Charting a Resilient Future: Climate Change as a Catalyst for Sustainable National Development
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SUSTAINABLE URBAN DEVELOPMENT AND CLIMATE RESILIENCE IN NIGERIAN CITIES

BY

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1.0: INTRODUCTION

The rationale for focusing on the urban space in environmental management and sustainable development is overwhelming on a number of grounds. As Tyler Miller Jr. (1996:251) deposed, the future is urban and that few of today's cities are sustainable. As at 1996, 43% of world's population lived in urban areas and by 2025 urban population would reach 61%. Galbraith (1993) argues that the test of life in an advanced economic society is now largely in the quality of urban life and that romance may still belong to the country side, but the present reality of life abides in the city.

From the European model of urbanization, industrialization and development occur together as joint processes affecting societies in the late 20th century and beyond (Drakakis-Smith 2000; Llyogd Evans and Potter, 2008; Satterthwaite, 2008). By 1970 total global urban population was 37.2%, 25.5% in the less developed regions and 66.6% in the more developed industrial countries, but by 2000 respective proportions were 46.7%, 39.5% and 74.8% and by 2025 respective proportions were estimated at 60.5%, 56.9% and 79.0%. In actual figures by 1970, 1,374 million people lived in cities of the world, with 675 million in cities of the less developed countries and 698 million in cities of the developed world. By the year 2000, 2.916 billion people were living in global cities with 1.971bn in cities of the less developed countries and 944 million in cities of the more developed countries. In 2025, respective figures would be 5.11bn, 4.050bn and 1.068bn (UN, 1989 and UNCHS, 1996). Much more striking is that urbanization is occurring at unprecedented rate in the modern era in the poor countries of the world with insufficient resources to cope with the spin-offs of development in the areas of poverty, deforestation, soil and gully erosion, air and water pollution, climate change impacts (disease burden and extreme weather events) declining agricultural productivity and relatively low pace of industrialization.

The complexity is that going by current population trends Miller Jr (1996) warns that global population will double in 41years, the urban population in 22 years and urban population of less developed countries (LDCs) in only 15 years.

The global urban centres, especially the primate cities and megalopolises account for an overwhelming proportion of their nation's industrial establishments. Lagos in Nigerian by 1993 accounted for over 60% of

Nigeria's industrial establishments, over 60% of industrial value added, and over 45% industrial employment. It also consumed over 50% of Nigerian electricity and had over 50% of Nigeria's automobiles (Taylor, 1993).

Much more spectacular is the growth of millionaire cities. In 1990 only 13 cities had population in excess of 1 million people and all, except Tokyo were in Europe and North America. In 1995 there were 335 metropolitan areas of more than 1 million people and only three of the ten largest cities were in the more developed countries. In 1995, London was the only city with more than 5 million people (Barney Cohen, 2006). By 2005 there were 19 of such cities. Futurists predict that by 2025 there would be 400 cities with more than 1 million people and 93 mega cities each with more than 5 million people, with 75 of these located in developing countries. They also believe that 95% of urban population increase in the coming decades will be in LDCs. All this is in spite of the fact that world cities occupy only 3% of the earth's surface, but account for 60 – 80% of energy consumption and 75% of CO_2 emission.

There are positive benefits of urbanization, if managed well. Cities are an efficient way of organizing people's lives: they enable economies of scale and network effects and reduce the need for transportation, thereby making economic activity more environmentally friendly. The proximity and diversity of people is an enabler for innovation and can create employment since exchanging ideas breeds new ideas (World Economic Forum, 2015). The diversity of cities can inculcate social tolerance and provide opportunities for civic engagement. As a matter of fact, the linkages between cities form the back bone of global trade, while cities overall generate a large proportion of the world's GDP. Cities are centres of modern living, where female labour force participation is greatest and where indicators of general health and well-being, literacy, women's status and social mobility are highest. They are important social and cultural centres that house museums, art galleries, film industries, theatres, fashion houses.

In cities high population density may be an asset for minimizing the effect of man on the local ecosystem. High population density ordinarily implies lower per capita cost of production of infrastructure and basic services. Cohen (2006) argues that despite the rates of urban poverty afflicting many cities, urban residents, on average, enjoy better access to education and health care, in addition to other public services, such as electricity, water and sanitation than people in rural areas.

Nevertheless, as cities grow their management becomes more complex especially with the speed and sheer scale of urban transformation. Risks to the immediate and surrounding environments, to natural resources, to health conditions, to social cohesion, and to individuals rank high. Add to these the massive increase in the numbers of the urban poor. Available data show that in a large number of the world's poorest countries, the proportion of the urban poor increases faster than the overall rate of urban population growth (Cohen, 2006). An estimated 72% of the urban population of Africa live in slums; in Asia & the Pacific it is 43%, 32% for Latin America, and 30% for the Middle East and Northern Africa (UNCHS, 2004; 2003).

Rapid urban population growth all over the developing world has more than seriously exceeded the capacity of most cities to provide adequate basic services for their people. Yet year in year out cities attract new migrants, in addition to within city natural increase, expand the number of squatter settlements and shanty towns, augmenting the problems of urban congestion and sprawl and constraining urban management attempt to improve basic infrastructure and deliver essential services. If we add to these the challenges of climate change, the scenario becomes over daunting.

The rest of the paper adverts attention to achieving resilient city system in Nigeria with particular reference to mitigating and adapting our cities to climate change challenges. In order to do this, the rest of the paper is

divided into six parts. The next section, 2.0 deals briefly with urbanization in Nigeria; section 3.0 surveys climate change reality in Nigeria, and urban vulnerabilities consequent on climate change. Section 4.0 deals with brief conceptual delineation of sustainability, mitigation, adaptation and resilience. The examination of climate Action and Policy in Nigeria is the agenda of section 5.0, while section 6.0 canvasses the achievement of sustainable urban development through the emplacement of urban resilience in urban development and planning in Nigeria. Section 7.0 is the conclusion.

2.0: URBANIZATION PROFILE IN NIGERIA:

Although pre-colonial urbanization existed in Nigeria before the intervention of colonialism, it is the colonially triggered urbanization that we are concerned with here. The problem with Nigerian population is the unreliability of census data because of the politicization of census, the difficult access to enumeration areas and the use of different population thresholds to define an urban centre. Up to 1952/53 census a population threshold of 5,000 was used and from 1963, the country adopted a population threshold of 20,000 to define an urban centre (Bloch, et al, 2015). Because of the unreliability of census data in Nigeria, data used in this paper were derived from population censuses, multiple indicator cluster surveys (UN, 2014) household surveys, and satellite imagery. In Nigeria urban centres are defined on the basis of population size, administrative status, and employment among other criteria.

Even though the data available on urban population in Nigeria is patchy and problematic, the nation's urban population has expanded rapidly over the past 60 years (from 1950) and is expected to grow relatively fast in the coming decades. The UN and Africapolis sources show a 10-fold increase from 1950 to 1990 (from 3 million to roughly 30 million). The two sources, which incorporated the 2006 census, show an urban population of 40 million by 2000. By 2010, the UN reported Nigeria's urban population to be 69 million and by 2020 the UN projected an urban population of 108.7 million (Table 1). The UN projected at a growth rate of 4.3% per annum, at which rate urban population would be expected to double in 17 years.

Table 1: Urban Population Growth in Nigeria 1950 – 2020

Year	Urban Population in Million
1950	3
1990	30
2000	40
2010	69
2020	108.7

Source: Compiled from Urban Research Nigeria (2015) and from Africapolis

Urban Research Nigeria (2015:17-18) shows that from 2010 – 2020 there were only one urban centre (Lagos) with over 5 million people, 5 with 1 to 5 million people (Abuja, Benin City, Ibadan, Kano and Port Harcourt), 14 cities with 500,000 to 1 million (Aba, Enugu, Ikorodu, Ilorin, Jos, Kaduna, Maiduguri, Nnewi, Onitsha, Oshogbo, Owerri, Uyo, Warri and Zaria), 18 cities with 300,000 – 500,000 people Abakiliki, Abeokuta, Ado Ekiti, Akure, Bauchi, Calabar, Gboko, Gombe, Igbidu, Katsina, Lokoja, Minna, Ogbomosho, Okene, Ondo, Oyo, Sokoto and Umuahia). The rest of the urban areas had populations of fewer than 300,000 (Table 2). These categories of towns had a total population of 108.61 million as at 2020.

Table 2: Urban Population Growth Trends by Settlement Size (2010 – 2020).

City Size	2010 Population (Million)	2020 Population (Million)	Average Growth Rate 2010 – 2020 %	Cities (Listed in Descending of Size in 2010
5 million or more	10.78	16.17	4.05	Lagos
5 million or more	10.96	21.7	6.83	Abuja, Benin City, Ibadan, Kano, Port Harcourt
500,000 to 1 million	9.56 million	13.80	3.73	Aba, Enugu, Ikorodu, Ilorin, Jos, Kaduna, Maiduguri, Nnewi, Onitsha, Oshogbo, Owerri, Uyo, Warri, Zaria
300,000 to 500,000	6.67	10.08	4.14	Abakaliki, Abeokuta, Akure, Bauchi, Calabar, Gboko, Gombe, Igbidu, Katsina, Lokoja, Minna, Ogbomosho, Okene, Ondo, Oyo, Sokoto, Umuahia
300,000	31.47	46.86	3.98	All others

Source: UN, 2014: World Urbanization Reports

Table 2 shows that by current UN projections Nigeria's second tier cities (1 to 5 million) will collectively outpace the growth of Lagos by a wide margin, while large secondary cities (between 300,000 and 500,000) will grow marginally faster. These growth trends, allied with the emergence of new urban settlements in Nigeria's urban system will likely dampen Lagos seeming primacy outlook in the coming decades, even though it will remain Nigeria's largest urban area given continued economic, educational, port facilities, commercial, financial and industrial investments.

At the level of individual cities over a period of 30 years (1952 – 1982), the population in most major Nigerian cities increased five-fold. For example, Lagos, Kano, Port Harcourt, Maiduguri, Kaduna, Jos and Ilorin had over 1000% increases. Ibadan rose from 625,000 in 1963 to 2.84 million in 1982; Enugu rose from 174,000 in 1963 to 850,000 in 1982; Lagos rose from less than a million in 1963 to over 4 million in 1982 (Onibokun, 1987).

Even though Table 2 shows the number of urban centres in each population size class, it does not show all the urban centres in Nigeria, especially as the last class did not show the centres in that category. Data from Federal Office of Statistics (1952 and 1963) projected by Onibokun showed the number of cities from 1921 to 2020 (Table 3).

Table 3: Population of Nigeria, 1921 – 2020 and Urban Centres

Year	Total Population 000's	Total urban population 000's	% of total population	# of cities with population 100,000	# of cities with population 200,000 & above	# of cities with population 500,000
1921	18,720	890	4.8	-	10	-
1931	20,056	1,343	6.7	2	24	-
1952/54	30,402	3,701	10.2	7	54	-
1963	55,670	10,702	19.2	24	185	2
1972	78,924	19,832	25.1	38	302	3
1984	96,684	31,902	33.0	62	356	14
2020	160,000	-	68.0	132	680	36

Source: Federal Office of Statistics (1952, 1963) projected by Onibokun at 5% growth rate for urban areas; 2.5% for rural areas & 10% for State Capitals.

