PREPONDERANCE OF TREES IN URBAN RESIDENTIAL NEIGHBORHOODS: A COMPARATIVE ANALYSIS OF SURULERE AND SOMOLU NEIGHBOURHOODS, LAGOS, NIGERIA

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ABSTRACT
Large urban trees are excellent filters for urban pollutants and fine particulates. Nevertheless, urban trees face a severe limitation of space and exceptionally stressful environment. In Lagos, uncontrolled land-use for development has relegated trees to a lower priority and intensified urban impacts on them. This study evaluated the impact of urbanization within a selected area in Somolu local government areas. High-resolution Aerial photographs and WorldView03 imageries were downloaded and analyzed using ArcMap 10.6 and ENVI 5.2 software to examine the changes within two time periods (1988 and 2019). Ten classes of features were extracted. Areal change and overlay analysis were used to investigate the impact of urbanization on tree space while structure questionnaires were used to assess residence perception on arboriculture practice. The result showed that there was an increase in built area with 17.15 ha of which 1.3 ha were tree space in 1988 for Somolu and 7.26ha increase in Surulere with 1.11ha were tree space in 1988. Road network also benefited from tree space with 0.19 ha and 1.2 ha in Somolu and Surulere respectively. This has widely damaged roadside trees and frequent roadside trenching associated with social utilities result in massive root damages which was also a major concern in the neighbourhood. This paper also noted that the neighbourhood was aware on tree planting but perceived that it is not of a concern to them, therefore they do not practice arboriculture. Hence, suggests that the public should be enlightened on the importance of trees within the community.

Keywords: Trees, Urbanization, Landuse, Lagos.

INTRODUCTION
Urban forests are ecosystems characterized by the presence of trees, community parks, woodlands, nature reserves, agricultural lands and other vegetation in association with human developments (Nowak *et al.*, 2001). A wide variety of

green spaces of different sizes could help solve many urban diseases and improve the quality of life for urban residents, as urban green spaces or provide a wide range of ecosystem services which is also an essential element in maintaining the urban ecological environment and human well-being (Wolch *et al.*, 2014). They play vital roles as filters and sinks of some gases in the environment. This is evident in their natural process of life as they absorbed carbon dioxide in exchange for oxygen which is needed by man for survival (Liu and Ding, 2008, 2008). Also, trees give visual indicator of toxic environment with the condition of the trees and this is because some tree species react to gasses and particulates pollution with higher sensitivity than man (Joshi *et al.*, 2009).

Trees provide a passive system for collecting pollutants for chemical analyses and obtaining direct identification of different pollutants on the basis of plant species and variety affected (Sikora et al., 1995). Also, a large number of trees and shrubs have been identified and used as dust filters to check the rising urban dust pollution level (Rai et al., 2010). Trees found around streams provide all of these functions and more. Urban forests, especially those around streams and drainage ways, are most important because they provide the city their first line of defense against natural disasters such as flooding and mudslides (Tollan, 2002). However, trees in urban areas have been relegated due to urbanization and infrastructural development.

Urbanization has both direct and indirect negative effects. The direct effect involves the physical loss of natural or cultural landscapes as well as agricultural lands while the indirect effects is associated with the sealing of surfaces, fragmentation of landscape and decrease in biodiversity (Bochaca and Puliafito, 2007). Urban areas are highly congested and densely populated with various kinds of commercial and industrial activities which increases demand for land. Also, the activities within the urban area usually demand for infrastructural development such as expansion of roads, laying of underground pipes, telecommunication mass etc. which would in one way or the other involves the transformation of land cover in order to meet the demand for space as land is fixed.

Both conversion of land cover and changing management intensity influence the functioning of ecosystems, the services they provide to society (Faleyimu, 2014) as well as their biodiversity (Nowak *et al.*, 2010). The quest for growth and development has led to the relegation of trees as vital component of the environment as trees are cut down and spaces meant for plants are used for urban purposes. Although several studies have shown that the urban area is expanding towards the natural landscapes but there are limited researches with regards to the rate of trees/ green space lost and the perception of people towards these trees.

