Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.4, No.14, 2014
www.iiste.org

Evaluation of Urban Forestry and Housing Patterns in Awka Metropolis of Anambra State, Nigeria

AGADA, H. C., OBIENUSI, E. A. & EZENWAJI, E. E.
Department of Geography and Meteorology, Faculty of Environmental Sciences, Nnamdi Azikiwe University Awka, Nigeria.P. M. B. 5025, Awka, Nigeria.

Abstract
This study evaluated urban forestry and housing patterns in Awka metropolis of Anambra State in Nigeria, with the aim of establishing the trend of housing and urban forestry / urban greening in the study area over a period of ten years (2001-2010) and to suggest ways of improving urban agriculture for a better environmental quality in Awka and other cities with high rate of developmental projects / urbanization. In other to establish this trend, the linear regression and correlation coefficient of the land use data over the time period was calculated using the concept of housing and urban forestry as a benchmark. The data analyses confirmed that there is a significant correlation between housing pattern (urbanization) and the vegetal distribution of trees (forestry) in Awka. Also, housing and urban forestry in Awka metropolis is spatially distributed in space; as shown in the results from the satellite imageries. The result of the least square regression showed that the rate of forest displacement is as a result of the increasing structural development in the study area. The work thus concluded by recommending the adoption of some tree planting techniques among urban structures and the replacement of failed trees by new one to be undertaken by the government, urban planners, land developers, the community and every individual.

1.0 Introduction

1.1 Background to Study

Urban forestry or urban greening is an integrated approach to the planting, care and management of all vegetation in cities, towns, townships and informal settlements in urban and peri-urban areas. Urban greening includes the components of urban forestry, urban agriculture or permaculture and agroforstry, shown in the figure below.

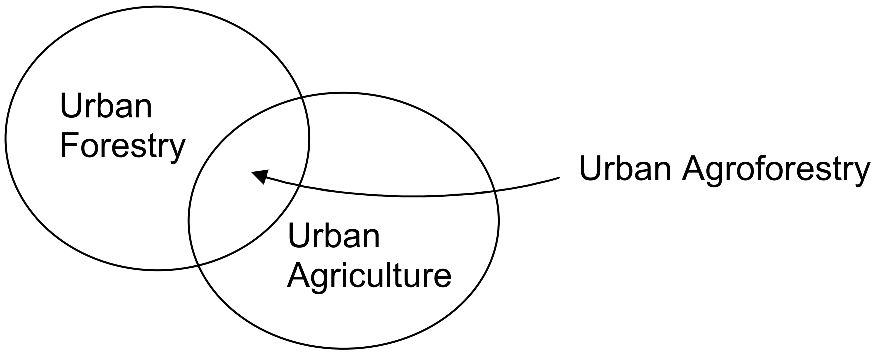

Fig. 1: Urban Agroforest

Urban forestry can be defined as an integrated approach to the planting, care and management of trees in urban and peri-urban areas of secure economic, environmental and social benefits for urban dwellers.
Urban agriculture produces and markets foods and fuel largely in response to the daily demand of consumers within a town, city or metropolis, on land and water dispensed throughout the urban and peri-urban area. Permaculture is a sustainable form of agriculture highly appropriate to urban areas, and comprises a system of farming and gardening that combines plants, animals, buildings, water, the landscape and people in a way that produces more energy than it uses.
Urban agroforestry is the combination of agriculture and forestry on the same land with livestock or cropping enterprises running underneath a regime of widely spaced trees either simultaneously or in sequence.
All these components can be applied to improve the quality of environments in the urban areas, generally in open spaces. Urban open space management is not only confined to parks and roadsides but includes household gardens, factories, business areas, mine dumps, transmission lines, flood plains, taxi ranks, rooftops, schools, clinics and churches.
Urban forest and trees contribute to a better quality of living environment in cities, for example by improving air quality and consequently the health of urban residents. The leaves of trees can take up many pollutants e.g. ozone, nitric acid vapour, nitrogen dioxide, ammonia, sulphurdioxide and particles (aerosols and dust). Some of these pollutants can cause serious health problems. Trees also provide valuable shading from the sun. An

individual tree can provide a sun protection (SPE) of 6 to 10, which means a level of exposure to ultraviolet radiation of one sixth to one-tenth of full sun (NUFU 1999).

By offering an attractive environment for recreational activities, urban forest, may seduce people with a sedentary lifestyle to become more active during their leisure time. Activities such as recreational walking and cycling already have a positive effect on one's health. (Ashcroft 2002, Grahn and Stigsdotter 2003).

Just visually experiencing a natural sitting reduces stress, this stress relief is as measured through muscle tension blood pressure in green and non-forested environment (Ulrich et al 1991). Moreover, viewing or visiting natural environments compared to built urban environments without natural elements after stressful or mentally fatigued situations, produces greater physiological changes toward relaxation and faster recovery of attention-demanding cognitive performances (Parsons et al 1998). Research has shown that even quite ordinary urban green areas have a stress-reducing influence in everyday life. In Sweden, Grahn and Stigsdotter (2003) demonstrated that the more often one visit to green areas the less often one reports sickness from stress.

A Dutch research confirmed that the relationship between the amount of green space in the living environment and self-reported health is positive, even after controlling for relevant socio-demographic and socio-economic characteristics (De Vries et al 2000).

In particular, forest edges, which are many in urban settings, are essential for human aesthetic experience and visual perception. A well-designed edge consists of mixture of bush and tree species, which have not only aesthetic but also ecological importance (Lucas 1991).

Urban greening has Climatic Engineering effects, Ecological Benefits and enhances Air Quality. If green spaces and trees are widespread in urban areas, it will provide an effective means to improve air conditions locally and provide shelter from ultraviolet radiation. (Nowak et al 2002). A recent large-scale study in the West Midland region of England estimated the overall removal rates of air pollutants by the urban forest to be notable. (Stewart et al 2001). The available data suggests that planting additional trees on land theoretically available for this purpose could lead to a significant reduction in concentrations of airborne particles in the West Midlands once these trees have matured. Planting of all available land could achieve a reduction of up to 20% of small airborne particles.

Urban forestry moderates and modifies the climatic characteristics of the urban areas: one of the primary causes of this modification is that in the process of urbanization, vegetated land surfaces are converted into concrete and asphalt surfaces (Roth, 2002). The temperature difference between air above concrete runways and adjacent grass can be as much as 4^0C. This is due to the reflectivity (albedo) differences between the surfaces (Pomerantz et al 2000). Dark pavement materials can store more heat than natural surfaces and lighter-coloured materials (Doulas et al, 2004; Synnefa et al, 2006). Trees have considerable applications in the development of better urban livelihoods and environments. These comfort and other benefits can be affected negatively by unfavourable human activities e.g. bush burning, deforestation, use of toxic chemicals or fertilizers for various agricultural purposes and the paving of the natural environment etc.