As urban population increased so did the physical expansion of the cities. For example, the physical extent of Enugu grew from 72.52km^2 in 1963, to 180km^2 in 1975 and to 204 km^2 in 1985, giving an annual physical expansion rate of 5.98 km^2 between 1963 and 1983. For Ibadan, its coverage was 36km^2 in 1951, by 1973 it was 112km^2, by 1981 total land area was 136km^2, in 1984 it was 176km^2 and in 1988 it was 214km^2, giving a spatial increase of over 84% in 7 years (Onibokun, 1995). Benin City grew from within-city-wall size of 384.2 hectares (Ikhuoria, 1984) to 486 hectares in 1938, to 7413.7 hectares in 1979 representing an annual growth rate of 10.3% as against an 8.8% annual population growth rate. The urban space for Akure grew from 977.20 hectares in 1972 to 2431.60 hectares in 1986 and to 3852.70 hectares in 2002 (Oyinloye, 2011). Such rapid urban population growth and expansion has produced not only the Nigerian urban system, but also growing urban conurbation or metropolitan complexes across the national urban surface. Bloch et al (2015) came up with four extended urban regions or conurbations using the 1991 Nigerian population census, UN population forecasts and satellite imagery (Figure 1):

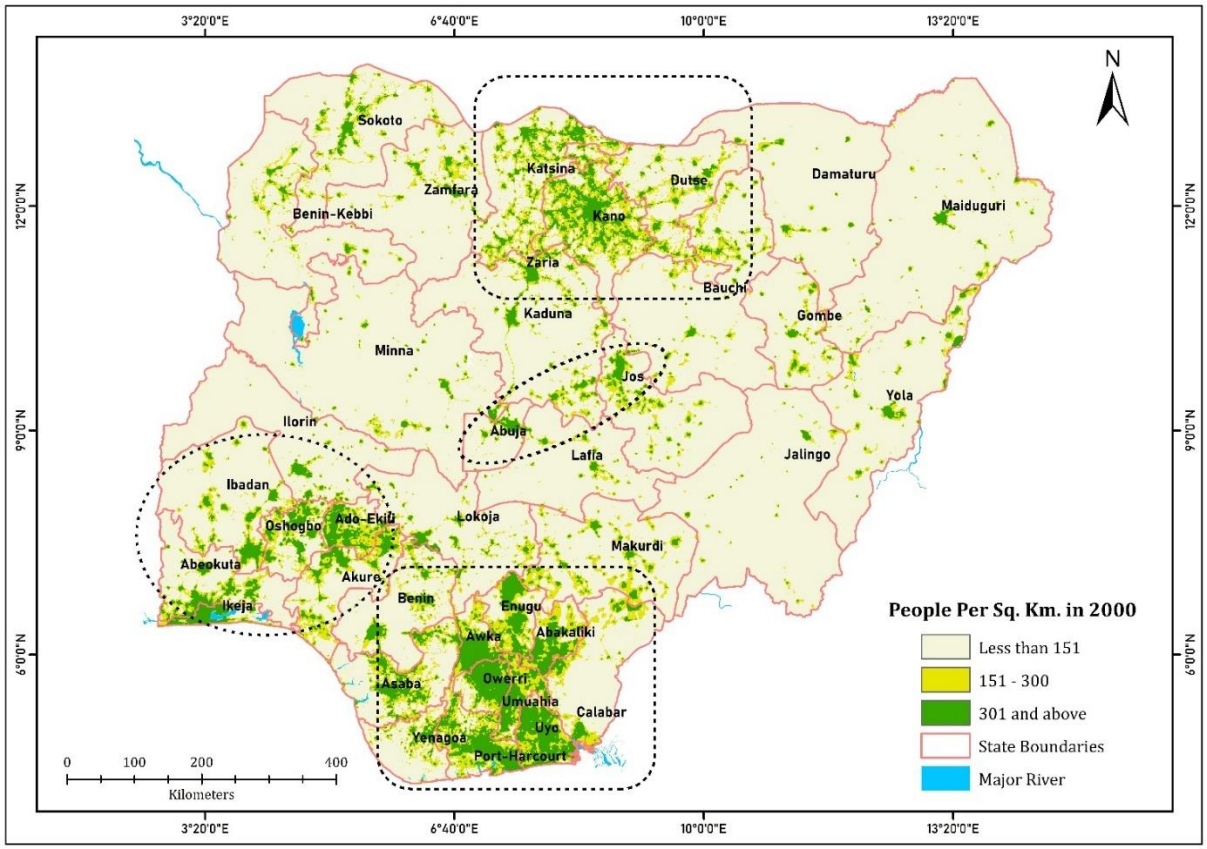

Figure 1: Nigerian Urban System
Source: Bloch et al (2015)

(i) a Northern conurbation centred around Kano with a North-South axis running from Katsina to Zaria and an East-West axis roughly from Funtua to Hadeija;
(ii) an emergent central conurbation running from Abuja in the South-West to Jos in the North-East;

(iii) a South-Western conurbation stretching from Lagos in the South to Ilorin in the North to Akure in the East;
(iv) a Southeastern conurbation including Benin-city, Warri, Port Harcourt, Onitsha, Calabar, Aba and Enugu.

These systems do not necessary constitute continuously built-up areas (though potentials exist), but rather networks of cities, towns and rural settlements of varying sizes linked by transport corridors. Of these four, Seto, Guneralp and Hutyra (2012) argue that the Northern conurbation around Kano is forecast to experience the most rapid physical expansion in the coming decades, even while it ranks among the top five most rapidly expanding settled regions in all of Africa. A significant feature of Figure 1 is that Nigeria exhibits a fairly "balanced" urban system, despite the generally held view that Lagos is an over-bearing mega city. This is because Nigerian urban system has shown dynamism in growth.

In the 1952/53 census, Ibadan was shown to have the largest population. In the 1991 census Lagos averaged as the largest settlement, with overall distribution remaining even. In 2006 Lagos still remained the largest city, while Kano surpassed Ibadan as the second largest city even though that census remained controversial to date. Nigeria's UN projection as shown on Table 2 shows that the second tier metropolitan – scale cities with population between 1 million and 5 million will collectively outpace the growth of Lagos with a wide margin.

The dynamics or drivers of rapid urban population growth and expansion include rapid population growth propelled by declining mortality and persistent high fertility, (See Table 4), resulting from natural population increase in existing urban centres and densification in rural areas resulting in the reclassification of settlements from rural to urban. As Bloch et al argue indirectly, rapid population growth in rural areas expands the pool of potential urban migrants and may, through demographic pressure on natural resources, contribute to the 'push factors' that can stimulate rural out-migration (Fox, 2012). Fertility rates (by implication population growth rates) have traditionally tended to be lower in urban areas than rural areas (McNicol, 2011), but in many developing countries in post-World War II era urban fertility rates have remained relatively high, while mortality has fallen creating an 'urban push' or rapid internally generated increase in urban population size (Jedwab, Christiansen and Gindelsky, 2014). Apart from rural densification and reclassification, political policies have led to the increase in the number of urban areas. For example all colonial provincial headquarters have become urban centres and with state creation have become state capitals. In addition, the Federal Government has conferred urban status on all 774 local government headquarters with planning areas of 5km radius. Government has also conferred urban status on settlements, such as Nnobi and Aguleri in Anambra State. With these policy measures, urban centres in Anambra State account for 2,996 million people or 71.56% of total state population, urbanized surfaces account for 2,739.25km^2 or 56.31% of total state physical space (Muoghalu, 2014) as at 2006 census. Bloch et al (2015) argued that while rural-urban migration is probably not the main contributor to overall urban population growth in Nigeria, it plays an important role in urban processes, particularly with regard to urbanization-defined as steady increase in the proportion of the national population residing in urban areas. Viewed in the long term, it is ultimately the transfer of people from rural to urban settlement that drives urbanization in these terms.

Table 4: Fertility and Child Mortality Trends in Nigeria 1990 – 2013

	1990	1999	2003	2008	2013	% change 1990 - 2013
Total Fertility Rate	6.0	4.7	5.7	5.7	5.5	-8.3
Under five mortality rates	191	133	217	171	144	-24.6

Source: Block et al (2015), p. 25.

There are four visible types of migration flows in Nigeria-rural-rural, urban-rural, rural-urban and urban-urban (Oyeniyi, 2013). The data from the 1993 Migration and Urbanization Survey of Nigeria, rural-urbanization migration accounted for only 37% (Mberu, 2005); while the 2010 Internal Migration Survey migration was responsible for 60% of all flows, while rural-rural represented 40%. Again an independent World Bank study discovered that rural-urban migration accounts for 83% of migrant flows (Mckay and Deshingkar, 2014). Economic trends may explain this as Nigeria had a protracted economic downturn consequent on the Structural Adjustment Programme introduced by the General Babangida federal regime in the 80s with robust economic performance at the turn of the new Millennium (Mberu, 2005).

Migration origins and destinations in Nigeria tell different stories. National Population Commission's sources show that 98% of migrants in Anambra State end up in urban centres; a similar story obtains in Lagos State with 97%, while for Nasarawa State 66% of migrants end up in rural areas; for Bauchi it is 81.8% and for Akwa Ibom it is 83.8% into the rural areas. Along geopolitical zones, greater flows into urban centres are true of South-Western, South-eastern and the Federal Capital Territory of the central conurbation, while rural-rural migration typifies the pattern in the South-south, North-central and North-eastern zones. Urban-urban migration accounts for Abuja's ascendancy in Nigeria's urban hierarchy. Migrations are propelled by search for employment, better life, education, escape from conflicts, and apprenticeships, poverty and vulnerability. Research in Nigeria shows different migration propensities across ethno-linguistic and religious communities. Christians are more likely to migrate than Muslims, with a greater propensity, Hausa/Fulani communities in the north showing less eagerness to migrate to urban areas (Mberu, 2005).

By way of summary the drivers of increasing urbanization in Nigeria are government concentration of social, political, administrative, economic and infrastructural investments in the urban environments. Financial institutions and commerce and transportation facilities are concentrated in the cities. Lagos is a case in point that controls not only the commercial investments in Nigeria, but is also the gateway to Nigeria through the ports, railways and air transport services. Social investments in terms of education, health and employment sources are concentrated in cities. The urban centres control the political structure of Nigeria, while the creation of more states, LGAs, and siting of strategic industries (politically manipulated) reinforce the cumulative-causation mechanism of cities. Living in cities is culturally and economically beneficial, since it provides access to labour market, better education, housing, safety conditions, money, services, wealth and opportunities. The major cities mediate between Nigeria and the rest of the country in terms of globalization. Cities as centres of modern living, provide the greatest opportunities for female labour participation, where indicators of general health and well-being, women's status and social mobility are generally highest. Cities represent important social and cultural centres that house museums, art galleries, film industries, theatres, fashion houses and other important cultural centres (Cohen, 2006).