Lagos State Government (LSG) launched a campaign advocating for tree planting in July 2009, but according to Soladoye and Oromakinde, there was high mortality rate of these new species of trees and poor management trees which implies that the problem is not about planting but the management and people's attitude to it matters. Therefore, an assessment of people perception and awareness of the importance of trees benefits accrued to it becomes necessary. To this end this study aims to assess the changes in trees and green space between 1988 and 2019 and evaluate the perceived benefit and/or concerns of trees to the neighborhood selected area of Somolu and Surulere Local Government Area (LGA) of Lagos state.

THE STUDY AREA

A comparative study was done in Somolu and Surulere Local government area (LGA) in Lagos Nigeria. Akoka neighbourhood was selected in Somolu, while Itire/Idi Araba neighbourhood was selected in Surulere. Akoka lies between longitude $3^0$23'20.0"E to $3^0$23'56.4"E of the Greenwich meridian and latitude $6^0$31'26.3"N to $6^0$31'48.0"N of the equator while Itire/Idi Araba lies on longitude $3^0$20'57.4" to $3^0$21'30.5"E of the Greenwich meridian and latitude $6^0$30'42.7"N to $6^0$31'6.2"N of the equator ((Figure 1).

Both areas cover 74.01 ha. They have mixed of commercial, residential, institutional and transportation Landuse/Landcover that are dominated by residential areas. Among the main locations around the Akoka neighbourhood include Morounfolu Street, Community road, Afolabi Brown Street, Obadiah Street, Tunde Bello Street to mention a few; while for Idi Araba/Itire neighbourhood are Lawani Street, Owodele Close, Atunrase Street and Ishaga Road.

Figure 1: The Study Area

DATA AND METHODOLOGY

The Remotely Sensed Data and their Pre-Processing

Both spatial and non-spatial data were adopted for the study. The trees in the neighborhoods were inventoried on the large-scale aerial photographs of the areas for the period 1984 and the WorldView-03 (WV03) image of 2019 (Table 1). The remotely-sensed images were backed up with direct field enumeration in 2019, and from which identifiable changes in both the number and some of the tree characteristics were established. The field exercise involved additional image interpretation tasks, geo-positioning using sets of GPS, and further data collection from the residents on the objectives of the study and the landuse/landcover chronology of the respective regions with a questionnaire adopted (Appendix 1).

Table 1: Sensor system characteristics of remote sensing data used in the study

Type of data	Identification/ Coverage	Spectral Resolution	Scale/ resolution	Date	Source
Aerial Photography	88711.51 (Akoka) 88711.53 (Idi Araba)	Panchromatic	1:4000	1988	Dept of Geography UNILAG
Satellite Image	WorldView Image 03(WV03)	Multispectral	34cm	2019	Digital globe
Questionnaire		Study Area		2019	Field Work

Archival data and topographic maps of the two areas were used to generate the land use and landcover on the remotely-sensed data. First, the aerial photographs and topographical maps were scanned to the image data format that is acceptable in the Arc-GIS environment. Geometric corrections for multi-temporal change detection were then embarked upon on the images including image-to-image rectification and image-to-image registration. Thereafter, the images were geo-rectified for planimetric accuracy using Universal Transverse Mercator (UTM) projection, Clarke 1880.

The satellites images were opened directly within the Arc-view software environment (Figure 2). Principal component analysis (PCA), a multivariate statistical technique that transforms original remote sensing datasets into smaller pixel sizes, was used to enhance the images for interpretation (Figure 3) Linear enhancement of 2% was done to pan sharpen the imagery. This method has proven better performance when compared with other change detection techniques in view of its simplicity and capability for information enhancement (Li and Yeh, 1998; Lu, *et al*, 2005, Jinsong, *et al.*, 2019). Thereafter, a hierarchical classification scheme which takes into consideration the characteristics of the multi-source and multi-temporal data, and the geographical setting of the study area was developed.