Hydrographs show how urbanization increases the peak flow intensity and quantity during rainfall events. Urban forests and trees can reduce surface runoff and thus alleviate the strain from the urban sewage system and dampen peak flows of streams. The main ways that individual trees reduce runoff are by:

- The interception of precipitation, which is stored and/or evaporated from the tree
- The increase of rainwater infiltration into the open soil under the canopy.
- An increase of water storage capacity of soils through evapotranspiration.
- The reduced impact of raindrops and consequently less soil erosion pollutant wash-off. (Xiao et al 2000, Whitford et al 2001).

Also enhanced by Urban Greening is Energy Demand and Carbon Sequestration. In Liverpool, United Kingdom carbon sequestration was estimated for four residential areas with a different provision of vegetation. The result shows that up to 0.13 + $ha^{-1}yr^{-1}$, well-treed areas sequestrated more than double the amount of carbon sequestrated by those areas with a poor provision of green spaces (Whitford et al 2001). Urban Forest and Trees are of great Economic Benefits and stimulates Biodiversity (Nowak and Dwyer, 2000).

Deforestation or the reductions of vegetation due to increased urbanization are some of the factors that contribute to the problem of Urban Heat Island. An Urban Heat Island (UHI) describes the characteristic warmth of both the atmosphere and surfaces in cities (urban areas) compared to their (non-urbanized) surroundings (Oke, 1982). Lack of vegetation reduces heat loss due to evapotranspiration (Lougeay et al, 1996). Vegetation, especially in the presence of high moisture levels, plays a key role in the regulation of surface temperatures, even more than many non-reflective or low-albedo surfaces (Goward et al, 1985) e.g. when vegetation is placed on urban surfaces, thermal balances can shift to new conditions, closer to the cooler conditions of rural areas. It is estimated that 1460kg of water is evaporated from an average tree during a sunny summer day, consuming about 860mj of energy; this offers a cooling effect outside a building that is equal to five average air conditions (Santamouris, 2001).

To be precise, urban agriculture is an important aspect of the urban economy and the quality of life in urban areas. It thus becomes paramount to evaluate the impacts of housing development on urban forestry in Awka, where urbanization is at its peak now.

1.2 Aim and Objectives

The main aim of this study is to establish the trend of housing and urban forestry / urban greening in the study area over a period of ten years (2001-2010) and to suggest ways of improving urban agriculture for a better environmental quality in Awka and other cities with high rate of developmental projects / urbanization. To achieve this aim, the following objectives were pursued;

I. to assess the locational pattern and percentage distribution of urban structures in Awka,
II. to assess the locational pattern and percentage distribution of urban forests and trees in Awka metropolis,
III. to assess the spatial relationship between urban structures and urban forests and trees in Awka metropolis and
IV. to assess the changes brought about by the rapid urbanization on urban forest and trees in the study area.

1.3 RESEARCH HYPOTHESIS

Ho: There is no significant correlation between housing pattern and the vegetal distribution of trees in Awka.
H_1; there is a significant correlation between housing pattern and the vegetal distribution of trees in Awka.

1.4 SCOPE OF THE STUDY

The study was focused on the housing and urban forestry in Awka metropolis, targeting to map out the forested/vegetated parts of the region and the determination of the spatial correlation of housing and urban forestry in Awka metropolis.

1.5 STUDY AREA

Awka is the capital of Anambra State. It is located between latitude $6^{0}11^{1}$N and $6^{0}15^{1}$N, and longitude $7^{0}04^{1}$E and 70091E

Fig.2 : Map of Anambra showing the study area,

Awka is predominantly a low lying region on the western plain of the Manu River with all parts at 333 meters above sea level.

Awka has rainforest vegetation with two seasonal climatic conditions. They are the rainy season and the dry season which is characterized by/with the harmattan. The dryness of the climate tends to be discomforting during the hot period of February to May, while the wet period between June and September is very cold. The harmattan which falls within December and February is a period of very cold weather when the atmosphere is generally mist (UN-HABITAT, 2009).

Awka is characterized by the annual double maxima of rainfall with a slight drop in either July or August known as dry spell or (August break). The annual total rainfall is above 1.450mm concentrated mainly in eight months of the year with few months of relative drought.

Awka has mean daily temperature of 27^0C, with daily minimum temperature of 18^0C annual minimum and maximum temperature ranges ace about 22^0C and 34^0C respectively. It has a relative humidity of 80% at dawn (UN-HABITAT, 2009).

The geological formation that underlies Awka urban are Imo Shale and Bende Amechi Formation. In the riverine and low-lying area particularly the plain west of Mamu River as far as to the land beyond the permanent site of Nnamdi Azikiwe University, the underlying impervious clay shales cause water logging of the soil during rainy season.

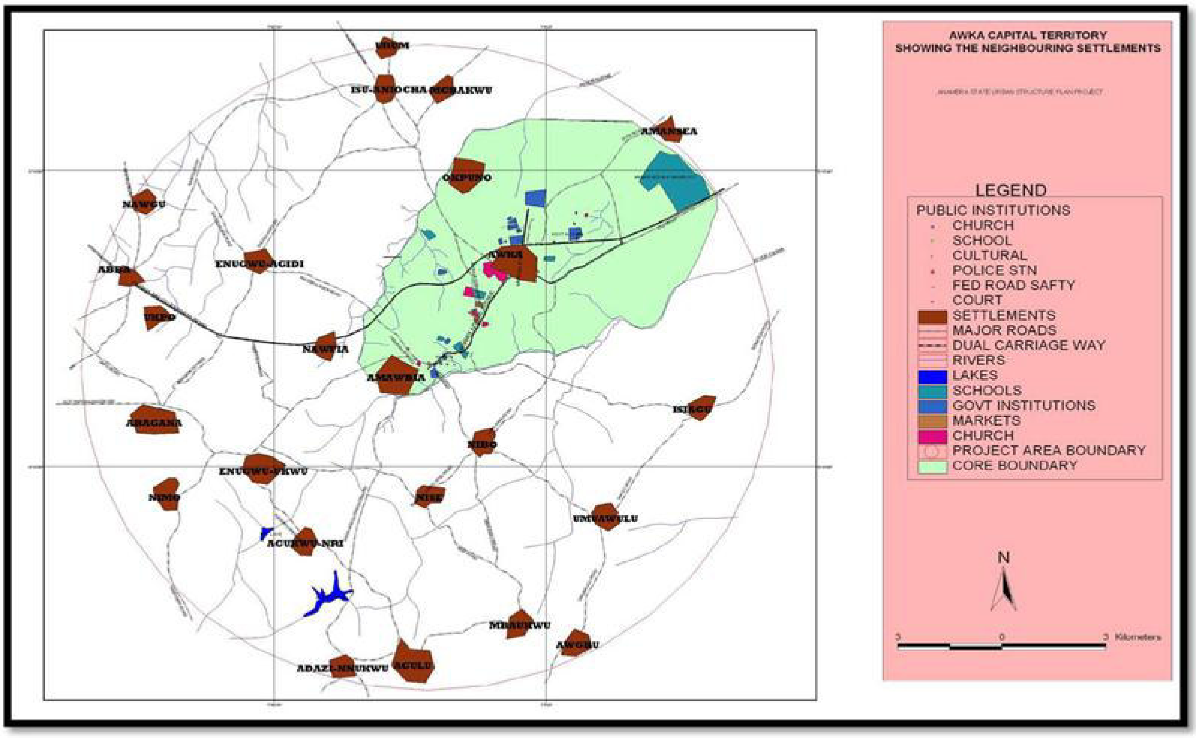

Fig. 3: Awka capital territory showing landuse distribution.

