



Urban Greenery a pathway to Environmental Sustainability in Sub Saharan Africa: A Case of Northern Nigeria Cities

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ABSTRACT

The Northern Region of Nigeria, which is located south of Africa biggest desert - the Sahara, is highly vulnerable to adverse impacts of climate change for some reasons. This paper attempts to review the variance between urban greenery, urban development and the quest for environmental sustainability. A critical review of relevant materials related to the study was carried out. The quantitative nature of the study was backed empirically. Findings from the study reveal that physical development plans for some urban areas have been very ad-hoc and loosely defined. Allocation of open green spaces is not in harmony with the urban population and it mostly characterized by a low percentage. Abuja master plan, for instance, has the highest allocation of 32.87%, while allocation in other master plans fall below 30% with Suleja master plan counts 2.5% only. Outdated master plan and the lack of will power from urban authority in plan implementation has often resulted in the distortion, encroachment, and conversion of green areas to other land uses. Increase carbon emission and pollution especially from the transport sector has been marked by a decline in greenery. Therefore, reducing the sequestration capacity of the urban area, weak urban planning and harsh climatic condition could be regarded as critical challenges. This study suggests the strict adherent to sustainable urban planning that integrates physical development and environmental consideration to enhance greenery. The study also recommends the placement of urban greenery on the same platform with the urban grey infrastructure by urban stakeholders.

1. Introduction

The rapid trend of urbanization coupled with the rate of urban growth in third world countries of sub-Saharan Africa remains a major challenge in the quest for urban environmental sustainability. On the global front, projected urban population by 2050 will surge up to 70 percent of world population (Seto & Shepherd, 2009). It is estimated that 90 percent of the urban population increase will take place in Africa and Asia (UN, 2014) with sub-Saharan Africa region leading across the continent. Evidence of fast urbanization and urban expansion remain visible in the region as agglomeration continues to attract physical expansion and a large scale proportional increase in demographic size over the years. As urban areas in the region continue to grow in the demographic and infrastructural basis, the environment becomes very much threatened due to intense human activities. As urbanization in Africa is marked by steady physical expansion which often surpasses formal urban planning system. This is resulted in the encroachment and conversion of rich natural green areas depicted in form of wetlands, farmlands, water bodies and earmarked open spaces within and away the urban area to residential and other uses (Amoako & Cobbinah, 2011; Angel et al., 2005; Karen, Güneralp, & Hutyrá, 2012; Watson, 2009). This negative trend of urbanization has stimulated broad interest in the planning and evaluation of urban environmental quality in order to meet

up with the yearning for environmental sustainability. The broader concept of sustainability plays a key role in urban planning and considered to be an important paradigm in urban development.

Urban greenery as a process, approach and a concept are synonymous with urban green space, urban green infrastructure, urban natural vegetation and organized open space. All are geared towards livable and sustainable human settlement. Urban greenery may be considered as a means of nurturing and enhancing the urban natural green space or infrastructure which may be very significant to people and the environment. The urban green spaces covered by lawns, shrubs, and trees in highly human alter ecosystem and are well recognized and organized to have a sequestration capacity to carbon emission (Dobbs, Escobedo, & Zipperer, 2011). Furthermore, urban green spaces comprise of both natural and semi-natural open spaces in towns and cities. They are primarily covered by vegetation that may be available for human usage (Jim & Chen, 2003). The urban green spaces stand as a very important environmental asset that covers areas of the urban land scape in different proportion. This space maybe natural or semi-natural forms in nature and may include parks, gardens, allotments, wetlands, playing fields, open space trees and forest (Mensah, 2014). The entire concept of urban greenery is an integrated approach that involved the planting and careful management of the vegetation stock

within the urban area. It may include the aspect of urban forestry, urban agriculture, urban park and botanical garden. Above all, urban green space can simply be considered as the composition of the natural landscape in an urban area. It may help in regulating the biodiversity of the urban environment and is of social economic and health value to human. The high ecological impact on urban life from urban green spaces has contributes greatly to public health, improved life quality of the urban dwellers through recreational activities, aesthetic comfort and psychological wellbeing (Jim & Chen, 2008). On the global front urbanization and development activities stimulated by fast growing population have impacted negatively and reduced natural vegetation cover of human settlement (Heimlich, 2001; Kaya & Curran, 2006). A study by Honu, Chandy, and Gibson (2009) revealed that rapid urbanization trend has led to the conversion of mass urban lands for development purposes which has consequently resulted in the destruction of the natural ecosystem and green spaces. In United States of America McDonald, Forman, and Kareiva (2010) observed and established a loss of an estimated 1.4 million hectares of green spaces due to rapid urban development. On the global front urbanization remains a major predictor of urban green open spaces, though the magnitude of this negative trend tends to vary from place to place. In developed countries and emerging economy of the world, concise efforts have been made over the years to balance between urban growth and open green spaces. However, the destruction and shrinking of urban green space in sub-Saharan Africa are right on alarming proportion. For example, a study in Lagos-Nigeria, Dakar-Senegal, Accra-Ghana, and Freetown- Sierra Leone, revealed that fast urbanization is a major cause of conversion of many earmarked green areas for infrastructure development in order to cope with the increase in urban population (Fuwape & Onyekwelu, 2011). Over the years, the emphasis has been on meeting the infrastructure needs of the growing urban population in the region. Urban managers have placed emphasis on the brown agenda of the cities at the expense of green agenda. The brown function of any city may greatly degrade is green resources (UN, 2009). On a similar note Daramola and Ibem (2010) pointed rapid urban development in Nigeria cities as a reason for the lack of green space. They further revealed that about 40,000hectares of green areas are lost annually and the loss is attributed to development purposes and household dependable on fuel woods for domestic consumption in both rural and urban settlement.