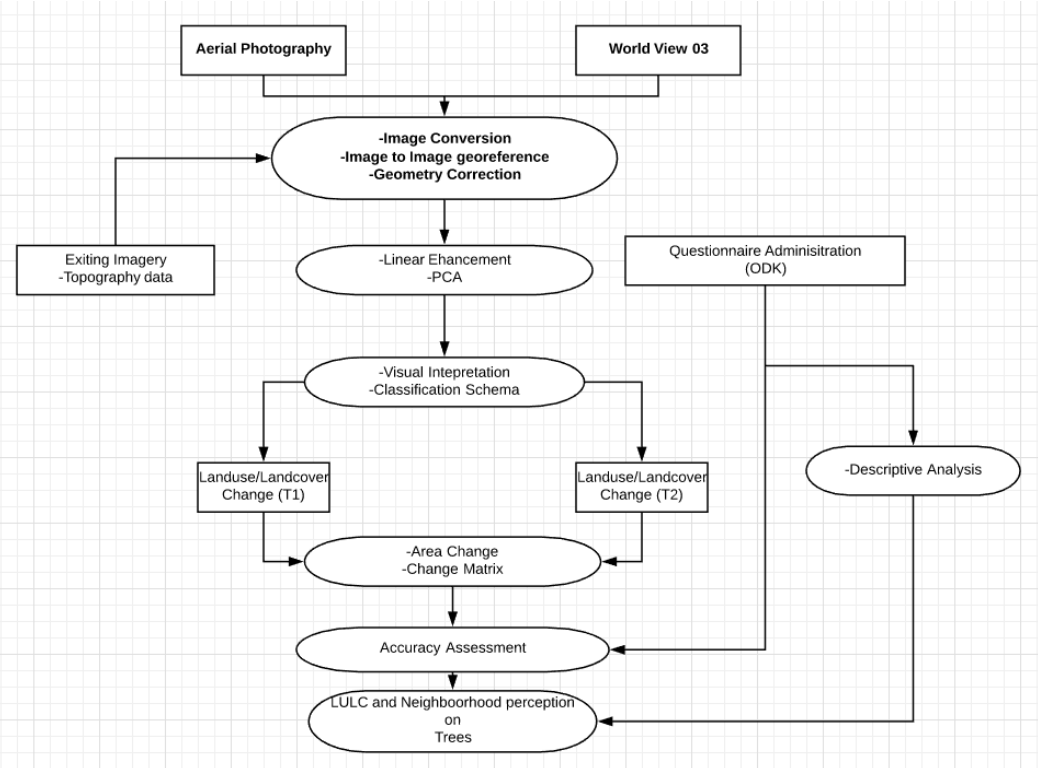
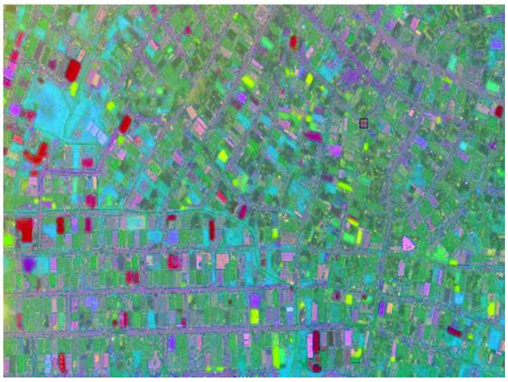
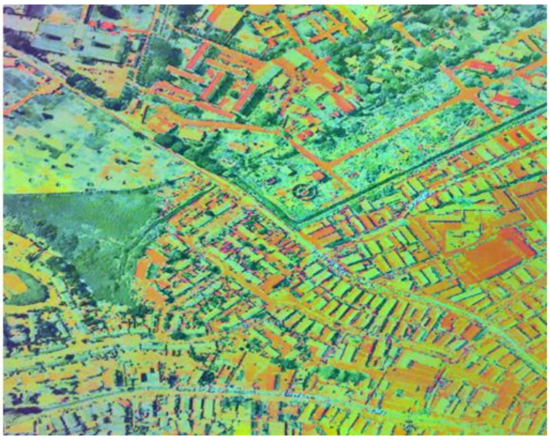