2.1 CONCEPTUAL FRAMEWORK

The concept of housing and urban forestry served as a reference guide for this work. Housing and urban forestry is a term used to explain the economic, aesthetic and organizational relationship between forest resources as spatially distributed within urban structures. As urban areas develop, changes occur in their landscape. Roads and infrastructure replace open land and vegetation. This rapid rate of urbanization (development) accompanied by man's quest for natural resource exploitation through lumbering etc has resulted to the loss of trees and agricultural farms among urban structures. These changes also cause the urban regions to become warmer than their rural surrounding forming an "island" of higher temperatures in the landscape; Urban Heat Island (UHI) which develops when a large fraction of natural land-cover in an area are replaced by built surfaces that trap incoming solar radiation during the day and then re-radiate it at night (Oke, 1982).

There has been substantial attention given to the benefits provided by urban forests (Pitt et al, 1979; Nowak and Dwyer, 2000) little emphasis, however, has been placed on the commoditization of urban trees and the means by which trees as commodities function within broader urban processes while there has been limited empirical investigation into the distribution of urban trees within the context of the distribution of socioeconomic characteristics (Schmid, 1975; Dorney et al, 1984; Talarchek, 1990; Shaw et al, 1998; Iverson and Cook, 2000), there has been even less research that investigates beyond the initial distribution of trees to consider issues of reforestation (Zipperer et al, 1990).

2.2 METHODOLOGY

The following data are considered necessary for the execution of the research:

a. The locational pattern and percentage distribution of urban structures in the study area.
b. The locational pattern and percentage distribution of urban vegetation in the study area.
c. Land use data

Moving over a long interval of time (2001 - 2010) trend of the time series which refers to the general dimension in which the time series (i.e. the changes in the quantitative values of the phenomena through time) was used to describe whether there is a significant decrease in urban forestry due to urbanization.

In order to find the trend, the linear regression and correlation coefficient of the land use data over the time period was calculated. The regression analysis provides an estimating equation which expresses the functional relationship between the variables (housing and urban forestry). The visual representation of their relationship was shown in a scatter gram, with forestry and housing on the y-axis and the year on the x-axis respectively. The equation used to express their linear relationship is known as the least square regression thus:

$$Y = a + bx$$

Where, a is the intercept
b is the gradient of the line

'a' and 'b' were determined using the following formulas respectively.

$$b = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}$$

$$a = \frac{\Sigma x}{n} - \left(\frac{\Sigma y}{n}\right) . b$$

where, x is the housing and y is the rainfall amount and n is the number of observations.

The correlation coefficient (r) measures the strength (magnitude) and directional of the trend. It is expressed as

$$r = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}}{\sqrt{\left(\Sigma x^2 - \frac{(\Sigma x)^{2-}}{n}\right)\left(\Sigma y^2 - \frac{(\Sigma y)^2}{n}\right)}}$$

In order to determine whether the correlation coefficient value is statistically significant, the student 't' test was employed using 95% level of confidence thus:

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

3.1 PRESENTATION OF RESULTS

3.1.1 Assessing the locational pattern and percentage distribution of urban structures in the study area

This was obtained from two sources: the variable data from a secondary source (the National Geological Survey) and from the researcher's fieldwork. Here, a 10year data on the research variables were collected.

Table 4: Percentage land use distribution for housing and urban forestry in Awka metropolis

Year	Residential	Administrative	Industry and Commerce	Horticulture	Agriculture	Other Vegetation	Total (%)
2001	28	7	0.3	6	15.7	43	**100**
2002	28	9	0.3	5.9	15.1	41.7	**100**
2003	30	10	1	5	15	39	**100**
2004	30	10	0.8	5.5	14.2	39.5	**100**
2005	31	10	1	6.5	13.5	38	**100**
2006	31	11	1.7	5	14.3	37	**100**
2007	31.5	12.5	2.5	5.5	14.5	33.5	**100**
2008	32	13	3	5	13.5	33.5	**100**
2009	34	14	3	5	14	30	**100**
2010	35	15	3	6	14	27	**100**
Total	**310.5**	**111.5**	**16.6**	**55.4**	**143.8**	**362.2**	**1000**

Source: National Geological Survey

From which the individual data of each variable was extracted and then the percentage distribution of the sub-variables (residential, administrative and industry and commerce) of each phenomena was gotten by summing the sub-variables under the urban concrete structures and finding the percentage. Then applying the final result to the satellite imagery to access the visual display of the study area with this, an analysis is made to access the locational pattern which was determined to be spatially distributed in space.

Table 5: Percentage distribution of urban housing structures in Awka

Year	Residential	Administrative	Industry and Commerce	Total (%)
2001	28	7	0.3	**35.3**
2002	28	9	0.3	**37.3**
2003	30	10	1	**41**
2004	30	10	0.8	**40.8**
2005	31	10	1	**42**
2006	31	11	1.7	**43.7**
2007	31.5	12.5	2.5	**46.5**
2008	32	13	3	**48**
2009	34	14	3	**51**
2010	35	15	3	**53**
Total	**310.5**	**111.5**	**16.6**	**438.6**

Source: Researcher's work.

3.1.2 Assessing the locational pattern and percentage distribution of urban forest and trees in the study areas

This is similar to what was done for the urban structures above. It also entails extracting the numerical variables for urban forest and trees from the 10 year data gotten from the National Geohazards and then calculating the percentage distribution of the sub-variables of urban forestry (Horticulture, agriculture and other vegetation).

Table 6: Percentage distribution of urban forestry in Awka

Year	Horticulture	Agriculture	Other Vegetation	Total (%)
2001	6	15.7	43	**64.7**
2002	5.9	15.1	41.7	**62.7**
2003	5	15	39	**59**
2004	5.5	14.2	39.5	**59.2**
2005	6.5	13.5	38	**58**
2006	5	14.3	37	**56.3**
2007	5.5	14.5	33.5	**53.5**
2008	5	13.5	33.5	**52**
2009	5	14	30	**49**
2010	6	14	27	**47**
Total	**55.4**	**143.8**	**362.2**	**561.4**

Source: Researcher's work.

Using the formula $\frac{X}{T} \times \frac{100}{1}$

Where x is the value of each sub-variable
T is the overall total of the sum of the sub-variables

Then comparing the final result with the satellite imagery to assess the locational pattern of the distribution.