A perspective of northern Nigeria cities over the years has revealed a challenging scenario of rapid lost in green areas due to pressure from intense human activities. Urban areas in Nigeria northern region like many African cities have witnessed physical expansion that has affected their resiliency (Cobbinah, Erdiaw-Kwasie, & Amoateng, 2015). For example, the morphology of Kano city has shown a drastic change in its landscape as evidence of mass reduction of open spaces and green areas which are followed by persistent seasonal flooding over the years (Barau, Maconachie, Ludin, & Abdulhamid, 2015). Katsina another traditional city in Northern Nigeria has witnessed a conversion of Fadamas, floodplains, wetlands, gardens and forest areas to residential development purposes (Ruma & Sheikh, 2010). On the same note, one and only Modoji forest reserve in Katsina urban area has 60 percent of trees cleared in order to pave the way for development purposes (Iguda Ladan, 2014). Kaduna which is third to Kano in terms of population in Northern Nigeria is also prone to this negative trend. In a study by (Ifatimehin, 2008) shows that from 1990-2000 green areas in Kaduna urban areas are declining steadily. The study revealed that an estimated 297.5hectares of vegetation are lost annually due to urban development as the city continues to expand at a rate of 167.8hectares annually. The

encroachment of built up areas along the flood plain of Kaduna River in the city is an example. Between 1976 and 2010 an estimated 3,350 hectares of the floodplain was taken over for physical development purposes (Opatoyinbo, Adepetu, & Abdullahi, 2015). The case of other towns and cities in Northern Nigeria is not far from the examples above. The negative approach towards urban greenery and the continue destruction of existing green areas in the region may be attributed to the poor land use planning system. The land use planning practiced in urban planning for sub-Saharan region has been criticized in studies by Egbu (2007), Kironda (2006) and Watson (2009). The inability of the land use system to regulate urban growth and improve urban welfare was the reasons for their criticism. Land use planning is seen globally as a vital tool in defining and safeguarding green infrastructure and its ecosystem activities over a long period(Benedict & McMahon, 2006; Glicksman, 2009). The week land use planning for the region has culminated into the growth of informal settlements. Urbanization in sub-Saharan cities is powerfully driven by informal settlements pattern (CLUVA, 2013). The ability of informal settlements to promote and enhance urban greenery remains very low. Therefore, the pathway to environmental sustainability using urban greenery as a platform is very challenging amid rapid informal urban growth in Northern Nigeria.

This paper aims to assess the variance between urban greenery and urban development and to ascertain its implications on the environmental sustainability in urban areas in Northern Nigeria. A general review will be focused on the following: looking at urban greenery within the provision of the land use plan for some urban areas, to look at urban transitions over the years and to determine the major environmental issues connected to climate change, greenery and sustainability and to suggest way forward towards promoting and enhancing urban greenery as a pathway to environmental sustainability and resilient urban development.

2. Approach and Study Area

The framework for this paper was drawn from an in depth review of related materials in line with the topic of discussion. Based on the aim and set out objectives, intensive search and review of relevant materials were done. The exposure and familiarization of authors with Nigeria Northern region have helped to logically affirm and refine all reviewed findings. The quantitative nature of the paper allows many reviews to dwell on the development master plan, journals, documented reports, books and government documents.

Emphasis was given on the review of existing development master plan of some urban areas in the study area. We considered the variables of duration of plans, the identity of open green spaces and percentage of land use budgeted. The reviewed journals, reports, and government documents were particularly focused on land use planning and urbanization, green open spaces, climate change and carbon emission, sustainability, and indicators. Finally, we carry out an extensive discussion based on extracts from review findings.

The Study Area, Northern Nigeria is commonly referred to as the Northern region, is an extensive land mass that substantially lies above the two Nigeria major Rivers Niger and Benue, and a small proportion of the area also found below the Rivers. See figure 1. The region is located south of the Sahara desert and extensively covers the Sahelian belt with an estimated area of 469,000sqkm, representing 51% of Nigeria land mass (Report, 2010). The region comprises of nineteen



Figure 1: Study Area and Nigeria Administrative Map
(Source: Africa Report, 2010)

states and Nigeria Federal Capital Territory, Abuja. Based on 2006 census figure, the region has a population of 75,025,166 million people representing 53.59% of Nigeria population (FGN, 2007). The agglomeration of urban settlements in northern Nigeria can be traced back to many years before the advents of the British Colony. Some major urban areas in the region include the following: Kano, Katsina, Sokoto, Kaduna, Abuja, Jos, Yola, Bauchi, Minna, Makurdi Maiduguri, Lokoja. Based on 2006 population census figure, Twenty-Seven town and cities in the region have a population of one hundred thousand people. Figure 1 showing Northern Nigeria region and other regions within Nigeria context.