Figure 2: The Methodology Flowchart

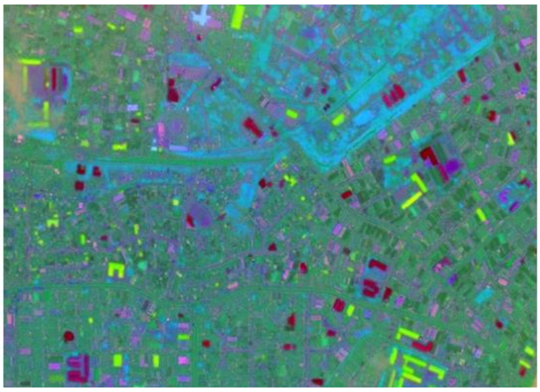
Fig. 3a: The Akoka Paned Aerial photograph The PCA-enhanced aerial photography

(3b) The Akoka Worldview03 Image **The PCA-enhanced Worldview03 Image**

(3c) Idi Araba paned Aerial Photograph **The PCA-enhance aerial photograph**

(3d) The Idi Araba Worldview03 Image **The PCA-enhanced Worldview03 Image**

Figure 3: The Remotely-sensed Images adopted and their respective PCA-Enhanced Image

Interpretation of the Imageries and Analysis of the Data

Topology of point, line and polygon were extracted from aerial photography and SPOT imagery visually. A classification schema (after Anderson *et al.*, 1976 classification scheme) was developed to harmonize the classes present on the image based on the composite images (Table 2). The minimum mapping unit (MMU), a 1:800 MMU was used to extract topology feature. Trees are often spaced apart depending on their mature canopy spread. Spacing of 12m - 19m was used to identify multiple trees for the study (after Christoph Krieger, 1998), while trees with lesser distance apart were classified as single trees (after Edward & Traci, 2007).

Table 2: LULC Classification Scheme

Code	**Level 1**	**Code**	**Level 11**	**Description of classes**
1	Urban	11	Buildings	This consist of completed buildings, uncompleted buildings, Foot path, Minor roads and Major road
		12	Uncompleted Building	
		13	Transportation	
2	Trees	21	Single trees	Trees within the proximity of 12-19 meters close were dissolved as multiple trees while stand-alone trees were trees that are far apart. These are areas covered by broad leaved evergreen and deciduous forest areas of height between 3-5m. These include light and heavy, gallery, palm and montane forest.
		22	Multiple Trees	
3	Water body	31	Lagoon	This includes all streams, ponds, lakes, dams and river within the study area.
		32	Drainage/Canal	
4	Agricultural Land	41	Farm Lands	This includes areas covered by all form of agricultural practices involving tillage including both plots with regular shapes and irregular shapes.
5	Wetlands	51	Marsh	This includes marshes, mudflats, and swamps situated on the shallow margins of bays, lakes, ponds, streams, and manmade impoundments such as reservoirs.
6	Barren Land	61	Open space/Bare surface	This include open space, sandy areas bare exposed rocks and transitional area

Accuracy assessments of the systems was achieved through the confusion error matrix for the information generated from topogrpahical maps while the accuracy of AP LULC classification while fieldworks were carried out with GeoODK form to validate LULC for 2019. A sample size of 100 locations/points were sampled using the stratified systematic technques for both locations. Kappa coefficient (K) was used to establish the pixels values per class (after Congalton and Geen, 1998; Congalton, 1991). The Kappa accuracy assessment was good with 0.76 and 0.71

for the aerial photographs, and 0.80 and 0.84 for WV03 in the Somolu and Surulere study areas respectively.