A similar calculation was done by the researcher to assess the present locational pattern and percentage distributions of urban forests and trees for the study area.

3.1.3 Assessing the spatial relationship between urban structures and urban forest and trees in the study area

This was done by employing statistical approaches as shown below:

Using the least square regression i.e. Y = a + bx

To find b;

$$b = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}}{\sqrt{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}}$$

To solve for $a = \frac{\Sigma y}{n} - \left(\frac{\Sigma x}{n} b\right)$

N.B: The least square regression is used to show the linear relationship between the two phenomena under survey.

Table 7: Regression table for housing and urban forestry

YEAR	Housing (x)	Forestry (y)	XY	X^2	Y^2
2001	35.3	64.7	2283.91	1246.09	4186.09
2002	37.3	62.7	2338.71	1391.29	3931.29
2003	41	59	2419	1681	3481
2004	40.8	59.2	2415.36	1664.64	544.64
2005	42	58	2436	1764	3364
2006	43.7	56.3	2460.31	1909.69	3169.69
2007	46.5	53.5	2487.75	2162.25	2862.25
2008	48	52	2496	2304	2704
2009	51	49	2499	2601	2401
2010	53	47	2491	2809	2209
	438.6	**561.4**	**24327.04**	**19532.96**	**28852.96**

Source: Researcher's work.

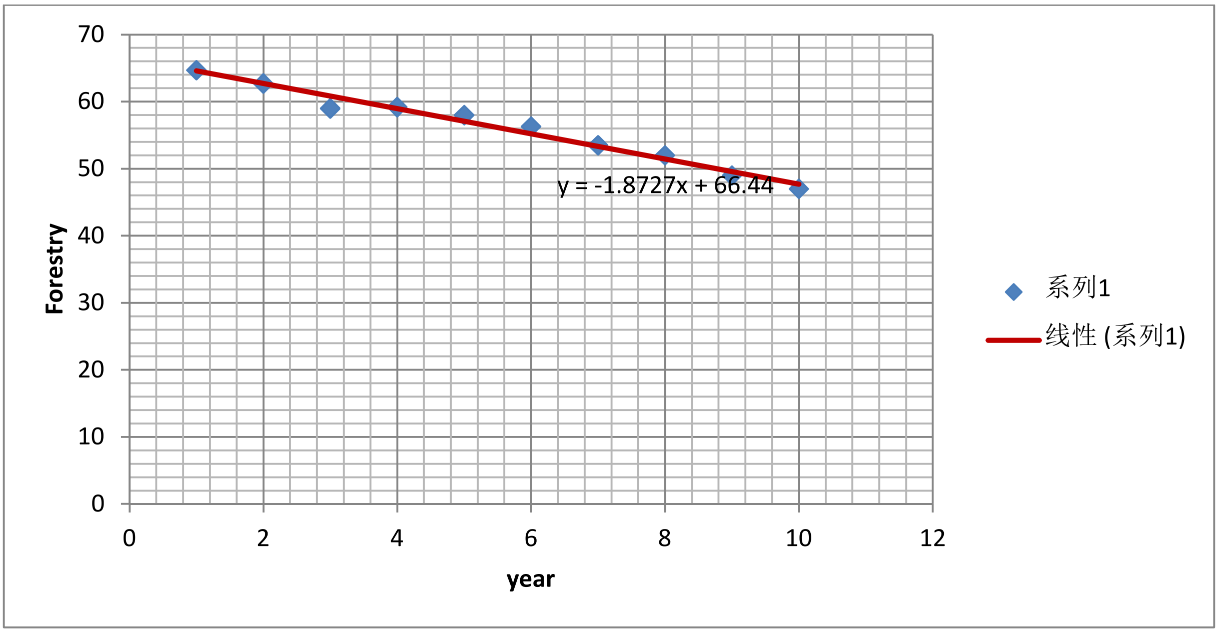

Fig.4: Trend analysis for urban forestry

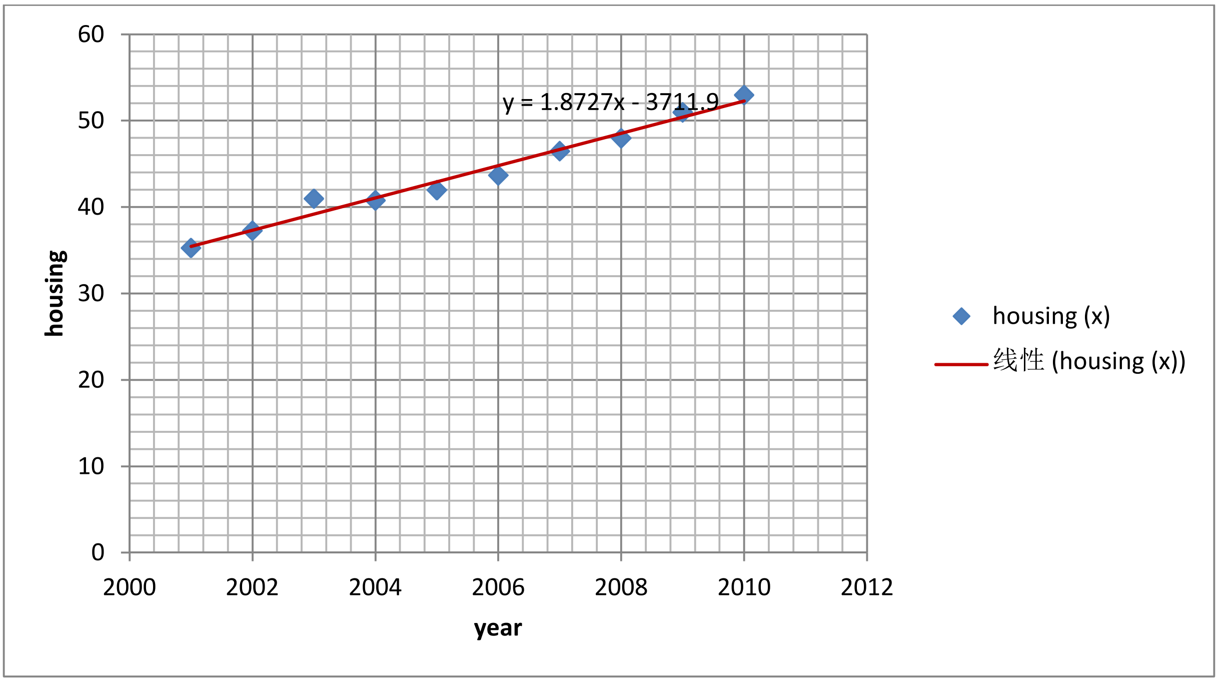

Fig. 5: Trend analysis for housing

Calculating the trend

$$t = r\frac{\sqrt{n-2}}{\sqrt{1-r^2}}$$

Calculated value = 0
Table value = 1.86
Since the calculated value is lesser than the table value, we will accept Ho, meaning there is a significant decrease in Y due to X.
The equation above is justified to be a perfect correlation (-1) using Pearson.

