468–482.

Bolund P, Hunhammer S. Ecosystem services in urban areas. Ecol Econ. 1999; 29: 293–301. doi: 10.1016/S0921-8009(99)00013-0

Chander, G., B. L. Markham, and D. L. Helder, 2009: Summary of current radiometric calibration coefficients for Landsat MSS, TM, ETM+, and EO-1 ALI sensors. *Remote Sensing of Environment*, **113**, 893-903.

Croci S, Butet A, Georges A, Aguejdad R, Clergeau P. Small urban woodlands as biodiversity conservation hot-spot: a multi-taxon approach. Landscape Ecol. 2008; 23: 1171–1186.

Crist, E. P., 1985: A TM tasseled cap equivalent transformation for reflectance factor data. *Remote Sensing of Environment*, **17**, 301-306.

Cvejić R, Eler K, Pintar M, Železnikar Š, Haase D, Kabisch N, Strohbach M et al. 2015, A typology of urban green spaces, ecosystem services provisioning services and demands. Work package 3 2015

Guido S. 2017, Remote Sensing to Detect and Monitor Trees in Various Environments: Case Studies in Chile, Submitted: Open access peer-reviewed chapter, February 27th 2017 Reviewed: December 4th 2017Published: July 25th 2018, DOI: 10.5772/intechopen.72903.

Huang, C., B. Wylie, L. Yang, C. Homer, and G. Zylstra, 2002: Derivation of a tasseled cap transformation based on Landsat 7 at-satellite reflectance. *International Journal of Remote Sensing*, **23**, 1741-1748.

Kasanko, M.; Barredo, J.I.; Lavalle, C.; Mccormick, N.; Demicheli, L.; Sagris, V.; Brezger, A (**2006**). Are European cities becoming dispersed?: A comparative analysis of 15 European urban areas. Landsc. Urban Plan.,77, 111–130.

Michelle, Arlington 2018: Effects of Urbanization on Plant Growth, Lewisville lake environmental learning Area (LLELA), https://www.llela.org/research-restoration/graduate-research/effects-of-urbanization-on-plant-growth.

Nnam V.C, Maduako I., Nnam G. U, Onwuzuligbo C., Eze M. A.(2014): Assessment of spatial Urban Dynamics in Enugu City Using GIS and Remote Sensing. Presented at the technical session, paper 6908. FIG Congress 2014, 16 – 21 June 2014, Kuala Lumpur, Malaysia.

Nnam V.C, Okonkwo U. and Onwuzuligbo C. U. (2018) Spatio-Temporal Monitoring and Prediction of Physical Urban Development of Part of Nike, Enugu, Nigeria Using Remote Sensing and GIS. Peer Review Paper published in the Environmental Review, Volume 6, No 2, 2018.

National Population Commission (NPC) (2006): Nigeria National Census: Population Distribution by Sex, State, LGAs and Senatorial District: 2006 Census Priority Tables (Vol. 3). http://www.population.gov.ng/index.php/publication/140-popn-distri-by-sex-state-jgas-and-senatorial-distr-2006

Onwe, F. O. (2004). The Environmental Effects of Brewery Industries at the 9th Mile Corner of Enugu State.(Unpublished Dissertation thesis). Department of Geography, Enugu State University of Science andTechnology (ESUT).

Zhang Yuandong, Xu Yingtao, Gu Fengxue, 2003. Correlation analysis of NDVI climate and hydrological factors in oasis and desert. *Acta Phytoecologica Sinica*, 27(6): 816–821. (in Chinese).

CONTACTS

Chukwudi Emmanuel EKPETE-EDEH
+2347032608449
chukwudimails@gmail.com
Post-Graduate Student,
Department of Geoinformatics and Surveying,
University of Nigeria Enugu Campus (UNEC),
Enugu State, Nigeria.

Dr. Victor Chukwuemeka NNAM.
+2348032760910
victor.nnam@esut.edu.ng
Lecturer,
Department of Surveying and Geoinformatics
Enugu State University of Science and Technology.
Enugu State, Nigeria.