2.1 Urbanization Challenges in Nigeria:

Urban Infrastructure:

Despite the manifest advantages of city living, the steep rise in urbanization (numerically and spatially) poses enormous problems in Nigeria that interrogate sustainable development. As Cohen (2006) warns, the challenges of achieving sustainable urban development in Africa will be formidable. A World Bank study of infrastructure provision in Lagos and its impact on productivity came up with three consequences: productivity has been affected seriously, quality of life has worsened, while inadequate provision of infrastructural services costs business firms over 20% of their capital outlay to provide their own infrastructure – electricity, water supply, transport, telecommunications and waste disposal. The capital value of electric power generating facilities alone accounts for 10% value of machinery and equipment for large firms and 25% for small firms. These costs are passed on to consumers in the form of higher prices (Lee, 1989; Verma et al, 1991). Because of inability to produce necessary infrastructure, small and medium sized businesses cannot provide enough employment opportunities very much needed for sustainable development (CASSAD, 1993).

The massive increase in the urban poor is outpacing the overall rate of urban population growth in a country that is the poverty capital of the world, where over 118 million people live in absolute poverty, living on less than $1.25/day. The National Bureau of Statistics (2004) showed that 54.7% of Nigerian population lived in absolute poverty in 2004 and predicted that 60.9% would be absolutely poor by 2010. At the 2018 International Monetary Fund/World Bank meeting, Nigeria was placed 3rd after India and China as having the highest number of the poor in the world (UN, 2018). The causes of the depressing level of poverty include high rate of population growth ahead of economic growth performance, low economic performance, crime, violence, poor governance, ill-health and prevalence of diseases, lack of skill, debt burden, unplanned urbanization, poor and slow rate of industrialization, the dominance of informal activities in cities, and environmental resources degradation and massive corruption among political and bureaucratic classes. At the state level poverty varied from 8.5% for Lagos to Anambra, 11.2% to Yobe 90.2% and Zamfara 91.9% (UN, 2018).

Most of the poor are in our urban centres. In a paper presented by Pepple (2012), the Minister for Lands, Housing and Urban Development at the Rabat International Conference on slums, it was envisaged that 53.9% of Nigeria's poor would live in cities by 2020. Lagos mega city had 42 slum communities in 1981 and this was expected to rise to 100 by 2010. In Onitsha, the Okpoko slum community, the most densely populated slum settlement in Nigeria with a density of 44,000 persons/ha is frightening (Muoghalu, 1981). Enugu had 19 slum areas by 1979 out of 29 residential neighbourhoods (Okoye, 1979).

Even though a certain critical mass of population is economically viable in delivering many infrastructural projects, such as public transportation, yet a higher population density also creates negative externalities, especially when as in Nigerian urban centres, urbanization is rapid, poorly-planned and occurs in a context of widespread poverty (Glaeser, 2013). Such urban concentration in slums accounts for increased risks of illnesses, worm infections, cholera, typhoid and diarrhoea, (a leading cause of preventable death in children) and helps to spread emerging infectious diseases. The report on vision 2010 had it that 85% of Nigeria's urban population lived in overcrowded slum housing environment (National Economic Planning Commission, 2004).

In 2014 Lagos Water Company's capacity was 210 million gallons/day compared to 540 million gallons needed by Lagosians. Its potable piped water reached about 7 million people, leaving 14 million (of Tinubu's claimed megacity population of 21 million) without safe water. (Ibukun and Kay, 2014). Kano metropolitan

area had a water demand of 550 million litres/day in 2014 but supplied only 200 mld, leaving a deficit of 350 mld giving a supply/demand ratio of 36% (Bello and Tuna, 2014). In Enugu as at 2014, estimated water demand was 144, 491, 774 litres per day, while supply was 67, 091, 096 litres per day, a supply rate of only 44% (Ezenwaji et al, 2016). In Awka, capital of Anambra State, there has been no public water supply since 1992.

Health: A combination of poor housing, increasing incidence of slums, poor infrastructure, lack of skills on the part of migrants, poverty, poor urban planning, ritual flooding, high levels of automobility and paucity of health facilities and health personnel due to diaspora epidemic combine to deepen urban health in Nigeria, because the environment in which people live greatly influences their health. As the World Health Organization puts it deteriorating environmental conditions are a major factor to poor health and quality of life and hinder sustainable development.

Poor environmental quality is directly responsible for around 25% of all preventable diseases/ill health in the world today with diarrheal and respiratory infections leading in mortality. In Nigerian urban centres with high level of slum incidence (intra city and peri-urban), poor or no sewage provision, poor water sanitation, high level of indoor pollution (due to prevalent use of fuel wood energy), overcrowding, high level of air pollution (by automobiles, motorcycles, industries, tricycles and power generating sets), poverty and poor health infrastructure, people's health is compromised, leading to premature death and chronic health disorders. Nigeria's water and sanitation profile shows that under 5 mortality rate due to diarrhea was 15.7%. Asthma, and diabetes rates are increasing because of urban life style.

Urban water run-off, polluted water created by rainfall on impervious surfaces, precipitation from rooftops, parking lots and sidewalks flows to storm drains, instead of percolating into groundwater and contaminated storm water in the drains are typically untreated and flow into nearby streams, rivers or even coastal waters, used by urban population all pose health challenges.

Social Instability: Rapid and unplanned urbanization in Nigeria is fraught with social instability and urban violence. Nigerian urbanization is bringing together large numbers of unemployed youths who engage in fraudstering, cultism, kidnapping for ritual killing and bank robbery. These arise because of widening social inequality, corruption in government, poor educational policies and programmes, and poor social values, impunity from the law, weak governance, terrorism in Northern Nigeria, greater awareness of the income gap between the rich and the poor by modern media and feelings of deprivation and poor security provision.

3.0 CLIMATE CHANGE REALITY IN NIGERIA

Evidence abounds of the reality of climate change in Nigeria. It includes changing rainfall patterns, increasing mean surface temperatures, floods, intensified gully erosion, desertification, prolonged droughts, increasing ocean surges, heat waves disappearance of Lake Chad and siltation of streams and rivers (Ajadike, 2015; Odjugo, 2009; Ekpo and Ansa, 2011 and Adefolalu, 2007). In a study spanning 105 years, Odjugo (2010) showed that the mean surface temperature in Nigeria up to 1950 remained steady, but from late 1960s a steady gradual rise has continued up till today. In his study of rainfall trends he discovered a decline of 81mm from 1901 to 2005. In a study of Sokoto, Ekpo and Ansa (2011) discovered that rainfall for the town declined by 8.8% of long term mean from 1915 – 2008, and that there is late onset and early cessation and a long break within the rainy seasons. Rainfall varied in total amounts for all regions of Nigeria together with quite erratic characteristic, all posing real challenges for planning and adaptation. Studies by Odjugo (2010) and Baudi

and Ahmed (2006) showed that rainstorms killed 199 people and destroyed property worth N85.03million between 1992 and 2007. Other studies showed that the number of rainy days in Northern Nigeria in the last 35 years has dropped by 53% in the Northeast, while along the coastal areas a drop of 14% was discovered. The double rainfall maxima has shifted southward. The "little dry season" usually experienced in August is now experienced in July (Odjugo, 2010). The most spectacular evidence of climate change is the Lake Chad which shrank from its 25,000km^2 in 1963 to just 1,350km^2 in 2018, attributed to the prolonged Sudano-Sahelian drought of the 1970s and 1980s, the high evapotranspiration rate in the region and construction of dams on the upper reaches of rivers draining into the Chad Basin (Muoghalu, 2024). Historically projected data from 2020 to 2050 used to examine trends in temperature and rainfall in Agbani, Enugu State via Trend Regression analysis shows a wetter and hotter regime. The years 2018 and 2015 show the heaviest and lowest amounts of rainfall respectively. Data from Nigerian Meteorological Agency show that mean surface temperature rose from 0.4^0C to 1.5^0C above the long-range average in the Sudan-Sahel zone as against the average increase in the rain forest area of 0.2^0C and 0.3^0C per decade (Ewa, 2011).

Evidence from research shows that climate change and variability will impact cities negatively and increase the complexity of urban planning and management.

As Nigerian cities grow, urban 'heat island' becomes a great concern. Urban heat island is formed when industrial areas absorb and retain heat. While much of solar energy incident in rural areas is used to evaporate water from plants and soil, in cities with less vegetation and exposed soil, most of the energy is instead absorbed by buildings, and asphalt leading to high surface temperatures. Vehicles, factories, heating and cooling units in factories, offices and homes release more heat. This results in cities being warmer than surrounding areas. Urban heat islands also make the soil drier and so absorb less carbon dioxide from emissions.

Flooding: Flooding is one extreme weather event affecting Nigerian urban areas. Flooding in our urban environment is caused by conversion of rural lands under natural cover into urban impervious surfaces, failure of regulatory processes in the siting of physical structures (e.g. housing and roads) along the right of way of natural rivers, flow paths and depressions, failure of flood defence structures, development of chaotic and unplanned squatter settlements, slums, non-provision of adequate drainage channels in their geometry, blockage of flood drainage channels, settlement in areas liable to flooding, indiscriminate disposal or dumping of solid waste in any available open space, torrential rainfalls, geology and slope incidence, the conversion of housing compounds into synthetic surfaces, and poor land management in river drainage basins (Odemeroto, 2005; Onibokun and Kunuyi, 1996; Omuta, 1987; Odemerrho, 1993; Mabogunje, 1980; Muoghalu, 2023; Muoghalu and Okonkwo 2004 and Muoghalu & Ikegbunam, 1997).

A major characteristic of urban flooding is that the incidence and severity of flooding increase as the urban centre grows spatially and demographically, while the frequency is correlated with deepening of climate change. Before 1970 flooding was infrequent, but with increasing urbanization, flooding has become more frequent. The greatest flooding in urban centres as recorded by the National Emergency Management Agency (NEMA) was in 2012 followed by 2017, 2018, 2019, 2021, 2022 and 2023. NEMA records show that of all disasters recorded up to 2009, rainstorms and flooding accounted for 49.86% (Nwajiuba, 2011). Though major cities in Nigeria have recorded one major flood disaster in the last 10 years, the major centres of yearly urban floods are Ibadan, Lagos, Warri, Benin City, Maiduguri, Port Harcourt, Onitsha, Lokoja, Aba, Kano and Ilorin. For example, Ogunpa flooding in Ibadan is one of the most reported and hazardous urban floods in Nigeria (Akinola, 1966). Important years of Ogunpa floods include, 1951, 1955, 1960, 196B 1969, 1978,

1980, 1982, 1984, 1986, 1987 and 1988 (Odemenho, 2005). These figures show that between 1951 and 1986, the flood cycle steadily decreased from about nine years to only two years.

Table 5: Indicators for Measuring Impacts of Flooding in Nigeria (2012 – 2019)

	2012	2018	2019
Affected Population	NA	1,921,026	130,934
Number of Deaths	363	204	126
Number Internally Displaced (18,200 injured)	2.1m	210,2026	28,114
Number of Houses Destroyed	618,000	82,376	29,356
Property Lost	₦1trn	₦246bn	₦176bn
No of Hectares of Agric Land Destroyed	NA	156,672	NA

Source: National Institute for Hydrological Services (2020). Annual Flood Outlook & Nigeria Climate Review, 2012 Acts of flooding in 2012, 2018 and 2019 flood episodes.