$$r = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{n}}{\sqrt{\left(\Sigma x^2 - \frac{(\Sigma x)^2}{n}\right)\left(\Sigma y^2 - \frac{(\Sigma y)^2}{n}\right)}}$$

In assessing the percentage distribution;

Table 8: Percentage of housing to urban forestry

VALUES	FREQUENCY	
X	438.6	43.86
Y	561.4	56.14
Total	**1000**	**100**

Source: Researcher's work

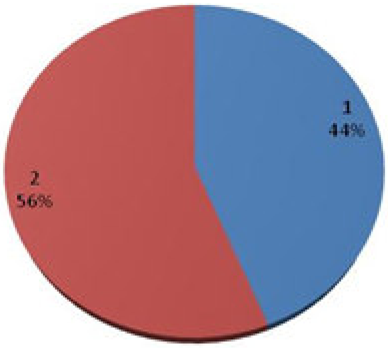

Fig. 6: Pie chart showing Percentage distribution of housing to urban forestry in Awka

Land use change for the past decade

2001	%
Housing	35.3
Forestry	64.7
	100

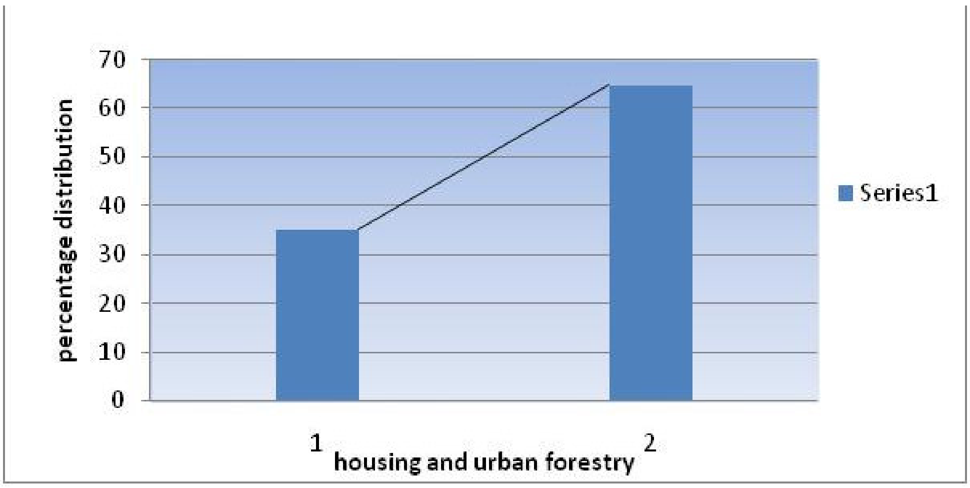

Fig.7: Frequency polygon for housing and urban forestry distribution in 2001

2010	%
housing	53
forestry	47
	100

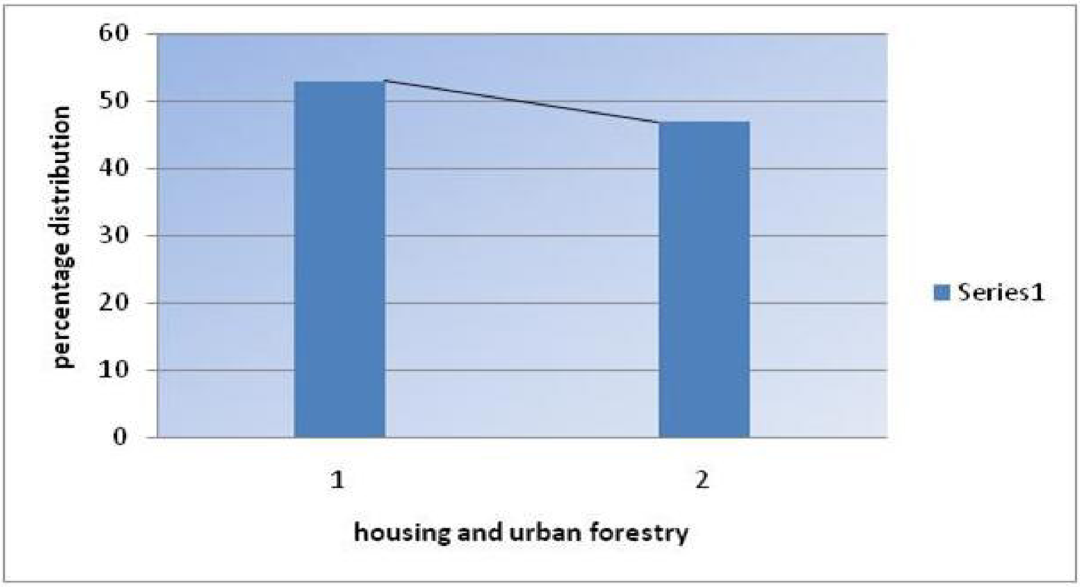

Fig. 8: Frequency polygon for housing and urban forestry distribution in 2010

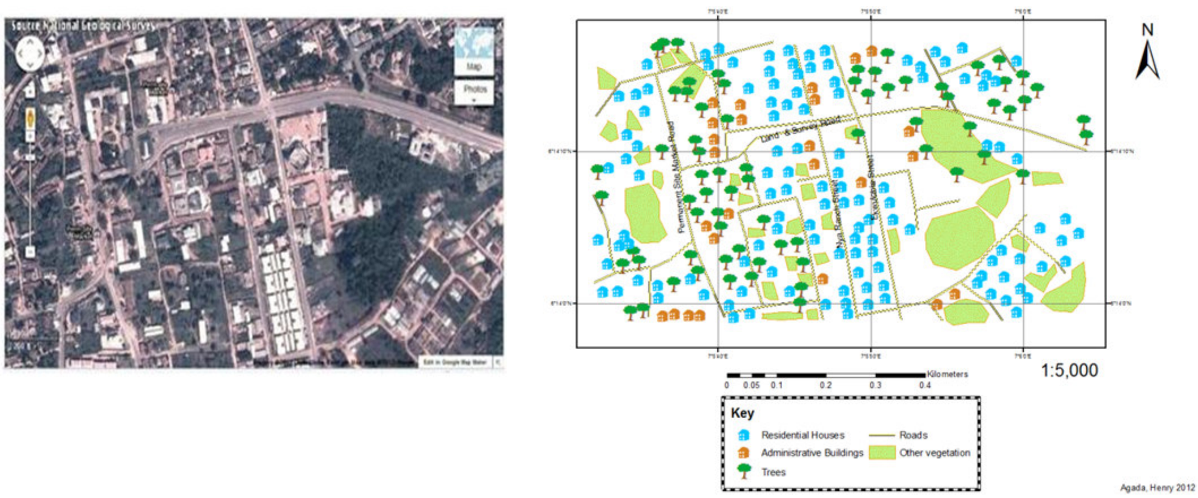

Fig. 9: Satellite image and Rasta result for Map of GRA, Awka showing housing and vegetation