Change analysis

Change analysis was carried out, after Jinsong *et al.* (2019), using the two time-period of 1984 maps and 2019 remote sensing images in the GIS environment. The parameters measured included changes is expanse of LULC, the change direction, trajectories of the use/cover types and accuracy of detection assessment. The change maps were generated and the squared matrix table showing the absolute values and proportions.

Perception Analysis

Knowledge and perception of the people on the importance of urban trees, the planting and green space within neighborhoods were determined using a systematic random sampling technique over four quadrants created for the exercise. Each quadrant was established to have about 300 houses. A total of 60 households were sampled for the questionnaire survey adopted using the Open Data Kit (ODK) tool (after Andreas *et al.*, 2016, Maduka *et al.*, 2017). The design served the purpose of linking the survey responses with locational characteristics and accuracy assessment of the interpreted imageries.

RESULTS AND DISCUSSION

Landuse/Landcover pattern for 1988 and 2019

Built up areas dominated the landuse pattern in the two sub-study areas over the 1988 and 2019 study periods (Figure 3). Respectively, they accounted for 42.78 ha (57.73%) and 53.70 (57.73%) in Somolu but and 47.21 ha (63.72%) and 48.77 ha (65.83%) in Surulere (Table 3). Comparatively, the results showed more single trees in Surulere with 2.17ha (2.93%) in 1988 and 2.33ha (3.14%) in 2019 as against the 0.20ha (0.27%) and 1.37ha (0.27%) of Somolu. Multiple trees cover also showed the same pattern.

Figure 3(b): The generated LULC of Somolu in 1988 & 2019

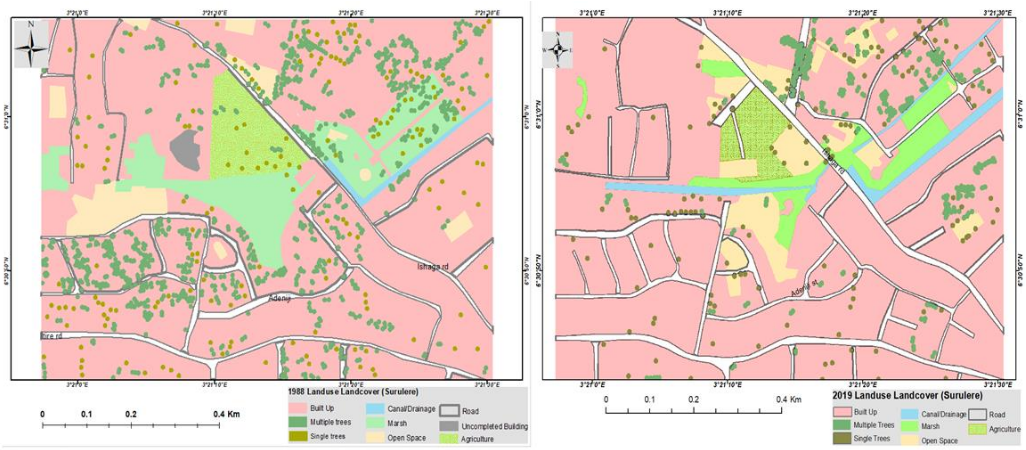


Figure 3(b): The generated LULC of Surulere in 1988 & 2019

The Change Results

Results of the changes in areal extent over the two periods are shown in Table 4 and Figure 4 for Somolu while that for Surulere are shown in Table 5. Multiple trees in Somolu lost about 2.49 ha of its initial area in 1988 to built-up (1.26 ha), road network (0.19 ha), single trees (1.02 ha). Single trees lost 0.19 ha mostly to built-up areas (0.17 ha), with a meager 0.1ha each to Open Space and Roads. As shown in Figure 5, built up areas and roads had more positive gains while marshes and the lagoon recorded the highest losses.