The 2012 flood affected 27 states with an estimated loss of ₦11trn in property and assets. Another one came in 2017 with less costs. In Benin City Rashid (1982) and Odemerrho (1988) demonstrated a steady growth in the number of flooded areas from only four in 1965 to 38 and 45 in 1981 and 1985 respectively, while Odemerrho (1988 and 1993) established a direct correlation between the magnitude and frequency of Benin City floods and the period when Benin City urban growth extended beyond the traditional city walls. In 2024 flooding, over 1.3million people were affected, 321 people lost their lives in 34 states (Daily Sun, Friday Nov. 1, vol. 20, # 5617, p. 1) with the South East and South-South geopolitical zones suffering the most. In Kano 31 died, while 5,280 houses were destroyed. The huge sediment load from urban runoffs in urbanscape as a result of perennial construction in Nigerian urban centres, severely gullied hill slopes and poorly managed watersheds in many of our urban centres have continued to affect intra urban and peri-urban rivers. These either silt up the drainage channels or change the drainage morphological characteristics and wetland ecology around major cities. This is the case with Ekulu River in Enugu and Ikpoba River in Benin City. In Onitsha, Nkisi River which supplied Onitsha with water in pre-Civil War years is almost completely silted up as a result of deforestation of Akpaka Forest Reserve and Oze Watershed (which has ensured steady water supply to Nkisi River).

Along the coastal belt of Nigeria, the transport of chemically polluted substances to the coastline along with coastal erosion by coastal water surges accounts for the eutrophication of the coastal belt water thereby affecting marine life negatively. In Lagos the Badagry coastal erosion rate ranged from 2m – 6m/year, Victorial Beach 25m – 30m per year, Forcados (Delta and Edo) 20m – 22m/year, Brass (Rivers State) 16m – 19m/year and Ibeno-Eket (Cross Rivers State) 10m – 13m/year in the eighties (Ibe, 1985). Such rates of erosion will be accelerated with climate change and will be responsible for saline water intrusion with implications for water quality and metal erosion.

One net result of flooding is gully and soil erosion. The South-East geopolitical zone is the gully erosion capital of Nigeria and Africa. All urban centres in the zone are ravaged by gully erosion. Anambra State had 700 gully erosion sites, Enugu had 600, Ebonyi 250, Imo 450 and Abia 30 as at 2008 (Igbokwe et al, 2008). In 1993, 70% of Anambra State land was being ravaged by gully and soil erosion at various stages of development and maturity, while over 20% had been lost to Hadesian gullies (Egboka, 1993). Gullies

undermine housing, and infrastructure and damage livelihoods. By 2009, 6000 gullies had emerged in Nigeria (Wikipedia, accessed 2005).

The associated challenges affect different regions of Nigeria differently because of location. There is high precipitation in parts of the Southeast, and Southwest and low in Northern Nigeria. These two rainfall regimes can result in aridity, desertification and drought in the north and erosion and flooding in the south and other regions.

Changes in surface temperature and variations in rainfall regimes, seasonality and duration is shifting climate regions in Nigeria. The same desert region in the North is receding north, while the steppe region in the North is set to expand southward. The savanna tropical climate is expanding and the tropical monsoon regions in the south are moving northwards, replacing tropical rainforest.

In 2018, Nigeria's total GHG emission was 336 million metric tons of CO_2 equivalent ($MtCO_2e$), which is less than 1% of global emissions (Wikipedia). This translates to less than 2 tons per person per year compared to the global average of 6 tons/person/year. These greenhouse gases, essentially CO_2 and CH_4 come from oil and gas production, land use change, agriculture and fugitive emissions. Since Nigeria is almost monoculturally dependent on oil and gas, it might be difficult to achieve the net zero target set for 2060 by Kyoto Declaration of Clean Development Mechanism.

Economists argue that fuel subsidies are ruinous vis-à-vis climate change since it increases automobility and unnecessary trips. It is recorded that transportation accounts for 28% of GHG emissions, (caused by gasoline and diesel use in cars), electricity production 25%, industries 23%, heat and refrigeration in buildings 13%, livestock and agricultural soils 10% and land use and forestry 12% since 1990.

4.0: CONCEPTUAL DELINEATION:

Before we look at the government response to climate change, it might be useful to consider the four concepts that will feature in the rest of our discussion: resilience, adaptation, mitigation and sustainability.

4.1 Climate Change Resilience:

It means the capability of individuals, communities, organisations or systems to withstand, recover from, adapt to and maintain competent function and return to some normal range of function in the face of adverse impact of climate change. It involves emerging stronger, more resourceful and more capable of dealing with future changes.

Resilience has six major components:

i. **Adaptability:** the ability to adapt to changing circumstances, events and environments.
ii. **Coping Skills:** involves effective strategies for managing stress, anxiety and other difficult emotions.
iii. **Emotional Regulations:** the ability to manage and regulate one's emotions in the face of climate adversity.
iv. **Positive Relationships:** existence of supportive connections with others, such as family, friends or community members.
v. **Self-Awareness:** clear understanding of one's strengths, weaknesses, values and goals.
vi. **Self-Efficacy:** confidence in one's ability to handle challenges and overcome obstacles.

Resilience is of five types and includes:

i. Positive childhood experiences, which involves a stable supportive upbringing that can foster resilience in later life.
   This underlines the importance of environmental education in schools.
ii. Social support: including strong relationship with family, friends and community members who will help build resilience.
iii. Coping skills and strategies: learning effective coping skills, such as mindfulness or problem-solving can enhance resilience.
iv. Self-Care: engaging in activities that promote physical and emotional well-being e.g. exercise can help build resilience.
v. Meaning-making: finding meaning or purpose in life can help individuals develop resilience in the face of adversity.

4.2 Mitigation

Mitigation or mitigation measures in the context of climate change refers to actions or efforts taken to prevent or reduce the severity, impact or likelihood of a potential threat or risk or disaster through preventing or slowing down the increase of atmospheric greenhouse gas concentrations by limiting current or future emissions and improving potential sinks for greenhouse gases.

There are three types of mitigation:

i. **Emission Reduction:** which is reducing the release of greenhouse gases, such as CO_2, CH_4, NO_2 through various means including renewable energy, energy efficiency and carbon capture and storage.
ii. **Risk Reduction:** through implementing measures to reduce the vulnerability of communities, ecosystems and infrastructure to climate change – related hazards, such as sea level rise, flooding, droughts, and extreme weather events.
iii. **Adaptive Management:** achieved by implementing flexible and adaptive management strategies to respond to changing climate conditions and reduce the risks of maladaptation.

Examples of Mitigation Strategies:

i. **Transitioning to renewable energy options:** This is a shift from fossil fuels to renewable energy sources, such as solar energy, wind energy, hydropower to reduce GHG emissions.
ii. Improving energy efficiency through enhancing the energy efficiency of buildings, appliances and industries to reduce energy consumption and emissions.
iii. **Carbon Capture and Storage:** Implementing technologies to capture and store CO_2 emissions from power plants and industrial processes.
iv. **Sustainable Land use:** Implementing practices that provide sustainable land use, such as reforestation, agro forestry, permaculture and proper land use planning/management.
v. **Climate-resilient Infrastructure:** through designing and building infrastructure that is resilient to climate change-related hazards e.g. sea level rise, floods, and extreme weather events.

Climate change mitigation has a number of advantages, including reduction of climate change impacts, protection of human health (through reducing the spread of climate-sensitive diseases and improving air and water quality), supporting sustainable development and reducing economic risks (through damage to infrastructure, loss of productivity and impacts to agriculture and tourism).

4.3 Concept of Adaptation:

Adaptation refers to the process of adjusting to changing circumstances, environments or conditions. It involves the ability to modify behaviours, strategies or physiological responses to better suit new or altered situations. Applied to climate change it refers to the process of adjustment to actual or expected climate change and its effects. Adaptation measure means any action or intervention to help communities and ecosystems cope with challenging climate conditions. Adaptive capacity refers to the ability of systems, institutions, humans and other organisms to adjust to the consequences of climate change, taking into cognizance available opportunities.

There are four types of adaptation, including physical, physiological, behavioural and cultural adaptation. For climate change challenge behavioural and cultural adaptation are relevant. Adaptation is significant on four grounds. It is important for survival in a changing environment. Adaptation is important as it drives evolutionary changes, allowing species to evolve and diversify. Thirdly adaptation helps individuals and communities build resilience to cope with uncertainty and change. Finally, adaptation can lead to innovative solutions and technologies in combatting climate change.

4.4 Sustainability of Development:

Sustainability is a multifaceted concept that encompasses the ability to maintain and support a process, a system, or activity over time without depleting natural resources or causing harm to the environment, social structures, economy or human well-being. Applied to climate change it refers to processes, activities or interventions in climate change context aimed at meeting the needs of present generations without compromising the ability of future generations to meet their own needs, including ending poverty and hunger, improving health and education, making cities more sustainable, combatting climate change and protecting waterways, and forests among others. In other words, mitigating and adapting to climate change will ensure sustainable development.

Sustainability has three components:

i) **Environmental Sustainability:** Conserving natural resources, reducing pollution and mitigating climate change.
ii) **Social Sustainability:** Promoting social justice, human rights and equitable access to resources and opportunities.
iii) **Economic Sustainability:** Ensuring long term economic viability, stability and growth, while minimizing negative environmental and social impacts.

Sustainability has four basic principles:

i) Inter-generational equity which ensures that in meeting the needs of the present generation sight is not lost of future generations meeting their own needs from undiminished environmental, social and economic capital assets.
ii) **Intra-generational equity:** ensuring fair and equal access to resources and opportunities within current generation.
iii) **Precautionary Principle:** Taking proactive measures to prevent environmental harm or social injustice even in the face of uncertainty.

iv) **Participatory Governance:** Encouraging inclusive decision-making processes that involve diverse relevant stakeholders and perspectives in a bottom-up approach.

Sustainability has a number of benefits including:

i) **Environmental Protection:** Conserving natural resources, reducing pollution, mitigating climate change.
ii) **Economic Benefits:** Ensuring long-term economic activity, stability, and growth, while minimizing negative environmental and social impacts.
iii) **Social Benefits:** Promoting social justice, human rights, equitable access to resources and opportunities.
iv) **Improved Quality of Life:** Enhancing human well-being, health and happiness through sustainable practices and decision-making. The major challenges to sustainability are climate change, resource depletion, social inequality and economic instability.

5.0 PUBLIC RESPONSE TO CLIMATE CHANGE IN NIGERIA:

Institutional Actions:

The Federal government of Nigeria has taken the following steps in the context of climate change:

1. Establishment of the Federal Ministry of Environment
2. Establishment of a Special Climate Change Unit (SCCU) in the Ministry of Environment.
3. National Council on Climate Change (Part II of the National Climate Change Act of 2021). We deal with this in detail later.
4. Creation of a Department of Drought and Desertification Amelioration in the Ministry of Environment.

In addition to institutional provisions, the Federal Government has achieved the following legal, policy and regulatory provisions:

1. **Ratification of the Paris Agreement in 2017:** This is an international agreement aimed at tackling climate change, by which Nigeria pledged to reduce its GHG emissions by 20% by 2030, with conditional reduction by 45% on the ground that Nigeria gets international support. The agreement provides for zero net production of GHG emissions by 2060.
2. **Gas Flaring:** The Federal Government has declared its commitment to eliminate gas flaring by 2030. It must be realized that gas flaring is a major contributor to acid deposition in the atmosphere. In 1994, the World Bank showed that total emission of CO_2 from gas flaring in Nigeria's Niger Delta was 35 million tons per year. But because of low combustion of Nigeria's flare (80%), a large proportion of this gas flare is vented as CH_4.
   Since CH_4 contributes in the proportion of 64:1 over CO_2, Nigeria's gas flare is of great significance.
3. **National Forest Policy (2010):** Since forests play an important role in atmospheric scavenging of CO_2, in watershed preservation, urban heat island attenuation and in the management of land and soil, the adoption of a National Forest Policy is strategic in climate change mitigation and adaptation. However, one would have expected that a National Forest Act would have been a necessary follow-up to the policy. For now, in Nigeria existing forest laws are outdated (Muoghalu, 2015).