3. Concept and theoretical framework of urban green space.

The concept of urban green space can be traced back to the urban open space planning concept of western cities during the industrial revolution era. This evolutionary trend that originated from the West attached much importance in earmarking of open spaces deep within existing human settlements. Down through the ages from medieval agora to renaissance city squares and baroque avenues. Each of the early civilization was developed around urban open space concept that was inclined to the existing socio cultural needs of the society. One major remarkable issue in modern city planning was "aesthetic". The aesthetic outlook of modern cities was connected to the availability of urban open space depicted in its green areas. The city park movement that was made populace by Fredrick Law Olstead in 1865 was a good example that carries out the New York City central park design (Mumford, 1961). The emergence of City park movement was seen as an environmental remedy to the problems emanating from the industrial revolution of the eighteenth and nineteenth centuries. The rapid urban congestion, depressed slums, pollution, and diseases are some of the notable problems the city park movement was a focus to tackle. The entire concept allowed nature to co-exist inside the densely populated cities and the pre-urban township of America. The organized open spaces and the existing natural recreation spaces were earmarked as escape exists

for people in search of psychological and social relief due to stress from the industrial Centre's. As form and pattern of American cities were sharpen by the city park movement, Ebenezer Howard in 1902 introduces the Garden City Concept in England. This concept was also developed on large scale integration of nature into the human settlements.

Public parks and private gardens in the form of the green belt were infused within the urban settlements, therefore, help to create harmony between man and his environment. The garden city concept was a workable solution to check the prevailing environmental ills resulting from the rapid industrialization of the nineteenth century in Europe. The city design takes into consideration ecological zones that enhance natural beauty and also function in cleaning and refining air which help in promoting the health of the city inhabitants. The neighborhood concept of urban design put forward in 1929 and was made popular by Bayer in 1965. Arthur Clarence who was a social worker developed the concept after taken his time to study the English garden city. He put forward six principles upon which the design of neighborhood should consider. Relatively to the urban green space, the concept makes provision for small parks and play areas for both adult and children relaxation and play.

The concept of integrating natural element into the environment globally influenced the renewal programs and the new town schemes of the twentieth century in Europe and America. The new town scheme and urban renewal program were earmarked to accommodate public green areas based on population parameters. For example in 1985 in Munich Germany the ratio of open green space per population was 300 people per planted hectare. While it was 2000 population/hectare in Mexico (Contreras, 1985).

The concept explained above have little or no any influence on the growth of towns and cities in Northern Nigeria. The commercial goal of white colonial masters in some regions of Nigeria was very clear. For example, the earliest influence of "City Park Movement" was seen in the establishment of cocoa and coffee plantation in western towns and cities in Nigeria. The focus was not towards urban greenery but it was driven for short term commercial gain by the colonial administration. Secondly, the high level of urban poverty in recent time has limited government at all level to be more concern on the provision of urban

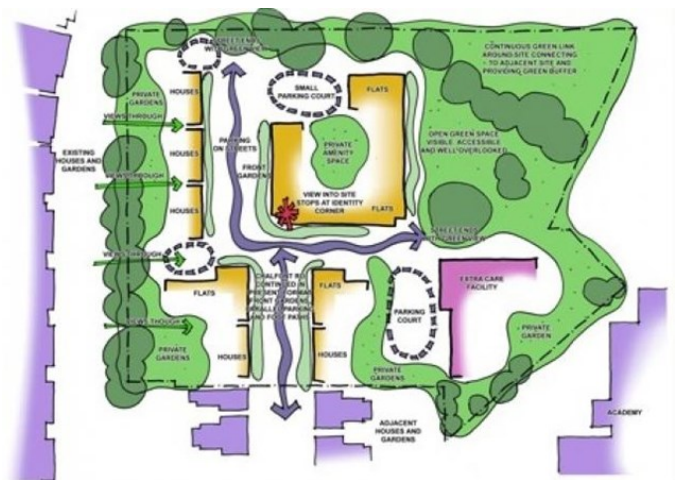


Figure 2: An illustration of a Green Neighborhood Concept
(After AR-Urbanism, 2010)

brown infrastructure, therefore, neglecting the provision of green open space. It must be noted that traditionally, the concept of urban design in Nigeria has greatly been characterized by the following features; City Wall, Gate, Central Square, Market square and Religion grounds (Achi, 2004). Formal organized green space was never seen as an isolated essential urban feature but was viewed as part of the natural farm land that makes up the general environment. (Figure 1. Shows the Green Neighborhood concept of 1929).