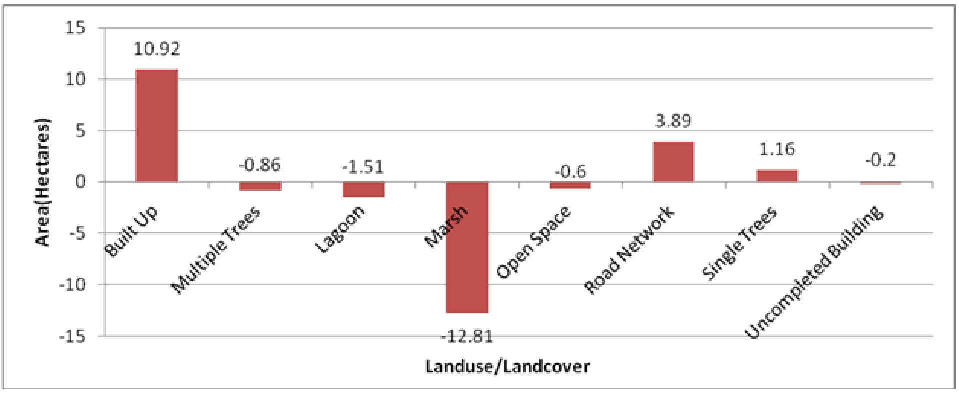


Figure 4: The LULC changes for the Somolu sub-Study Area, 1988 – 2019

Table 4: The derived LULC Change matrix for Somolu

		2019									
		Built Up	Multiple Trees	Lagoon	Marsh	Open Space	Road Network	Single Trees	Uncompleted Building	Total	Loss
1988	Built Up	36.55	1.02	0.01	1.09	0.07	3.47	0.22	0.32	42.78	6.2
	Multiple Trees	1.26	1.04	**0.01**	**0**	**0.01**	**0.19**	**1.02**	**0**	3.52	2.49
	Lagoon	1.32	0	0.22	0.14	0	0.16	0.01	0	1.81	1.63
	Marsh	11.11	0.61	0.06	4.65	0.2	1.78	0.1	0.21	18.72	14.07
	Open Space	0.66	0	0	0	0.17	0.16	0	0.08	1.07	0.9
	Road Network	**1.83**	**0**	**0**	**0**	**0**	**3.24**	0.01	**0.04**	5.13	1.88
	Single Trees	0.17	0	0	0	0.01	0.01	0.01	0	0.2	0.19
	Uncompleted Building	0.8	0	0	0.03	0	0.02	0	0.01	0.87	0.85
	Total	53.7	2.67	0.3	5.91	0.47	9.01	1.37	0.67	74.1	
	Gain	17.15	1.63	0.08	1.26	0.29	5.79	1.36	0.65		

For Surulere, multiple trees also lost to Marsh (2.79ha), road network and single trees (1.2ha each). (Table 5 and Figure 8). Also, single trees lost 0.19 ha which benefited built-up with 0.17 ha. Other land use also witnessed changes with built-up areas, open space and road network with 5.79 ha. Marsh recorded the highest loss (Figure 5).

Table 5: LULC confusion matrix for Surulere

		2019										
		Agric	Built- Up	Canal/ Drainage	Multiple trees	Marsh	Open Space	Roads	Uncompleted Building	Single Trees	Total	Loss
1988	Agric	**1.47**	0.25	0	**0**	0.05	0.93	0.09	0	**0**	**2.79**	1.32
	Built Up	0.04	**41.51**	0.25	**0**	0.41	1.59	3.41	0	**0**	**47.2**	5.7
	Canal/Drainage	0	0.01	**0.42**	**0**	0.04	0	0.02	0	**0**	**0.49**	0.07
	Multiple Trees	**0**	**0.11**	**0.00**	**2.79**	**0**	**1.2**	**1.2**	0	**1.18**	**6.48**	3.69
	Marsh	0.14	1.98	0.69	**0**	**2.04**	1.29	0.16	0	**0**	**6.3**	4.26
	Open Space	0	2.03	0.16	**0**	0.02	**0.67**	0.35	0	**0**	**3.23**	2.56
	Road	0	1.55	0	**0**	0	0.31	**3.2**	0	**0**	**5.06**	1.86
	Single Trees	**0**	**1.01**	**0.01**	**0**	**0**	**0**	**0**	0	**1.15**	**2.17**	1.02
	Uncompleted Building	0	0.36	0	**0**	0	0	0	0	**0**	**0.36**	0.36
	Total	1.65	48.96	1.54	**2.79**	2.61	4.78	7.22	0	**2.54**	**74.1**	
	Gain	0.18	7.26	1.15	0	0.52	5.32	5.23	1.18	0		