4. **The Great Green Wall Project:** This is one of the mitigation measures taken by the Federal Government to combat desertification, food shortages and climate change impacts for the Sahara and Sahel Initiative. It is a project focused on the creation of a wall of trees of some 15km wide and 7,775km long from Dakar to Djiboute passing through 11 countries. Since 2005 it shifted gradually to a holistic, multi-sectoral and integrated vision of sustainable land management (SLM) and poverty alleviation. The achievements include rehabilitation of 12,000ha of degraded land through afforestation, oasis rehabilitation, sand dune fixation and range land conservation between 2006 and 2010. Corruption was a major challenge.
5. **National Climate Change Policy and Response Strategy:** The FGN launched the National Climate Change Policy 2021 – 2030 in 2012. Climate Change is complex and dynamic and so requires a multidimensional and multi-sectoral mitigation and adaptation initiatives. It defines a new holistic framework to guide Nigeria's response to development challenge from climate change. As a framework document, the policy prescribes sectoral and cross-sectoral strategic statements and actions for the management of climate change resilient development in short, medium and long term basis.

The policy recognizes that all aspects of Nigeria's development are vulnerable to climate change-related stressors including its natural capital (land, forests, landscapes, water, fisheries) and physical capital (cities, infrastructure, and other kinds of capital), as well as human capital. The national economy and other sectors of development are all vulnerable to climate change. Climate change threatens the national ability to build and maintain its human capital especially through health and education. A combination of frequent natural disasters, large population, poor infrastructure and low resilience to economic shocks makes Nigeria vulnerable to climate risks. The 2019 Climate Risk Index published by Germanwatch Organization classified Nigeria as a region of high risk and one of the topmost vulnerable countries in the world. The document classified the Northeast and Northwest regions of Northern Nigeria, constituting the arid and semi-arid zones, (Adamawa, Borno, Bauchi, Jigawa, Kano and Yobe States) as the most vulnerable on grounds of low average adaptive capacity, low sensitivity, high relative exposure and high relative vulnerability. The document states that the causes and impact of climate change, as well as the policies, strategies and ability to respond to or address it are not gender neutral. Climate change and gender inequality are inextricably linked. They both create obstacles to achieving poverty reduction and also have strong potential to reverse development gains. As we shall see later this is a big problem to sustainable city development in Nigeria where an overwhelming proportion of the urban population are poor people engaged in informal activities and occupying the inner and suburban slums. In the face of the above, the National Climate Change Policy recognizes that SDG5 (Achieve gender equality and empower all women and girls) is central to the mitigation and adaptation of climate change in socio-economic development in Nigeria.

In view of the above the FGN initiated a number of measures to address climate change challenges including:

(i) Institutional Framework:
The Department of Climate Change (DCC) in the Federal Ministry of Environment drives the national response to climate change at the national and international levels and is the Focal Point to the UNFCCC, as well as the Designated National Authority (DNA) for the Clean Development Mechanism and works with other Ministries through the Inter-Ministerial Committee on climate change.

(ii) Enabling Climate Change Policies:

A number of enabling policies and programmes related to climate change mitigation and adaptation (19 of them) have been adopted and include:

a) National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN) 2011.
b) National Renewable Energy and Energy-Efficiency Policy (NREEP) 2015.
c) National Gas Policy (2017).
d) National Biodiversity Strategy and Action Plan (NBSAP) 2016.
e) National Forest Policy (NFP) 2010.
f) National Forestry Action Plan (NFAP) 1996.
g) National Policy on Environment (2016).
h) National Agricultural Policy 2001.
i) Agricultural Promotion Policy (APP) 2016 – 2020.
j) National Climate Change Policy and Response Strategy (NCCPRS) 2012.
k) National Policy on Drought and Desertification (NPDD) 2007.
l) Great Green Wall for Sahara and Sahel Initiative National Strategic Action Plan (GGWSAP) 2012.
m) National Agricultural Resilience Framework (NARF) 2013.
n) National Health Policy (2016).
o) National Water Policy (2012).
p) National Transport Policy (2016).
q) Nigeria Industrial Revolution Plan (2014).
r) National Gender Policy (2006).
s) REDD+ Strategy, 2019.
t) Petroleum Industry Act

In addition, the main development plans which set strategies and priorities related to the pursuit of climate-resilient and climate-compatible initiatives include:

1. Economic Recovery and Growth Plan (ERGP) 2017 – 2020;
2. The Transformation Agenda (2011 – 2020); and
3. Vision 20:2020.

(iii) National Determined Contribution (NDC): This is contained in Nigeria's National Climate Action Plan under the Paris Agreement. The NDC represents an integrated and comprehensive strategic approach towards promoting a low carbon high growth climate-resilient path for national sustainable development. The NDC sketches the country's climate change priorities for the post-2020 period and includes targets, concrete strategies for addressing the causes of climate change and responding to its effects. It constitutes Nigeria's central pillar of development policy and integrates it with existing national development agenda and the SDGs.

The NDC includes among others:

a) Inducing long term changes in key economic drivers and sectors such as power, oil and gas, industry, transport, agriculture and land use;
b) Improved national scope to drive climate change actions at the local level;
c) Keeping up political momentum at the national level and strengthening climate change legislation;
d) Inclusion of long-term vision for low-emission climate resilient development for social and economic development as well as poverty eradication;

e) Mobilizing finance for climate change from various sources and creating an enabling environment for private sector investment in climate change mitigation and adaptation;
f) Providing innovative measures and mechanisms for the integration of climate change into development planning and strategies at all levels of governance in Nigeria;
g) Encouraging a common determination to strengthen national adaptation efforts;
h) Housing climate policy coordination in a high-level policy-coordinating organ that is better able to influence policy in major sectors of the economy; and
i) Engaging with government departments, companies and stakeholders in sectors that need to transit into a low-energy resilient development pathway and help mainstream climate action into sectoral policies and departments. The NDC Implementation Framework outlines 19 outcomes, with 150 outputs and 300 Key Performance Indicators (KPIs) aligned with sectoral action plans and national development goals.
j) A major focus of the National Climate Action Plan is Nigeria's Energy Transition Plan (ETP), a long-term strategy to decarbonize the country's energy sector and achieve net-zero emission by 2060. The ETP was launched in August 2022, based on a data-driven approach that identifies the most cost-effective pathways to decarbonization. The ETP key sectors are as follows:
    1) **Power:** The ETP aims to increase the share of renewable energy in the power sector to 30% by 2030 and 60% by 2060 through development of solar, wind & hydro projects.
    2) **Cooking:** The ETP aims to transition to clean cooking fuels by 2030. This will be achieved through the promotion of solar-powered cooking stoves and the development of a national gas grid.
    3) **Industry:** The ETP aims to decarbonize the industrial sector by 2060. This will be achieved through the adoption of energy – efficient technologies and the use of renewable energy sources.
    4) **Transportation:** The ETP aims to electrify the transportation sector by 2060. This will be realized through the deployment of electric vehicles and the development of a national charging infrastructure. The ETP is envisaged to create 840,000 jobs by 2060 (Wikipedia). The President has designated 23 locations for charging electric vehicles throughout Nigeria although the centres have not been published.

(iv) Climate Change Financing: Nigeria recognizes that to effectively respond to climate change mitigation and adaptation challenges, the country needs a critical mass of financial resources (that will not be embezzled by corrupt political and bureaucratic destroyers) beyond the capacity of all levels of government to mobilize. To do this, the government has issued Green Bonds targetting $250 million as innovative and alternative way of raising climate finance to support national projects in environment, agriculture, power and energy efficient transportation.

(v) Global and Regional Cooperation: Nigeria strongly commits to the achievement of an effective and equitable international agreement on climate change. It is committed to meeting its obligations to the UNFCCC and supporting the implementation of climate change initiatives of ECOWAS and African Union. Because of the potentials of energy, oil and gas, biomass (agriculture, forest and land-use), health, transport, industry, water and waste for GHG emissions, the National Climate Change Policy advanced policy measures to mitigate GHG emissions from these sectors (pp. 17 – 24), as well as adaptation measures (pp. 25 – 35). Human settlements, security, human capacity development, the private sector, technology and innovation and research and development as well as international cooperation have their policy measures provided for (pp. 35 – 44). Policy measures on implementation strategies and actions were elaborated in respect of mainstreaming climate change

concerns into National development, mainstreaming gender and social inclusion, roles and responsibilities and public participation and partnerships into all forms of development.

(vi) The National Climate Change Act 2021: The Act provides for the setting up of the National Council on Climate Change chaired by the President of the Federal Republic of Nigeria, the setting up of a Secretariat of the Council to be headed by a Director-General to be appointed by the President on the recommendation of the Council. The Director-General shall hold a minimum of a Masters Degree in any of Environment related field. The Council shall also appoint six Zonal Coordinators and State Directors for each of the states of the FRN. The Council consists of the President of the FRN, the Vice-President of the FRN (as Vice Chairman of Council), Federal Ministries of Environment, Petroleum Resources, Budget and National Planning, Justice, Mines and Steel Development, Finance, Agriculture and Rural Development, Power, Women Affairs, Transportation, Water Resources, Governor of the Central Bank of Nigeria, National Security Adviser, Chairman of Nigerian Governors Forum, President of Association of LGs of Nigeria, representative of the private sector on climate change or environment-related matters, nominated by the most representative registered national umbrella association, representatives of women, youths and persons with disabilities, representative of environment-related Civil Society Organizations (CSOs) appointed by the President on the recommendation of the Minister of Environment, and the DG of the Council. One of the important provisions of the Act is Nigeria's National Climate Action Plan in which the Country's National Determined Contributions (NDC) is embedded. In the next section we discuss how the above policies, Act and programmes apply to resilient urban development.

6.0: ACHIEVING SUSTAINABLE CLIMATE – RESILIENT URBAN DEVELOPMENT IN NIGERIA:

6.1 Basic Assumptions:

Although some of the issues discussed in Section 5.0 apply to urban settlements, we isolate the urban centres here for fuller treatment because of their role in propelling socio-economic and political development and the increasing concentration of population in the urban space in Nigeria. All that will follow here is based on the fact that Nigeria, especially the policy-makers and managers of our urban environment internalize the warning contained in 2023 IPCC 6th Assessment Report that precipitation will increase in the high latitudes, the tropics and the monsoon regions as the planet warms. The Report warns that intensifying water cycles means both wet and dry extremes and the general variability of water cycle will increase. This knowledge means that the more the delay by government and appropriate agencies in reducing GHG emissions and taking appropriate steps to mitigate and adapt to climate change, the higher the costs. When Nigeria realizes that the cost of adaptation for a developed economy has been put by IPCC (2023) at between $64 and $80 billion per year for the urban areas, Nigerian governments will understand the need to start at once and not continue with business-as-usual. The IPCC warns that the cost of doing nothing will be 10 times this level by the mid-21st century. This is the warning for Nigeria where rogue politicians spend billions to rig elections for their own benefit rather than for the citizens reeling under extreme poverty and spend very little on health and education.