4. The Concept of Sustainable Development and Environmental Sustainability

The concept of sustainable development is basically to balance between economic prosperity, environmental quality and social welfare for the benefit of human wellbeing. Sustainable development is to address the need of the present without jeopardizing the ability of the future generations to meet their needs (WCED, 1987). This definition shows that the baseline for sustainable development is the need for proper integration of environmental management in the quest for efficient economic development across all sectors. The environmental component of sustainable development is a major concern for urban stakeholders' amid rapid urbanization trend in third world countries of sub-Saharan Africa. "Environmental sustainability" as a concept is defined as a condition of stability, resilience, and linkages that enable human society to meet its needs. Table 1 is a highlight of sustainable indicators from different authors which have direct link with greenery.

Table 1: Sustainability Indicators

No	Theme	Relevant Indicators	Sources
1.	Protection of the atmosphere.	<ul style="list-style-type: none"> Emission of Greenhouse gases e.g. CO2 Consumption of ozone depleting substance Ambient concentration of air pollutants in urban areas Emission of nitrogen oxides, Sulphur oxides and carbon Monoxide. 	Jackson & Roberts, (2000); UN (2007b); ESI (2005).
2.	Land	<ul style="list-style-type: none"> Fertile and available cropland area for agriculture. The land area covered by Natural Vegetation e.g. Forest. Land use change 	UN (2007b)
3.	Urban Environmental Quality	Public green area, neighborhood green area, Green-belt area, Green playground.	EuroStat (2001)
4.	Reducing Human Vulnerability	<ul style="list-style-type: none"> Natural disaster exposure e.g. Flooding, earthquake Percentage of people living in hazard prone areas. 	ESI (2005)
5.	Biodiversity	<ul style="list-style-type: none"> Terrestrial coverage under protection Threat to available Species, and Native Vegetation 	UN (2007b)
6.	Human Settlement development	<ul style="list-style-type: none"> Urban Population density Formal and Informal Urban Settlements. 	Jackson & Robert, (2000)
7.	Water	Water quality, underground water reserves and dissolved Oxygen in water.	ESI (2005), UN(2007).
8.	Human consumption and Production Pattern	<ul style="list-style-type: none"> Yearly energy consumption, Amount of energy used, waste reuse and recycle Modal split and urban transportation. 	UN (2007), EuroStat (2001).

A significant decline in urban green areas will have a multiplier effect on the range of environmental sustainability indicators on the table.

5. Urban Greenery and Urban Development Planning System.

The weak land use planning system in sub-Saharan Africa region remains very visible in many urban areas in Northern Nigeria. The failure of land use planning to regulate and control urban growth remains a major constraint to urban development in the region. This has further translated into inadequate and ad hoc provision of open green spaces in many urban development plans. The preparation of urban development plan in Northern Nigeria can be traced back to the British colonial era, while others are the product of the post-colonial administration. Tracing back the years, traditional cities in Northern Nigeria considered greenery in form of open space earmarked for agricultural farmland, a sacred shrine, cemeteries, city squares for traditional festivity. They usually function as market spheres, areas earmarked for Durbar, Hawwan Daushe and Nassarawa (Alabi, 2009) and were located in the front of the emir's place or any suitable area in the city. For example the sketch map of ancient city of Kano in 1826 and the geographical review map of 1937 shows the availability of sizable gardens, Marshes, Cemeteries and green open spaces within the built up areas of the city (Barau et al., 2015) this was the case with another ancient city within the region. However, the advent of the British colonial administration gave birth to the introduction of modern urban planning in some of the urban areas. The creation of European Reservation Areas (ERAs) was followed by proper layouts of buildings and the formal earmarked of open spaces. The ERAs were later renamed as Government Reserve Areas after the exit of the colonial masters. This area later becomes very outstanding and shows a high level of the green landscape for many Northern urban areas. However, as time passes by the destruction of this greenery became very eminent due to increase human activities and pressure from urban expansion. Another issue as noted by Falade (1998) was that the growth of urban areas across the entire country was without adequate provision of greenery in the form of parks.

A glance at an urban development plan for some urban areas in Northern Nigeria as shown in table 2, indicated the percentage of land use budget allocated for open green spaces. Based on the table a number of issues will be discussed with regard to the following: Nature of Green space allocation, the percentage of land use allocated verses the urban population, level of implementation and distortion of plans.

Allocation of urban green space has never been clearly defined in most of the plans the merging green spaces with other non-green urban elements and generally considered as open space, need to be clarified (Jiriko, 2014). Virtually in all the development plans, the open space was used in principle to represent the open green space. However, the word open space is too broad and ad hoc. Over the years, urban managers have found it very easy to extend physical development projects into this open spaces. The emphasis in urban development plans should be shifted from a broad open space to clear specification of soft open green space together with other related soft natural landscape elements. Only the Abuja and Zaria master plan captured terms like parks, open space, natural rock outcrops, and monuments. The planning concept that has upgraded greenery to a modern urban concept of green infrastructure has no place in many of the master plans as indicated in Table 2.