Table 9: Urban housing data for GRA

Type of urban houses	frequency	
duplex	54	38.6
storey building	62	44.29
bungalow	24	17.15
Total	**140**	**100.04**

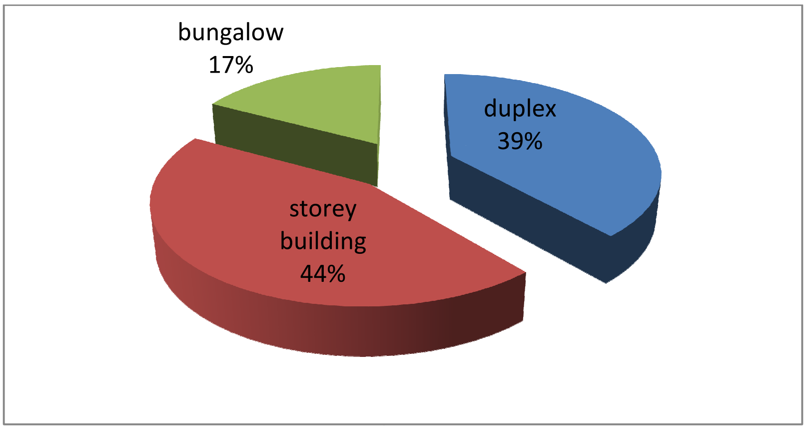

Fig. 9: Percentage land use cover for urban structures in GRA

Table 10: Urban forestry data for GRA

Type	frequency	
urban trees	121	44.33
shrubs and grassland	30	11
other greenspace	122	44.7
Total	273	100.03

Source: Researcher's field work

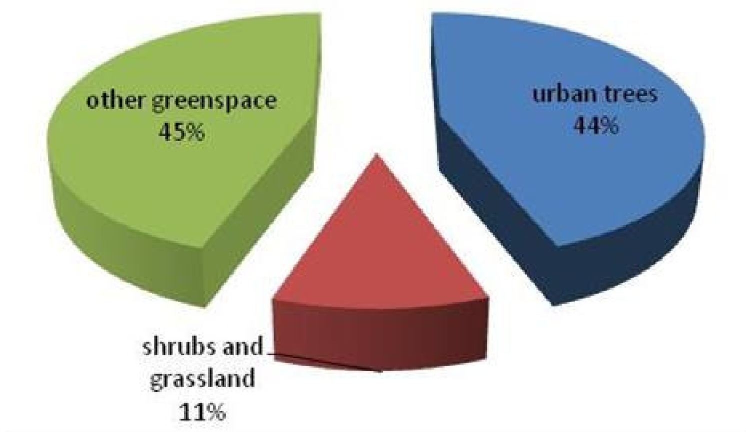

Fig. 10: Percentage land use cover for urban forestry in GRA

Table 11: Graphical illustration on the percentage of housing to urban forestry In GRA

Values	Total Frequency	
Housing total	**140**	34
Forestry total	273	66
Total	413	100

Source: researchers field work

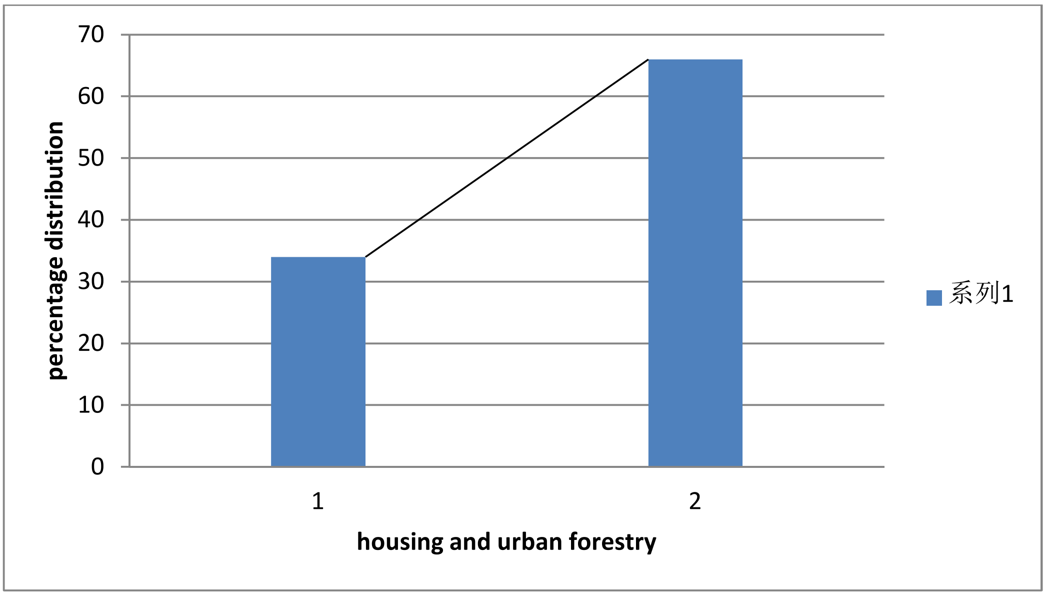

Fig. 11: Frequency polygon for housing to urban forestry in GRA

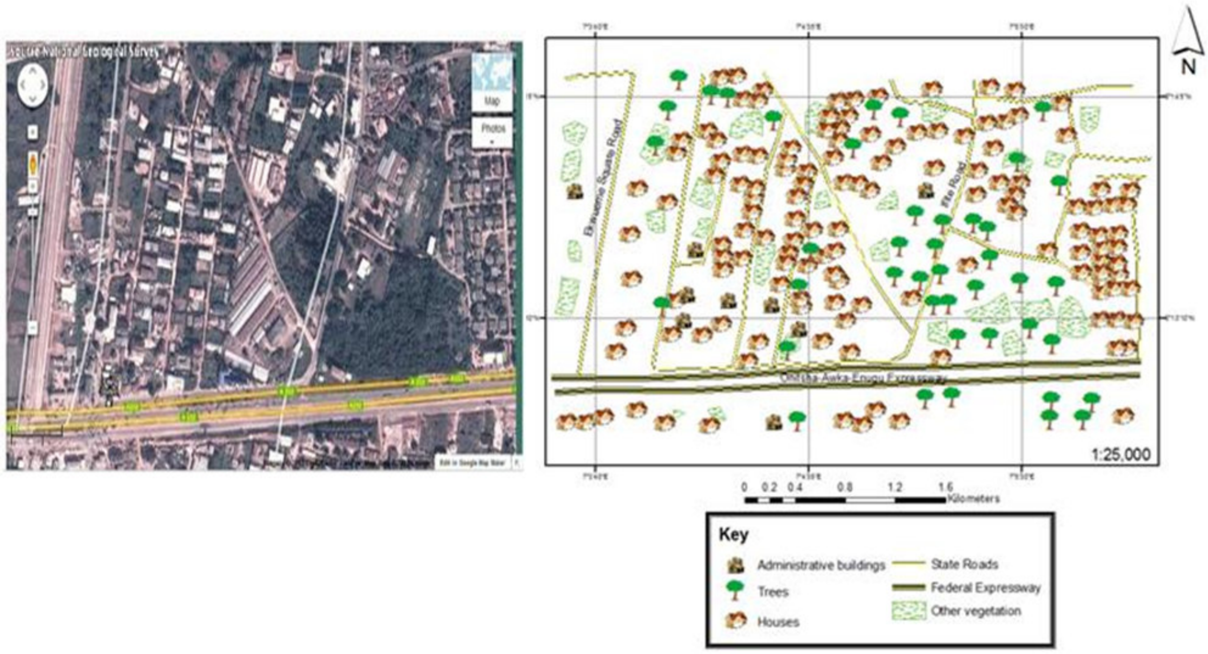

Fig. 12: Satellite image and Rasta result for Map of Arroma, Awka showing housing and vegetation.