Secondly, achieving climate-change resilience and sustainable development is based on human rights-based approach to SDGs, education, economic growth, poverty reduction, gender and health. Humans must have access to highest attainable standards of health, adequate food, housing, social security and education.

Thirdly, it is necessary to stress that in order to achieve the necessary climate change resilience both the political and bureaucratic classes must have the political will to recognize that the basic needs for food, water, energy, transport, shelter, population, and land hang precariously on climate change. To ensure that they are provided and conserved requires the participation of all and that all perspectives are considered (Muoghalu, 2024).

Fourthly, the study of vulnerability and risk assessment of all urban projects in our urban engagement must be achieved in order to balance efforts and costs in any project. In assessing the resilience of existing systems and their capacity to adapt to climate change extreme events, there is need to interrogate the following:

a) Whether the service area can in its current context accommodate expected climate change hazards;
b) The constraints in the services area's ability to accommodate changes in climate; and
c) Whether the service area is already strained in ways that will diminish its ability to handle future climate change extreme events.

The information gathered on these will be applied to urban land use planning bearing in mind the risks and opportunities associated with the changes and local vulnerabilities. The vulnerability and risk assessment will help to:

a) Determine opportunities to facilitate the development of new services and products.
b) Enhance reputation with stakeholders.
c) Protect community investments.
d) Improve quality of life.

Finally, is the emphasis on urban governance:

This involves inclusiveness, transparency and accountability in terms of how urban entities are managed in relation to sectoral laws and policies (FAO, 2017). It is about increasing the capacity of urban management authorities, their local governments, NGOs, CSOs, parastatal organizations incharge of various utility provisions, ministries, national and international donor agencies, women organizations, youth organizations, and the entire urban communities in delivering livable and sustainable urban environments. It involves building partnerships, mobilizing support for capacity building, and institutional strengthening, knowledge management, focusing on experiences gained and developing governance toolkits, such as participating in urban decision-making. The significance of integrating good urban governance and urban poverty reduction, urban greening and waste management and the critical centrality of integrating climate change into urban land use planning cannot be sidelined.

Good urban governance is a requisite for economic efficiency, and efficient administration because it is pivoted on the concept of subsidiarity. Achieving resilient sustainable urban development derives from the fact that the security of individuals and their living environment is a cardinal principle that improves the security of communities against natural and human-induced hazards in terms of designing and disseminating information on disaster, mitigation, preparedness, recovery, and rehabilitation tools.

As poverty incidence spirals by the day in Nigeria, city administrators, decision makers and planners need to make capital of women's and youth involvement in decision-making in poverty reduction through inclusiveness. It must be stressed that it is people's needs that drive the planning process. Effective public participation can be achieved through local discussions, broadcasting, newspaper articles, town hall meetings, technical workshops and extension services. We now pick the key urban sectors of the socio-economic

aspects of Nigerian urban management and discuss how to manage them with a view to achieving resilient and sustainable development in view of climate change.

6.2 Key Issues in Management of Urban Development Resilience in Nigeria

1. Urban Growth:

Much of the problem of urbanization management in Nigeria derives from uncontrolled demographic and spatial growth of urban centres in the country. In order to check this, it is recommended that emphasis should be placed on medium and small size cities so as to stop the gigantism of the first- and second-class urban size centres on Table 2. New town concept could also take steam off the first and second category of urban centres. This will reduce the problem of metropolitan-wide development and management especially as our cities extend over a number of jurisdictions, especially where there is no area-wide metropolitan institution charged with metropolitan planning and management. The assumption that higher productivity in big cities is brought about via economies of scale (Richardson, 1973 and 1976) may not be true of Nigeria where sprawling urbanization is occupied by the poor living in slums, accentuating problems of achieving resilient and sustainable urban development. In Nigeria large urban growth is achieved at the expense of productivity. As Gilbert (1976) argued, if infrastructure of the same quality as in the over urbanized space, were provided in medium and small-sized towns, productivity in these urban centres would rise.

It is on record that between 1975 and 1980 zero urban growth strategy was introduced in South Vietnam, in China periodically from late 1950s, while in Cuba since the socialist revolution of 1959 urban-rural imbalance in terms of development has been implemented (Potter et al, 2008: 400 – 403). For the four urban clusters shown in Figure 1, what is recommended is three-pronged policies of concentrated urbanization and genuine interregional deconcentration and decentralization. I would think that the Structure Plan prepared by UN-HABITAT (2009) for Awka is based on a polycentric urban structure to minimize problems of congestion and pollution. In this way development corridors or axes, can be designated, leading from the region, and growth can be focused upon them. It seems to me that this is what Governor Soludo is doing in the dual carriage ways he's doing from Awka to Ekwulobia and from Agulu to Nnewi; Awka is already linked to Onitsha by the Enugu-Onitsha Expressway. The remaining limb is Oba-Nnewi-Ekwulobia double carriage way.

The major problem with management of urbanization in Nigeria is that policy makers are touting sustained growth (aimed at seeing the city have a pivotal role in initiating and maintaining national economic growth), rather than laying emphasis on sustainable urbanization. No doubt, economic growth is an essential component of sustainable urbanization, but is only a fraction of the processes that constitute a contemporary city (Potter et al, 2008). In this scenario economic factor, while contributing to the economy, should focus on the repercussions of the economy on the residents of the city in terms of employment, incomes and poverty at the household level, as well as impact on the environment and social issues, such as workers' rights (Potter et al, 2008). The main components comprise demographic factors, economic factors, social, political and environmental factors (See Figure 2). As Potter et al (2008) argue for urban management to achieve sustainability a new set of priorities need to be pursued including the pursuit of equity and social justice, satisfaction of basic needs, recognition of social and ethnic self-determination and human rights, environmental awareness and integrity and appreciation of the inter linkages across space and time.

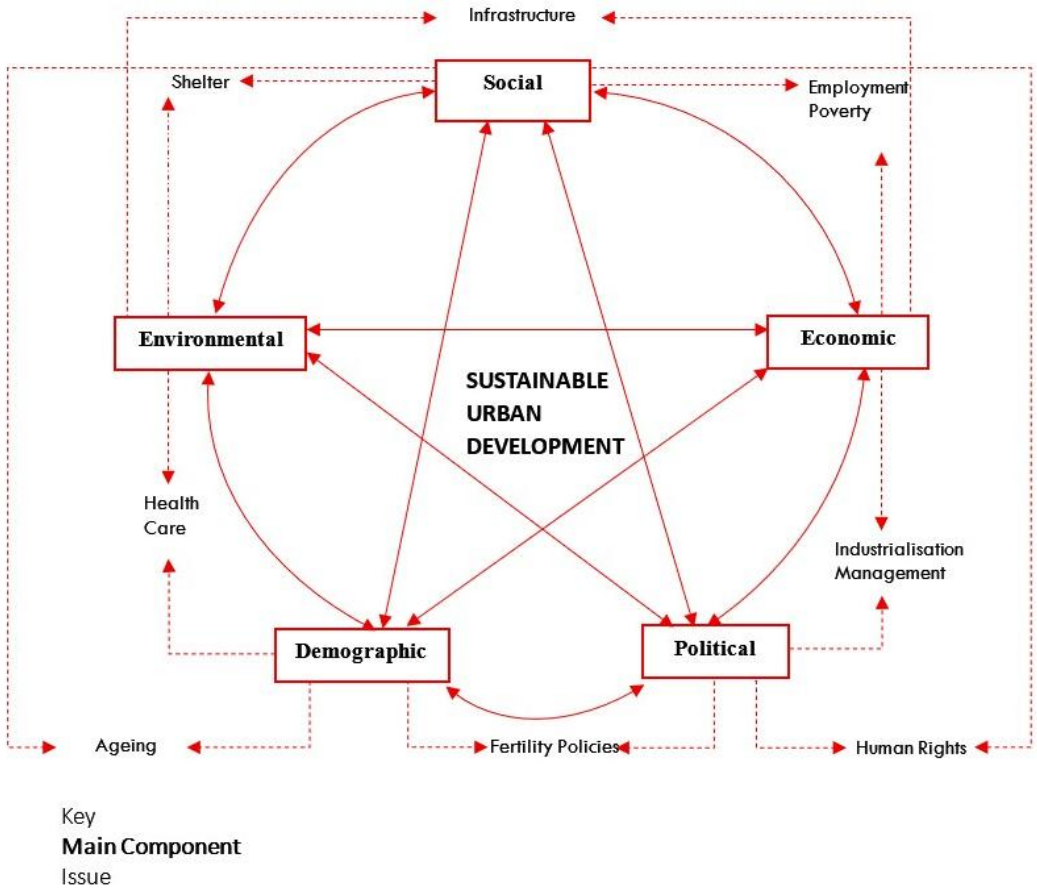

Figure 2: Main Components of sustainability system

Source: Potter et al (2008)

2. Demographic Factors:

In the burgeoning rapid urban population growth, achievement of sustainable urban management effort should be made to invest attention on demographics. Family planning is essential since raising children and access to family planning services is more expensive in cities. Demographic data is essential. The 2006 Nigerian census results show that 82.66% of total Nigerian population is 39 years and under. Management of fertility is important in a context where 43.0% of national population is aged 19 years and below. This segment is the target of education, health and skill acquisition in an environment of extreme and spiralling poverty and in an economy characterized by a paucity of manufacturing industrialization and proliferation of informal activities that are incapable of providing large-scale industrial employment. Nigeria has an average household size of 6. The role of women in household income generation and meeting basic needs of nutrition, education, health and housing demands their unquestioning participation in all aspects of urban management. Knowledge of urban ethnic composition and ways in which migration has created complex and tense situations in the competition for limited urban resources is essential. It is known that in all major urban centres in Nigeria apart from the indigenous people, the Igbos come next. Their migration propensity derives from their home area being starved of any meaningful federal government and multinational company investments. Their preponderance in urban centres outside their home area instead of being capitalized upon for sustainable urban development, has been responsible for their persecution and targeting in all urban settlements in

Nigeria, especially in Lagos, Plateau, Kano and Kaduna States. This is why urban development in the South-East geopolitical zone should make provision for medium to large scale industrialization.

3. Housing:

The crucial issues in Nigeria's urban housing has to contend with urban slums/squatter settlements, matching urban population growth rate with housing provision and places of employment, transportation needs, social infrastructure provision, and urban planning and taking care of risks and vulnerabilities the slum areas are facing. As Governor Soludo in partnership with UNDP did at Okpoko slum settlement in Onitsha, tarred 15kms of roads, reticulated pipe-borne water, installed solar energy street lights, provided a general hospital and provided the much-needed storm water drainage channels. Before this renewal up to 99.9% of the residents lived in a waste dump area, facing numerous health and environmental risks with unsafe water, land, air pollution and ubiquitous crimes (Fides Newspaper, March 23 – 29, 2025). In dealing with slums, it must be realized that they are solution to urban housing shortage in Nigeria. What slum residents want is secure tenure and rising income which will facilitate their self-help housing effort (Turner, 1976).