Table 2: Status of Provision for Urban Green Space in Selected Urban Master Plans in Northern Nigeria

No	Name of Master Plan	Period	Status of Master plan	*Urban Population as of 2006 Census	Nature of Green space	Percentage of land use budget
1	Kaduna Master Plan	1967-2017	Reviewed	1,652,844	Open space	4.48%
2	Akwanga	1978-1995	Need for review & update	113,430	Open space	19.00%
3	Jos Bukuru Metropolitan Master Plan	1980	Need for review & update	900,000	Open Space	5.0%
4	Nguru Master Plan	1976	Need for review & update	150,000	Fallow land and public open space	23.6%
5	Abuja Federal Capital City Master Plan	1980-2000	Partial review	3,000,000	Green Parks, open space, Rock outcrops	32.87
6	Nasarawa Master Plan	1978-1995	Need for review & update	189,835	Road and Open space	21.00%
7	Zaria Master Plan	1975-2000	Need for review & update	1,018,827	Parks, Play fields and open space	7.0%
8	Lokoja Master Plan	1975-2005	Need for review & update	195,261	Open space and Recreation	-
9	Bichi Master plan	1978-1995	Need for review & update	277099	Open spaces	8.0%
10	Sokoto Master Plan	1997-2010	Need for review & update	500,500	Green areas	11%
11	Suleja Master Plan	1986-2006	Need for review & update	216,578	Open spaces	2.5%
12	Gusua Master Plan	1997-2010	Need for review & update	201,200	Organized open spaces	4.1%
13	Dutse Master Plan	1997-2020	Functional	246,143	Organized open spaces	4.0%

This lack of upgrading to greenery in many of the master plans tend to buttressed CLUVA (2013) that pointed out that in Africa cities, the term urban green infrastructure has hardly been used over the years. Current principles for adaptation of green infrastructure planning were lacked in the broad and ad hoc open space that was considered as urban green spaces in the various development plans.

Another issue of consideration is the percentage of land use budget for urban green areas. Abuja master plan was the highest with 32.87 percent and followed by Nguru master plan with 23.36%. Others trailing from behind and can be considered as grossly inadequate. For example, Zaria with an estimated population of over one million people has a budget land use of 7% for parks, play fields, and open space. A critical consideration of urban green spaces base on rigid land use budget allocation as in table 1 tends to be deceptive and lack consideration for the urban dynamism of population. The fragile nature of the region and the need for environmental sustainability of urban areas, allocation for urban green paces should be guided by demographic parameters and not the rigid approach is shown in the table. Though, population per planned green spaces depend on some factors such as the city land scape, culture, social economic development and political consideration (Adejumo, 2003). The Urban population should be a major parameter of consideration. For example, a minimum of 10 hectares per 1000 person is the required standard in Hong Kong urban area (Guideline, 2016). In Scotland, 1 hectares per 1000 percent is required for natural green reserve in urban areas (Scottish, 2005). In 1995, the ratio of planned green spaces per population in Munich Germany was 300per hectares, while in Mexico it was 2000 people per hectare (Contreras, 1985). A

reviewed by the author shows that Kano a city with a population of 3,626,068 people in 2006(FGN, 2007) have four National parks only. Kaduna the former administrative headquarter of Northern Nigeria with an estimated population of 1,652,844 people in 2006 (FGN, 2007) have one natural park located at the city center. Jos the capital of Plateau state with a population of 900,000 people (FGN, 2007) have one wildlife park only. The story is not different for other urban areas in the region.

It must be noted that urbanization or urban growth in northern Nigeria is a reflection of the sub-Saharan African region in which demographic forces related to natural birth increase and the push-pull factor of rural-urban migration has always been the pivot. The rapid population growth may likely impact on the structure of the urban Centre's. The intake of new population triggers the expansion of land cover and the emerging of the new agglomeration which may likely alter the general morphology of existing urban areas. Therefore, the provision of open green spaces should be tired to the urban population. Understanding the trend of urban expansion and increase in population will greatly help in formulating a standard requirement ratio for open green space and demographic. This will greatly help to see that increase in open green space goes together with an increase in population and urban expansion. Above all, it will further enhance proximity and accessibility since distance or walking time from resident appeared as a major determinant for the use of open green space such as parked (Van Herzele & Wiedemann, 2003).

Another issue of concern is the level of plan implementation and distortion of the development plan. The open green space has never

been seen as part of urban development fabric that enhances human wellbeing especially in northern Nigeria. This may be attributed to high level of poverty. Low level of plan implementation is a common trend in most of the urban areas, therefore making it very difficult for achieving the set-out goal for open green space development as budgeted in the existing proposed plan. One major advantage of a guided land development lie in its ability to protect areas of great environmental significance (UN-Habitat, 2009). The low level of plan implementation may stand as a threat to urban greenery. Plan distortion is a reflection of a weak land use planning system of sub-Saharan Africa region (Dowall & Ellis, 2009). Though evaluation has shown a more prominent use of master plan as a tool for urban development in northern cities than the southern part of Nigeria (NITP). Distortion amid plan implementation has been the major challenges facing open green spaces. The distortion of Abuja master plan is a good example. The ministerial committee on illegal structures in Abuja 2003 identified encroachment into the earmarked open green areas in which 84 plots sub divided and allocated for residential development, in addition, another 30 neighborhood parks were converted to corner shops (FGN, 2006). The open green areas have always been the target of encroachment in many urban Centre's in Northern Nigeria.