Table 12: Percentage distribution of urban housing structure in Arroma

Type of urban houses	**frequency**	
duplex	53	30.814
storey building	77	44.77
bungalow	42	24.42
Total	**172**	100.004

Source: researchers field work

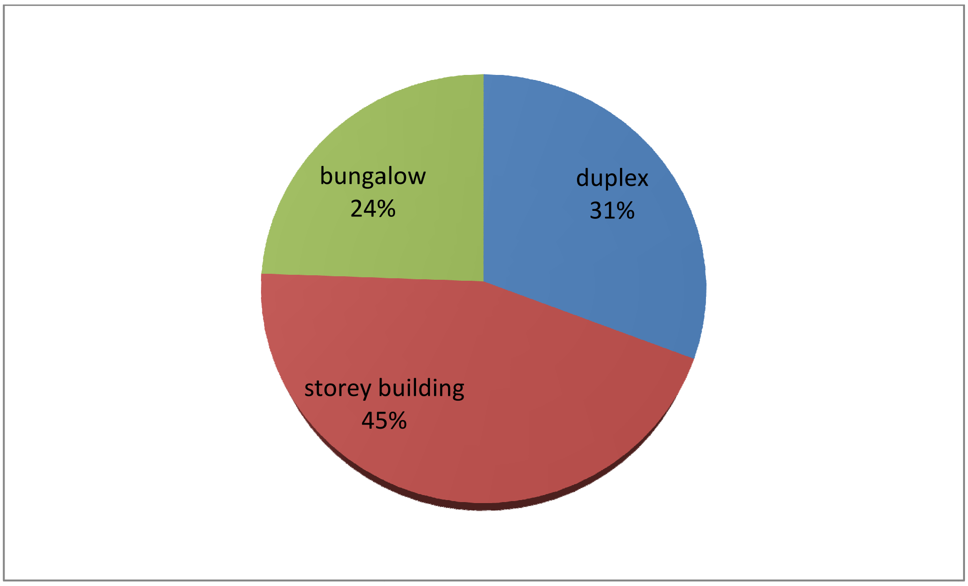

Fig. 13: Percentage distribution of urban housing structure in Arroma, Awka.

Table 13: Urban forestry distribution Arroma, Awka

Type	**frequency**	
Urban trees	132	44.148
Shrubs and grassland	14	4.7
Other greenspace	153	51.18
Total	299	100.028

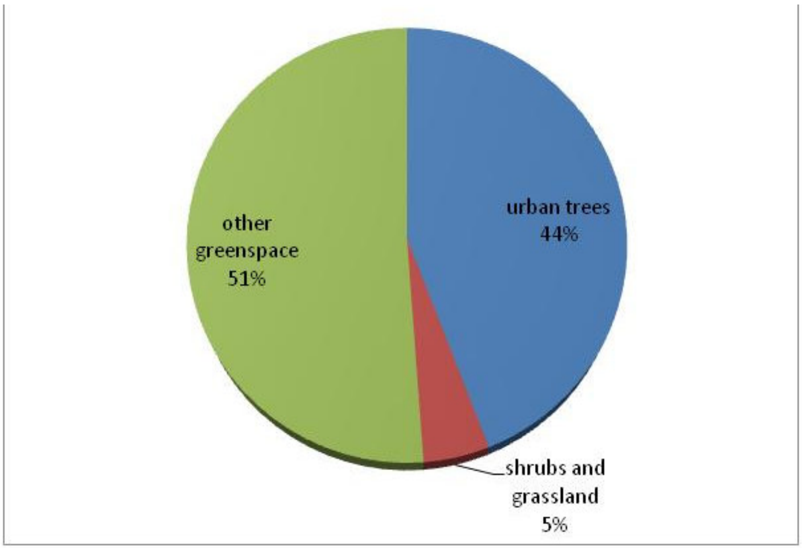

Fig. 14: Percentage distribution of urban forestry in Arroma, Awka

Table 14: Percentage distribution of housing to urban Forestry IN ARROMA

Values	**Total frequency**	
housing total	172	36.6
forestry total	299	63.5
Total	471	100.1

Source: researchers field work

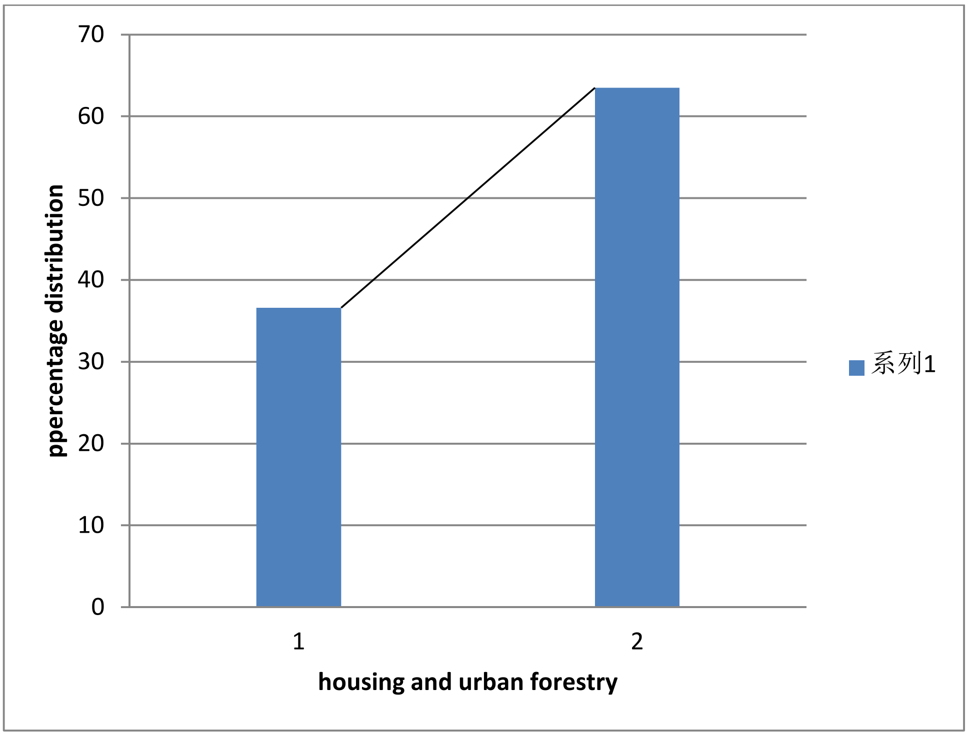

Fig. 15: Frequency polygon for distribution of housing to urban forestry in aroma, Awka