Self-help consists of upgrading (i.e. improving existing area), development of site and services schemes (where new lands are opened up) and core housing on site. It must be noted that too high standards in building makes housing inaccessible to the urban poor. A scheme, imported from South Africa by the Peter Obi administration, known as "hydraform", could have delivered moderately standard housing of inexpensive brick in slums, but was frittered away in the whirling melee of politicking and quest for self-interest. Organizing squatter populations to improve their living conditions in education, health, sanitation, services, tree planting, schools, day-care centres, water sewers reduce illiteracy through adult education. Tree planting in urban areas should be taken seriously.

At the total urban level budgetary allocations should make provision for urban infrastructure maintenance and repair such as water pipes, storm water drainage channels, sewers, roads, primary health centres, hospitals, parks and open spaces and not just for new constructions only. To avoid neglect and dilapidation low interest long term loans to low- and middle-class families through mortgage institutions should be provided to encourage home ownership.

Effort should be made to evolve a paradigm shift in urban planning by preventing informal settlements (squatter and spontaneous settlements) in areas that should not be developed. The 1992 Urban and Regional Planning Law provides for implementation of urban renewal activities and creation of Urban Renewal Agencies in the 36 states and the Federal Capital Territory (FCT). This should be implemented.

The National Urban Renewal and Slum Upgrading Programme which commenced in 1989 involved the extension of grants to states for urban improvements should be aggressively pursued.

The implementation of an MDG Programme initiated in 2011 – 2012 and consisting of public buildings and utilities (69 projects), construction/ upgrading of access roads (56 projects), slum electrification (64 projects, and water & sanitation) (70 projects) were not realized and should be continued into the SDGs to reduce water borne diseases, improve public health, improve housing for the urban poor and disadvantaged, improve pedestrian and vehicular access and improve employment opportunities.

The participatory urban planning at State and urban levels involving UN-HABITAT ended up with the latter doing structure plans for Awka, Onitsha and Nnewi without implementation. The policy prescriptions should be driven to the end as well as being continuous as a medium, long-range programme. This is because the

programme targeted 100% slum upgrading in cities. Community consultation and participation to facilitate confidence and buy-in and ownership for project support and post-implementation maintenance and sustainability has been on paper only.

Urban Transportation, Urban Planning and Urban Infrastructure:

As we observed in the closing section of urbanization challenges in Nigeria, transportation, despite its numerous advantages is the highest contributor of GHG emissions. Because of the fact that cities need transportation to survive, steps must be taken to tone down its negative effects, especially in its GHG emission potential, its effect on health not only to human beings, but to plants and forests, aquatic ecosystem and acid deposition.

Apart from the Energy Transition Plan, which is a response to Global intervention, the following steps can be taken in Nigerian urban centres. Because urban transportation and urban planning are related, the recommendations we make here are all embracing prescriptions. We have earlier treated urban growth, some of the prescriptions here may touch that too.

(i) Controlling the growth of mega cities through new town or satellite town and medium size town development.

(ii) Controlling the number of cars on urban roads by administrative, economic legal and planning instruments.

(iii) Establishing and equipping LPG and CNG filling stations in all first, second and third grade urban centres in Nigeria and at designated fourth and fifth grade cities. At the moment NIPCO Oil Industry says 15,000 of their trucks are running on electric battery.

(iv) Introduction of decent urban mass transit vehicles, subways, especially along the most travelled collector and arterial roads. Urban light railway system is cheaper as it carries more people over a narrow strip of land, produces less air pollution, makes less noise and could be safer. This is very necessary in Lagos (which is already implementing these) and in the second and third level urban centres that are bursting at the seams. To mitigate traffic congestion, traffic control such as stop and yield signs, traffic lights and signals at road intersections, use of traffic wardens, voluntary paramilitary organizations and philanthropic individuals are recommended. Road channelization (road markings), modal and route assignment and routeway rehabilitation can reduce traffic congestion. Technology can be of relevance, such as introduction of catalytic converters which will guarantee efficiency in fuel combustion, removal of lead in fuel refining and efficient vehicle inspection will mitigate air pollution.

The use of zoning instrument can assist in ensuring better traffic flow, while the use of cleaner technologies in vehicles and factories and stricter control on importation of used/second hand vehicles will reduce GHGs. Proper and strictly controlled waste management system will reduce CH_4 from decomposing garbage. Economically, the use of polluter pay principle will make drivers/owners of vehicles assume full responsibility for the costs of the problems they create including time lost in traffic congestion, and pollution. In the same way heavy trucks should pay for road damages they cause. This would shift more freight to energy efficient rail systems. The evolution of differential licence will vary by time and area so as to reduce the volume of traffic at peak hour periods.

Buildings:

Heating, cooling and lighting buildings consume about one-third of the energy used in modern societies (Miller Jr., 1996:340).

(i) Orientation of buildings to capture solar energy and block out the higher dry season sun can reduce air conditioning costs.
(ii) Building super insulated houses that are heavily insulated and sufficiently airtight from direct sunlight; appliances and human bodies warm them, with little or no need for backup heating system. An air-to-air heat exchanger prevents buildup of indoor air pollution without losing much heat.
(iii) In the developed industrial countries, microprocessors will monitor indoor temperatures, sunlight angles, and the occupants' locations in order to send heat or cooled air where it is needed.
(iv) Researchers have developed "smart windows" which electronically from being clear (which lets in sunlight and heat on cold days) to being reflective (which deflects sunlight when the house gets too warm). Thinner insulation now being developed will allow roofs and walls to be insulated far better than in today's super insulated houses. Researchers are experimenting with smart walls, consisting of wallboards made with materials that absorb heat, and release heat to a room as determined by a thermostat. Sensors will turn off lights in unoccupied rooms or dim lights when sunlight is available.
(v) Improve energy efficiency of existing houses by adding insulation, plugging leaks, and installing energy-saving windows.
(vi) Buying the most energy-efficient appliances and lights. More new-saving computers using low-power microchips designed for battery-powered portable computers are already in the market.
(vii) Planting trees in the compound can reduce energy bills and lower greenhouse gas footprint.
(viii) Using light coloured roofing sheets and painting houses with white paints can reduce ecological footprints.

Physical/Land use Planning

Interrupted and uncontrolled urbanization has made cities the focal points for climate change impacts. Rapid urbanization, accelerating demand for housing, resource supplies and social and health services, place pressure on already stretched physical, social and regulatory infrastructures heightening existing risks and vulnerability related to inequality, poverty, indigence and informality (informal work and settlements). To attenuate these, physical planning has a great role to play.

(i) In this endeavour, efforts should be made to identify and protect areas critical for preserving water quality, supplying drinking water and reducing erosion in areas that are most likely to suffer from hazards accentuated by climate change. This is why the deforestation of Akpaka Forest Reserve in Trans-Nkisi in Onitsha was an ecological tragedy. The same is also true of the destruction of forests in Omagba, which has given rise to the growing gully erosion stupendously extending behind Anglican Girls Secondary School, Nkpor down to the Water Field behind Governor's Lodge in GRA Onitsha. Our recommendation for new satellite, medium sized and new towns should take care of this.
(ii) Effort should be made to identify and prioritize goals to encourage/discourage further economic development and population growth to preserve prime no plan, forests, wetlands from development to reduce soil and gully erosion. This is why the invasion of the massive wetland stretching for kilometres from behind Nkwelle Awka-Umubele-Amawbia into Nise by residential development

through sand filling is an ecological crime. This stretch will experience severe flooding as slopes on both sides of the wetland have been deforested and are being replaced by concrete structures.

(iii) Zoning as planning tool to control urban growth and protect areas from certain types of development. Planning authorities can control the rate of development by limiting the number of building permits, sewer hookups, roads and other services in some areas. This is why the sale of land and rapid development of residential houses from Isuanaocha to Urum down to Oba-Ofemili raises issues of prime agricultural land (Muoghalu, 2024).

(iv) Integrating homes, work places and shopping areas will reduce urban sprawl, energy waste and loss of community. China embarked on comprehensive national zoning plan to achieve zero net loss of farmland to residential, industrial and commercial development. Large lot zoning is a colossal waste of land.

(v) Making Cities Ecologically Sustainable: In ecologically sustainable cities or ecocities people walk or cycle most short trips and walk or bike to bus, metro or trolley stops for longer urban trips. Rapid rail transport between cities would replace many long drives and medium-distance airplane flights. These ecologically healthy cities would rely on energy-efficient renewable energy sources, recycle or reuse almost everything, encourage biodiversity and use composting to help create rather than destroy soil (Miller Jr., 1996, pp. 270 – 271).

Example of Curitiba, Brazil.

Curitiba, an example of an ecocity, had a 1994 population of over 2million people. It has trees everywhere because city officials gave residents 1.5million trees to plant and care for. No tree in the city can be cut down without a permit and for a tree cut down, two are planted. Air is cool because it was not built around the car. There are 145kms of bike paths and more are being built. It has the world's best bus system. Each day a network of clean and efficient buses carries 70% of city commuters and shoppers at a low cost with unlimited transfers. Only high-rise apartment buildings are allowed near major bus routes. Each building must devote the two bottom floors to stores. The stores minimize the need for residents to travel. Curitiba recycles 70% of its papers and 60% of its metals, glass and plastics. The trash goes to a separation plant, itself built of recycled materials. Recovered materials are sold mainly to the cities over 340 industries. The poor can swap for food and receive free medical, dental and child care with 40 feeding centres for street children. As a result, infant mortality rate fell by more than 60% since 1977.

The major factor for the success of Curitiba is the willingness of citizens to work for a better future, including those who are resident in slums, shanty towns, in addition to city officials who genuinely care about providing a high quality of life for all of the city's inhabitants who relish solving problems by using imagination, common sense, determination and good planning (Miller Jr., 1996: 270 – 271).

The benefits of bicycle include its energy efficiency as a form of transportation (including walking), burns no fossil fuel, produces no pollution, makes little noise, is rarely a serious danger to pedestrians or cyclists and takes few resources to make.

The use of light-coloured sand to asphalt increases reflectivity and establishes energy efficient standards for vehicles, buildings and appliances. There is poor monitoring and implementation of planning regulations in Nigeria. The Anambra State Physical Planning Board (ASPPB) has a regulation that three trees should be planted in each compound yet nobody does this and nobody forces implementation.

(vi) Urban and Peri-Urban Agriculture:

A major impact of climate change will be reduced food production as a result of heat-related plant stresses, flooding and vulnerabilities faced by small-scale producers. In sub-Saharan African a recent study shows that yields will drop by 22% for maize, 17% for sorghum and millet, 18% for groundnut and 8% for cassava in mid-21st century, while extreme wind, storms and turbulence are expected to decrease fish catches. Scarcity of freshwater will threaten livelihoods linked to agriculture and forestry. Sprawling urbanization reduces valuable agricultural and forest land (Ackerman et al, 2012). Because of the above reasons encouraging urban agriculture will pay dividends. Such urban-based agriculture is prevalent in Kano and can be adopted as a model. The cultivation is made possible by the construction of a number of dams together with sinking of wells and boreholes in a region of 700mm of annual rainfall and a long dry season from September to May (Potter et al, 2008:408 – 410). Considerable amounts of fruits and vegetables are produced in and around Kano within 10km radius of the walls of the old city (Figure 3).