6. Urban greenery, carbon emission, climate change and environmental sustainability

The linked between urbanization, carbon emission, and climate change is said to be intrinsic and phenomenally incline to human development. The record has shown that world cities are attraction poles for human agglomeration and large scale economic activities. Therefore consumed two-third of world energy and in return generating 70 percentage of global emission (World Bank, 2010). In general Africa, CO₂ emission is less than 4 percent of the general world emission, but the rate of emission has increase in recent years (MDG Report, 2013). Promoting urban greenery can greatly help in regulating rate of carbon emission and the adverse impact of climate change in northern Nigeria cities. A good number of urban centers in northern Nigeria are found within the frontline states adjoining the hottest and longest Saharan desert with an average annual precipitation of 600mm (Folaji, 2006). The entire region is said to be fragile and prone and vulnerable to desert encroachment. Urbanization and urban growth in the region have always been characterized by a drastic reduction of greenery. For example a study on morphology dynamics and environmental changes in Kano urban area shows a continue alteration of it green landscape from sizeable gardens, marshes areas and vast open green spaces to a sporadic and shrunk open green landscape depicted in form of urban cemeteries, and few public buildings providing open green spaces in the city (Barau et al., 2015). The loss of greenery in Katsina and Kaduna urban area was established by Iguda Ladan (2014), and Ifatimehin (2008).

A gradual decline in urban greenery may reduce the carbon sequestration ability of this urban areas, therefore, increasing the carbon foot print. In Nigeria, CO₂ has increased by about 54% within the interval of 25 years (i.e. 1980-2005) (FGN, 2006) and the trend has continued to rise steadily. High emission from the transport sector especially road transportation is recorded in Nigeria due to increasing use of fairly used vehicles and motorcycles in urban areas (OKhimamhe & Okelola, 2013). The mono centric land use pattern which is very common in many urban areas in the North has been the major cause of traffic congestion resulting to high emission. For example, a look at

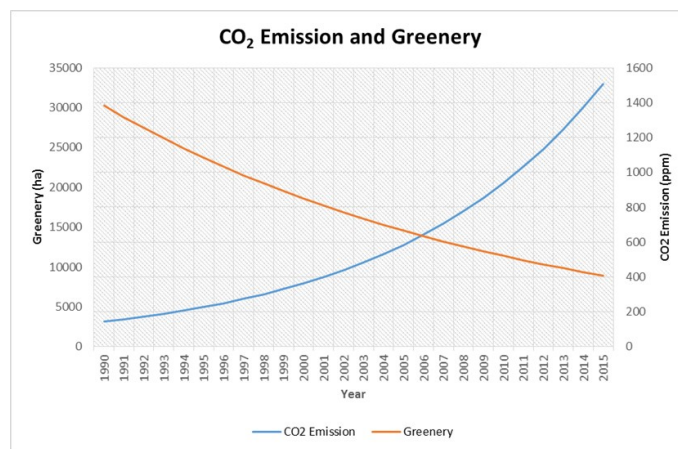


Figure 1: Relationship between CO₂ emission and urban greenery in Kaduna urban area.

Kaduna urban area as shown in Figure 1, we looked at the relationship between the steady decrease of urban greenery and the increase of carbon emission, especially from transport sector over a period of 15 years. The collapsed of textile industries and prolong short down of the Kaduna refinery due to lack of maintenance over the years are strong indicator that linked carbon emission to the transport sector in the city. Our findings show that the energy and industry sector in the city remain insignificant. Thus, we consider the contribution of energy and industry sectors on the release of CO₂ emission as trivial in the city. The CO₂ emission stems from transport sector is based on two sources that are, from the monitoring station data, and from the vehicle kilometer travel of various types of vehicles including private cars, commercial cars and buses, trucks, motorcycles, and tricycles. According to our estimation, based on the projected data in a period of 1999-2015, the relationship between CO₂ emission and urban greenery shown in Figure 1 depicted a strong interconnection between the gradual decline of urban greenery and steady increase of emission. The case of Kaduna is a reflection other major cities in the region such as Kano, Abuja, Jos, Sokoto etc. The effect of greenhouse gas like carbon in the global climate change poses the greatest environmental threat across the globe. Furthermore, based on previous studies on air quality, it has been proved that conventional air pollutants and CO₂ are both generated by fossil fuel combustion (Smith, 2013). By implication, high CO₂ from fuel implies high emission of harmful air pollutants such as Carbon monoxide, Nitrogen Oxides, Sulphur dioxide and particulate. For example, air pollution related diseases in three hospitals in Kaduna revealed an estimated 3,073 cases of Asthma, Cardiovascular and Bronchitis diseases between the year 2006-2011 (Ezra, Dyaji, & Nwokedirioha, 2013). The case of other urban areas in the north is not far from that of Kaduna. This alone can stand against the air quality index for most of the urban areas. Natural vegetation such as trees and plants function as lungs of the cities (McPherson, 2005). Plants act as a natural filter by absorbing contaminated carbon oxides emitted in the form of pollutants in the urban Centre's. An estimated 26 pounds of carbon dioxide can be removed from a single tree from the atmosphere in a year (Abbas & Arigbede, 2012). This show the significant role of green space in improving the environmental quality of urban areas. A significant decline or lost in green areas in northern Nigeria urban areas will have a multiplier effect on the range of environmental sustainability indicators as listed in table 1. Assessing and promoting the quantum of urban greenery will amount to meeting substantially environmental target simultaneously.