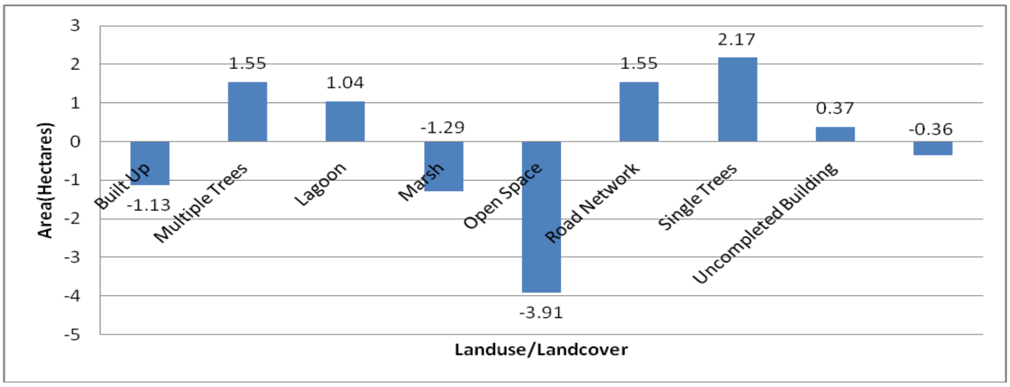


Figure 5: The LULC changes for the Somolu sub-Study Area, 1988 – 2019

Peoples' Perception of the Urban Trees

There is an appreciable perception of the changes in the availability of the urban trees in both sub-study areas. As shown in Figure 6, 49.3% of the respondents in Somolu and 64.3% in Surulere noted that the trees were on the decrease over the periods of study while only 10.7% thought otherwise in both neighborhoods.

Awareness of tree planting campaigns by the state government in particular is established to be higher in the Somolu neighborhood with 71.2% of the informants attesting to this. The figure is low in Surulere with just 42.9%. This is justifiable in view of the dominant types of development in the two areas, whereas more buildings in the Surulere axis are mono-family occupied and fenced up. Nonetheless, the informants complained of not being carried along on the campaigns thereby affecting the success being recorded. Only 21.4% in Surulere and 7.1% in Somolu opined that the tree campaign programmes are desirable beautification programmes for their communities while 7.2% in each area applauded these as innovative. Some 28.6% in Surulere and 14.3% in Somolu perceived the exercise as shear waste of resources.