4.0 SUMMARY OF FINDINGS, RECOMMENDATION AND CONCLUSION

4.1 SUMMARY OF FINDINGS

The data analyses confirmed that there is a significant correlation between housing pattern (urbanization) and the vegetal distribution of trees (forestry) in Awka. The research findings have proved that housing and urban forestry in Awka metropolis can be described as being spatially distributed in space; as shown in the results from the satellite imageries. Applying the least square approach of regression, it was also confirmed that there is spatial relationship between houses and urban forests and trees in the study area and subsequently applying the trend equation on the regression result, it was proved that urban forestry is a dependent factor on housing in terms of urbanization, that is the rate of forest displacement is as a result of the increasing structural development in the study area. To determine the rate of this increase in development, the coefficient of variation was applied in line with the mean deviation for each sub-variable of the two phenomena.

4.2 RECOMMENDATIONS

Sequel to the above findings, the following were recommended in order to improve environmental conditions and the quality of life in urban areas, with focus on housing and urban forestry;

1. A tree planting technique should be adopted among urban concrete structures in order to enhance human comfort e.g. each urban structure must have about eight (8) trees planted round it, this will also enhance the aesthetic characteristics of urban structures.
2. The federal government should lobby for and provide urban greening funds and funding mechanism, and make these available to local governments, other service providers and urban communities.
3. The federal government and stakeholders should support a network of advice and information on urban forestry issues and also make it available for local government and other service providers.
4. The local government should incorporate community participation in urban forestry programmes in urban areas.
5. Local governments should include urban forestry in their housing development schemes.
6. Household should adopt tree maintaining techniques to promote the health and longevity of the green space.
7. Land developers should balance the rate of urbanization with the rate of forest displacement since urban structures are rapidly replacing agriculture and forest landscapes.

4.3 CONCLUSION

In conclusion, the environmental variables were spatially distributed in space and the rapidly fading green environment is dependent on the rate of urbanization of which the only way to solve the problem is to adopt tree planting techniques among urban structures like the proposed one above and also the replacing of failed trees by new ones. To achieve this, all hands must be on deck that is the government, the community and every individual.

REFERENCES

Ashcroft P (2002) "Case study: walking the way to health initiative". *Summary of papers of the National Conference Green space and healthy living*, 14 May 2002, Manchester. National Urban Forestry Unit (NUFU), Wolverhampton Association." *Mediation Quarterly* 13 (2).

De Vries S (2000). "Regional differences in the demand for and supply of nature-based recreation within The Netherlands". In: Krishnapillay, B, et al. (eds) Forests and Soiety: the role of research. *Proceedings of the XXI IUFRO World Congress 2000,* Malaysia, 7–12 August. IUFRO/FRIM, Vienna/Kuala

Dorney, J R, Guntenspergen, G R, Keough, J R and Stearns, F (1984) "Composition and structure of an urban woody plant community". *Urban Ecology* 8, 69–90.

Grahn P, Stigsdotter U (2003) *Landscape planning and stress*. Urban For Urban Green 2(1):1–18

Iverson, L R and Cook, E A (2000) "Urban forest cover of the Chicago region and its relation to household density and income". *Urban Ecosystems* 4, 105–124. James Publication

Lucas OWR (1991) *The design of forest landscapes.* Forestry Commission, Oxford University Press, Oxford Luft (ed) Umweltmeteorologie. VDI-Schriftenreihe 15, pp 87–104, (in German).

Nowak, D and Dwyer, J (2000) "Understanding the benefits and costs of urban ecosystems". *In Handbook of Urban and Community Forestry in the Northeast.* pp. 11–25. Kluwer Academic/

Nowak, D.J., Crane, D.E., Stevens, J.C., Ibarra, M., (2002). "Brooklyn's Urban Forest". United States Department of Agriculture, Forest Service, North-Eastern Forest Experiment Station, *General Technical Report* NE-290. Radnor, Pennsylvania.

NUFU (1999) "Trees and healthy living". *Proceedings of National Conference, Wolverhampton, UK, 17 November 1999. National Urban Forestry Unit,* Wolverhampton

Oke, T.R. (1982) "The Energetic Basis of the Urban Heat Island", *Quarterly Journal of the Royal Meteorological Society,* 108 (455): 1-24.

Parsons R, Tassinary LG, Ulrich RS, Hebl MR, Grossman-Alexander M (1998) The view from the road: implications for stress recovery and immunization. *Journal of Environ Psychol* 18:113–140

Pitt, D, Soergell II, K and Zube, E (1979) "Trees in the city". *In Nature in Cities:* The Natural Environment in the Design and Development of Urban Green Space. (ed.) I Laurie, pp. 205–229. Wiley, Chichester, New York.

Santamouris, M. (2001) *Energy and Climate in the Urban Built Environment,* London, James & Savings of High-Albedo Roofs", *Energy and Buildings*, 25: 117-126.

Schmid, J A (1975) *Urban Vegetation.* The Department of Geography, University of Chicago, Chicago.

Shaw, W W, Harris, L K and Livingston, M (1998) "Vegetative characteristics of urban land covers in metropolitan Tucson". *Urban Ecosystems* 2, 65–73.

Stewart H, Owen S, Donovan R, MacKenzie R, Hewitt N (2001) *Trees and sustainable urban air quality.* Brochure, Lancaster University and Centre for Ecology and Hydrology, Lancaster

Talarchek, G M (1990) "The urban forest of New Orleans: an exploratory analysis of relationships". *Urban Geography* 11,65–86.

Ulrich RS, Simons RF, Losito BD, Fiorito E, Miles MA, Zelson M (1991) "Stress recovery during exposure to natural and urban environments". *Journal of Environ Psychol* 11:201–230

United Nations Human Settlements Programme UN-HABITAT; (2009): "Structure Plan for Awka and Satellite Towns, Nairobi, Kenya." Website: http://www.unhabitat.org

Whitford V, Handley J, Ennos R (2001): "City form and natural process – Indicators for the ecological performance of urban areas". *Landscape Urban Plan* 57:91–103

Xiao Q, McPherson EG, Ustin SL, Grismer ME, Simpson JR (2000): "Winter rainfall interception by two mature open-grown trees in Davis, California". *Hydrol Process* 14:763–784

Zipperer, W C, Burgess, R L and Nyland, R D (1990): "Patterns of deforestation and reforestation in different landscape types in central New York". *Forest Ecology and Management* 36, 103–117.