The adverse impact of climate change amid a drastic reduction in urban greenery may likely be intensified in Northern Nigeria considering the vulnerability of the region. A total of eleven states out of the nineteen states in the Northern Nigeria representing 43 percent of the country land mass (Christine, 2015) are referred to as desert frontline states and are facing a threat of desert encroachment. The estimate has shown that 350,000 sq.km of land mass across this eleven states is annually lost to the desert (Tercula, 2015) and the desert is advancing at a speed of 0.6km every year (FOS, 1997). This trend is very threatening to human settlements in the region. Excessive flooding is another consequence of climate change in the region. Major urban areas are exposed to the menace of flooding in recent years. In Kaduna, it was believed that over 2000 residential houses along the plain of the Kaduna river were submerged and thousands of people were displaced following excessive night rainfall in the September 2015 (News, 2015).

The Urban Heat Island phenomenon that creates discomfort to dwellers also has high implications. Studies over the years show a correlation between urban greenery and UHI. Changes in land use that may cause encroachment and destruction of urban green spaces may likely increase the intensity of UHIs (Mather, 2008). The increase in surface temperature due to changes and conversion of the green vegetative surface to hard and impervious surfaces affected the urban environment. The trend has an implication on the solar radiation evaporation rates, storage of heat, wind turbulence and can drastically change the micro climate condition of the city. On the general Nigeria is experiencing a global warming at the rate of the global mean temperature. The increase in temperature in Nigeria from 1971-2008 stood at 1.78 degree centigrade which is above the global mean increase in temperature of 0.74-degree centigrade (Odjugo, 2011). Some urban centers in the north recorded the highest temperature of 40-degree centigrade compare to the 25 degrees centigrade in the southern part of Nigeria. An increase in temperature of between 1.4 to 5.8-degree centigrade will have serious consequence on the socio-economic wellbeing of the people (IPCC, 2010). A correlation between harsh weather condition and meningococcal meningitis is a reason for increase threat of these disease in Northern Nigeria over the years (Idowu, 2014). For example, in 2009 a higher proportion of deaths among meningitis affected persons was recorded in Nasarawa, Adamawa, Borno, and Niger (Bassey et al., 2016).

7. Current trend and challenges.

Environmental sustainability as equally defined as a condition of stability, resilience, and linkages that enable human society to meet its needs without jeopardizing the ability of the future generations to meet their needs. The current trend regarding urban greenery in urban areas of northern Nigeria is scored below the acceptable bench mark. In many developed countries of the Western Europe, North America and rapidly developing countries of South- East Asia, effort towards harmonizing greenery and urban development towards environmental sustainability has been prioritized and entrenched through the green growth concept. For example, Singapore has upheld the practiced of greenery in which the city is said to be 50 percent green (Jiriko, 2014). The high valued placed on the natural environment amid urban development creates a condition for stability, resilience, and livability in the city. Looking back on the greenery, carbon emission and climate change across northern Nigeria. It is very clear that urban environmental quality has fallen short of the relevant indicators as shown in Table 1. The current trend has shown an imbalance between

urban development and environmental conservation depicted in the greenery. Over the years large scale projects have always favored the brown agenda of the Medium size urban Centre's to the detriment of the green agenda defined the open spaces. Generally, the current trend of urban greenery in the region can be attributed to the following challenges.

Weak Urban Planning: The grey nature of urbanization in northern Nigeria can be traced to the weak urban planning practiced. A number of urban settlements have a master plan, but many of the plans are out dated. Therefore, development is carried out beyond the spatial scope of the original plan (Planning Report, 2012) For example the Kaduna master plan designed to cover a radius of 15km from the center has exceeded the plan limit to about 20km to 25km (Masterplan, 2010). The same thing applicable to the master plan for Sokoto, Kano, Birni Kebbi, Dutse, Minna, and Bauchi. In urban areas with functional and up dated master plan like Abuja, the problem has always been a lack of will power in plan implementation and weak enforcement that has always led to distortion and encroachment into the earmarked green areas. This trend has created an enabling environment for informal growth in most of the urban areas. One among the ill associated with informal growth is the destruction of urban natural resources embeds in the green open space. Weak urban planning in northern Nigeria is a reflection of the sub-Saharan Africa region and best be summarized using the word of Freire that said "Urban planning and Master Plans have lost their meaning in many Africa Cities (Freire, 2013).