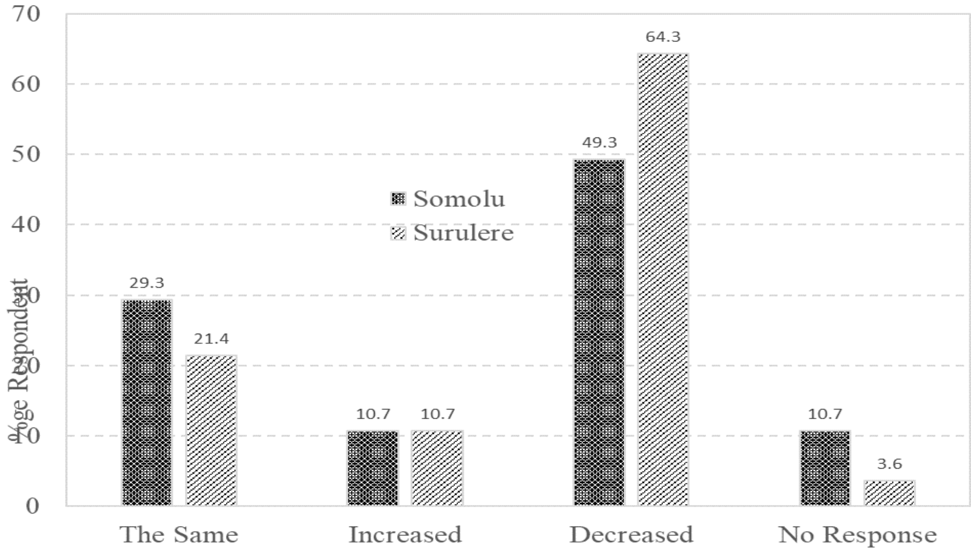


Figure 6: The Respondents' Opinions on the Urban Status

The results suggest that the residents are in support of cultivating trees in urban areas, are willing to participate in public tree planting programs and also cultivate trees in their compounds if so encouraged. This corroborates some findings for other cities in Nigeria, Ghana and Democratic Republic of Congo by Faleyimu, 2014; Faleyimu and Akinyemi (2014), Mills *et al*. (2016), Etshekape *et al*. (2018), Sy *et al*. (2014) and Nero *et al*. (2018).

The justifications provided for their supporty include improved aesthetics, cooling the surrounding environment, reduction of flooding and storm damages, increased infiltration properties, enhanced soil nutrients and provision of habitats for birds amongst other organisms (Table 6). A main challenge to the support by the residents however is on availability of spaces for such as most plots are fully utilized for structures while the required open spaces by planning authorities are hardly adhered to. Some levels of concern were raised as presented in Table 7 including potential damages by falling trees to human lives, buildings, surface transmission lines, drainages depending on the tree species, density and maintenance.

Table 6: Perception on the importance/benefits of trees

	No Benefit	Minor Benefit	Major Benefit	Indifferent	Total Respondent
Helps cools the environment	3	21	34	2	60
Improves the appearance of a property	8	23	20	9	60
Improves appearance of neighbourhood	4	13	37	6	60
Provides a sound barrier	11	29	12	8	60
Improves appearance of commercial areas	13	26	14	7	60
Improves property values	11	17	25	7	60
Reduces flooding from rain	7	14	28	11	60
Provides nutrients to soils	7	15	27	11	60
Removes carbon from atmosphere	9	16	26	9	60
Provides habitat for birds and wildlife	12	21	24	3	60
Total	**85**	**195**	**247**	**73**	**600**

Table 7: Concerns about tree planting in the urban area

	No concern	Minor concern	Major concern	Indifferent	Total Respondent
Blocks views	15	21	17	7	60
Damage from falling branches	21	29	7	3	60
The effort to clean branches & leaves	10	26	20	4	60
The effort to remove leaves from gutterstress	17	18	20	5	60
Risk of forest fire	14	24	15	7	60
Makes yard too dark	22	25	10	3	60
Causes moss to grow on roofs	9	38	9	4	60
Damage to power lines	8	20	32	0	60
Damages created when roots enter pipes and drainage, building's foundation	8	24	28	0	60
Total	124	225	158	33	60

5.0 CONCLUSION

The study revealed that the geographical areas for trees and green spaces have lost considerably to expansion of built-up and road construction in both Somolu and Surulere study areas over the study periods of 1988 to 2019. It also established the local perception on urban trees in terms of provision, benefits and disbenefits to residents. It is evident that the neighborhood will trade their support urban trees campaigns and programmes if they are carried along and given appreciable sense of belonging. The findings suggest a significant need to monitor trees reduction within the neighborhoods. There is also the need for improved sensitization of the populace on the importance of the trees within the typical built-up environment, addressing their ecosystem needs/concerns and also involving them in purposeful tree planting campaigns, preservation and natural space conservation.

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