Urban Poverty and dependence on natural resources: the affinity between poverty and environment can be interrelated and turn to affects each other (Ibimilua, 2011) poverty leads to environmental deterioration in terms of destruction of green areas and in return environmental deterioration tend to worsens the rate of poverty. Considering the pattern of urban development in Nigeria, driven by high population growth but less developed and poor economic system (Agbola, 2005). This has continued to fuel urban poverty. Urban poverty which has greatly affected livelihood is a reflection of the Africa continent in the 21st century (McGranahan, Mitlin, Satterthwaite, Tacoli, & Turok, 2009). Urban poverty is a major challenge facing urban greenery in northern Nigeria. A look at Nigeria context shows that poverty is higher in the Northern part of Nigeria. For example poverty level in the North-east, North-west and North-central zones stood at 63%, 62.9%, and 62.3% respectively (MDG Report, 2013; NPC, 2007). The current security challenging in the northern part of Nigeria tend to worsen the poverty rate.

The brutal attacked of rural areas in the North-East by the Boko Haram insurgent and the constant nocturnal raiding of villages in the North-Central states has also worsened the poverty rate. An estimated 3.3million rural dwellers have been displaced (Briefing Paper, 2014). This has forced many victims to move into urban areas in the region. Unemployment has forced many to depend on the excessive exploitation of the natural resources in order to earn a living. The propelling factor that is threatening urban greenery is the influx of rural poor into the urban areas in the region. Considering the fact that urban areas in Africa lack the ability to absorb and manage the unprecedented influx of migrants, therefore this often results to rapid and unguided urbanization (Eric, Shouyu, & Qin, 2010; Rosado, 2008) that may not be able to safeguard the earmarked green areas. Existing open green spaces are often targeted for the unsustainable harvesting of it available resources, cultivation, grazing and even resettlement of the rural migrant by the government. A field survey 2015 on the daily source of energy for cooking in Kaduna urban area shows that 59% of the

population depend on fire wood and kerosene for cooking. The level of dependence on fire wood may likely be higher in other medium size urban areas in the region. Urban poverty reflected in over dependence on natural resources is a major cause of unsustainable exploitation of available urban green areas.

Climatic Condition: The climatic condition of the region further aggravated by the current impact of climate change poses a major challenge on urban greenery as a derive toward environmental sustainability. The long period of dry season extending from 6-7 months may affect the growth of plants and vegetation. A wet season of 5-6 month may not be enough to support effective plants propagation. The prolonged dry season and the lack of appropriate technology for water harvesting affects the earmarked open green spaces within the urban Centre's. The dry and grey nature of green areas is sometimes destroyed during the dry season bush fire.

8. Conclusion and Way forward.

Sustainable and resilient urban future in northern Nigeria depends greatly on balancing between urban development and the integration of greenery at a large proportion. A large scale urban agglomeration characterized by rapid population increase and unguided expansion call for a sober reflection. An antecedent of weak land use planning as shown in outdated urban development plans which are characterized by ambiguity and the neglect of urban dynamism in population growth in it land use budget. This has led to widespread encroachment into earmarked open green spaces over time. Urban development beyond the ambit of urban planning is a threat to greenery and it accrues longtime gain. An increase in carbon emission in some of the urban areas and the shrinking of green areas reduces the sequestration ability, therefore, increasing the carbon footprint. This is a thing of concern in our quest towards environmental sustainability. The adverse impact of climate change may continue to escalate amid declining greenery. The stretching of Sahara desert across the region creates more pressure on the green areas, the seasonal flooding resulting to the loss of life and properties is becoming an annual threat. The increase in urban temperature correlated the outbreak of meningococcal meningitis in urban settlements.

Considering the above trend in the region, the attainment of environmental sustainability is seen as very illusive. Above all, urban greenery is confronted by the following: weak urban planning resulting in informal settlements that degrade greenery. High dependence on natural resources due to urban deprivation and finally a harsh climatic condition characterized by prolonging dry season may greatly hamper the flourishing of urban greenery in northern Nigeria. Based on findings from this review the following recommendations are put forward:

- Considering the fragile nature of the region and increase in urban population, greenery should be budgeted base on population growth and vulnerability of the environment to climate change.
- Open space should be clearly defined to embrace the concept of green infrastructure in all out dated master plan due for review.
- Adherent to the concept of urban planning that integrates physical development and environmental consideration will enhance urban greenery.
- A commitment towards poverty reduction will help reduce dependence on natural green areas.

- The provision and safeguarding of urban greenery should be placed on the same platform with urban grey infrastructure by urban stakeholders.

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