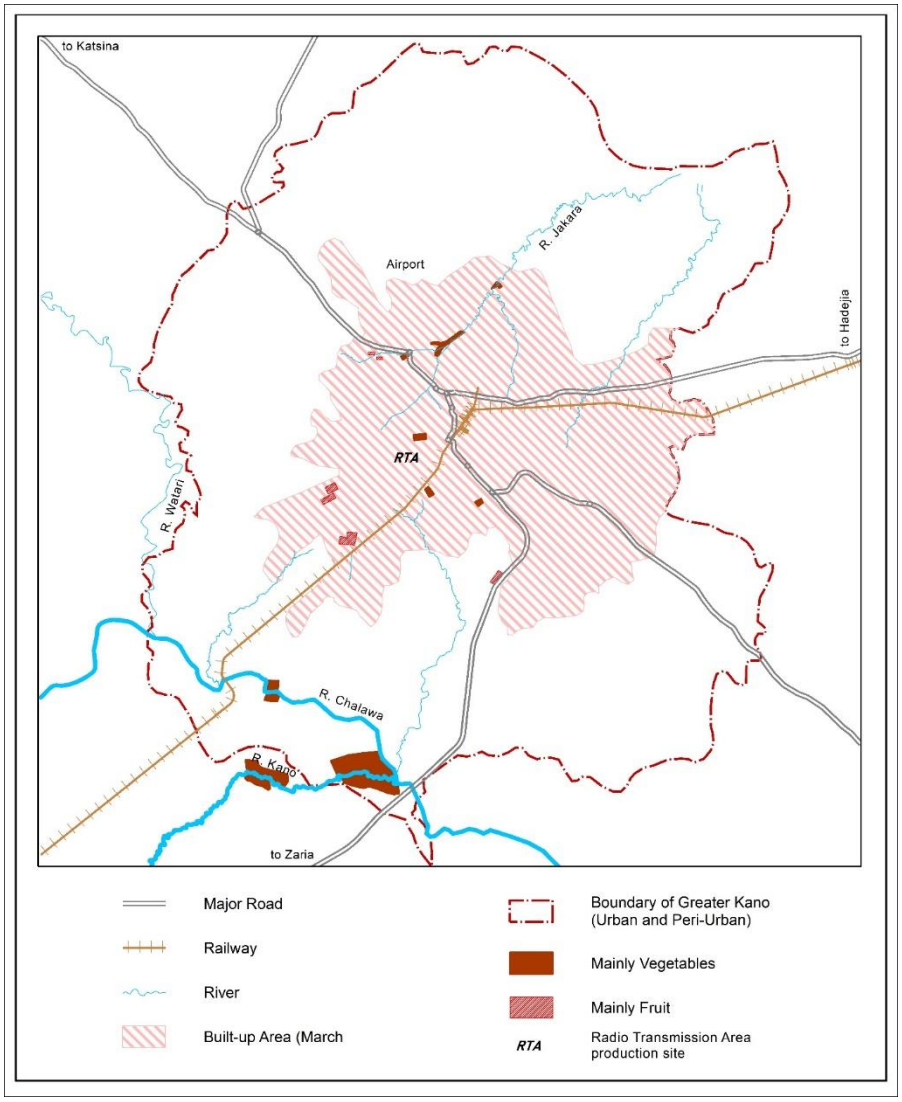

Figure 3: Urban and Peri-Urban Agriculture in Kano
Source: Potter et al (2008)

The production, transporting and marketing of the fresh products is a critical income-generating business, as well as satisfying the basic needs of metropolitan Kano population. Figure 3 shows that many plots are located in built-up areas where farm plots are small ranging from 0.01 to 0.40 hectares. Major vegetables grown are spinach, maize, okro, lettuce, onion, tomato, sorrel, pepper and sugar cane, while the main fruits grown are mango, guava, orange and pomegranate. Major inputs into this agriculture are chemical fertilizer, ash, household refuse and animal manure. Large trucks, mini buses, taxis, motor cycles, bicycles and donkeys transport the produce to metropolitan markets. Urban agriculture in Kano is a significant form of land use, employment and food supply. For the sustainability of Kano urban and peri-urban agriculture, the practitioners identified two important issues: the heavily polluted nature of irrigation water and uncertainties of security of tenure in many of the production locations (Lynch et al, 2001). Urban management authorities should give life to these constraints. Urban planners worry about land-use conflicts and possible disease transmission when irrigated areas are juxtaposed with residential buildings.

This paper suggests that this is what the UN-HABITAT sought to provide Awka Capital Territory in its Structure Plan of 2009 by making provision for Agricultural City encompassing the State College of Agriculture (UN-HABITAT, 2009) at Mgbakwu in Awka North LGA.

(vii) Education and Awareness for Climate Change:

At the heart of all our discourse is mass education on what climate change is, its risks and vulnerabilities, how earth systems work and the need to mitigate and adapt to climate change hazards. The education of the urban masses, especially the low-income folk, the jetsams and floatsams of our urban society, is most critical in confronting the war on urban economic growth and development, social relationship and environmental sustainability. There is need to involve all stakeholders in our development decisions. The bottom-up approach in decision-making is necessary to involve all in ensuring sustainable cities. This is the rationale for developing workable urban governance model that elicits the involvement of all stakeholders and all perspectives. Neighbourhood buy-ins in housing, provision of the much-needed infrastructure, waste management, community sense, settlement locations, etc are necessary. Early warning systems are essential in climate change adaptation. The radio, television, local newspaper advertorials, cell phones provide avenues for information sharing and education. Education here should be to make the urban centres better not worse and that activities that make the urban environment unhealthy, not give jobs, that pollute air and water, that degrade the soil, that diminish green space or biodiversity, that waste resources, that create inequality, that degrade the beauty and integrity of landscape and encourage and proliferate crimes are forms of theft from the commonwealth much as like bank robbery. Thus education is a plea to urban managers, decision makers and planners and design professionals to assume the roles of diplomats, brokers, technicians, mobilizers and advocates for the social, economic and environmental constituents of our Nigerian urban space, especially for the disadvantaged members of our urban communities who crowd up areas of minimum choice in search of livelihood (Muoghalu, 2015).

Sea Level Rise:

Many urban centres in Nigeria are located along the 800km coastal lands. These include Lagos, Badagry, Yenagoa, Port Harcourt, Warri, Bonny, Calabar. The rates of shoreline erosion were shown earlier in this paper. Rising temperature causing defreezing of perma frost areas can inundate coastal areas with significant impacts on natural shorelines, and on coastal development and infrastructure, especially in relation to oil and gas and fishing. Receding shorelines threaten coastal development, transportation infrastructure, tourism and freshwater aquifers. For coastal cities defensive walls against ocean sea level rise are needed. Studies by Moffat and Linden (1995) shows that a sea-level rise of 1m/100 years would cause flooding over about 18,000km^2 (or 2% of Nigerian land area), of the Niger Delta area. If this happens, much of the economic activities in the Niger Delta (oil and gas production, agricultural activities and fisheries) would be disrupted and 80% of Niger Delta population will move to higher ground, while property damage would approximate to US $9bn. Lagos, Okitipupa, Warri, Bonny, Calabar, Burutu and Port Harcourt would face the same scenario. It would be advisable that further urban expansion should move farther inland to reduce vulnerability.

Research programmes must identify the most salient research questions to improve Nigerian urban centres in coping with projected impacts of climate change and develop the most practical solutions based on current knowledge. This can be done at the MSc and PhD levels and academic staff research. Nigerian coastal zone management should balance competing uses of the coastal zone and address the full range of coastal issues, including managing development in high-hazard areas, protecting natural resources, providing public access, redeveloping urban waterfronts and ports, siting energy facilities, protecting coastal water quality, and ensuring that local governments and the public participate in coastal decision-making.

Individual Actions:

Environmental thought advocates thinking globally, but acting locally. The locality consists of society, communities, families and individuals. Sustainable development thinking involves behavioral change. This change finds expression in individual behavioural change. On account of this, discussion will end with individual actors. In relation to our topic of discussion what can the individual do? Although long-term effective action will, without fail, involve new global policies and market incentives, individuals can play a significant role in initiating and building greater support for the required changes (Schmidt and Wolfe, 2008).

i) *Self-Education:* Although climate change is complex with a lot of scientific detail, yet it is understandable in general terms. The more we know as individuals, the easier it is for us to take correct decisions. Such a decision will be how we can reduce our carbon footprint, which mirrors the CO_2 we emit through the use of fossil fuels and other activities in our daily life. Our individual carbon footprint is calculated not by finding our individual direct emission from air and car travel, heating, and electricity, but also the indirect fossil fuels required to produce and transport food, clothing and a whole lot of other consumer goods and services. For now our carbon footprint in Nigeria is low compared to American average per person of 20 tons or global average of 4 tons. For our wealthy class, their carbon footprint may be higher than the American average.
ii) *Increasing energy efficiency in our houses:* This is the best way to reduce our carbon footprint, while at same time reducing our heating and electric bills. Choosing the best energy saving options when you replace old windows can have a larger impact.
iii) *Apply the conservation measure of purchasing energy-efficient Energy Star appliances*-everything from refrigerators to air conditioners to exit signs and turning off televisions, stereos when not in use.

Leaving them on standby mode consumes 10 to 60% of power they do when on. The same with sensors and timers that turn off lights and other electrical items when not needed.

iv) *Start using compact fluorescent light bulbs* (CFLs) that use about 80% less energy than standard incandescent bulbs and last up to 10 times longer.

v) If possible, choose your energy from renewable resources-usually wind, solar or hydropower.

vi) *Transportation is a good avenue to reduce GHG emissions.* Opt more for mass transportation; Biking and walking are far healthier than driving for us and the environment. Where there is no choice about driving, use a more fuel-efficient car. Keeping tyres more adequately inflated can save 0.125 tonnes CO_2 per year, while checking your car's air filter monthly and changing it as necessary can eliminate another half-ton of CO_2.

vii) *The most significant individual role is to let your voice be heard*. Politicians at all levels need to know that this issue is important to you and that you want them to focus on the problem. This is true for the media and businesses. Write letters to support emission reduction. Ask questions on how climate change will impact your communities and what action is being taken to support green-building codes.

viii) *Vote with your pocket book by buying energy-efficient products*, locally produced goods, and products made from recycled materials.

ix) *Vote for politicians with demonstrable leadership on climate change*. Support local, national and international efforts to protect habitat and plant trees. Urge town/communities, schools, businesses to embrace energy efficiency and increase their use of solar, wind, gas, hydropower, etc.

The Role of the Faculty of Environmental Sciences, Chukwuemeka Odumegwu University:

Within the context of our discussion, what is the role of our Faculty of Environmental Sciences in achieving sustainable urban development and climate resilience in Nigerian urban centres. Although we do not have a full complement of 10 departments as indicated by the National Universities Commission due to poor or nil funding by the state government and society generally, we have a sacred and moral obligation to contribute to the healthier and sustainable development of our urban centres as urbanization is irreversible.

Apart from teaching our students to acquire skills to visualize and approach environmental planning as a holistic entity by developing in them the habit of thinking clearly, creatively, purposefully, analytically, critically, logically and reflectively, we have an obligation to make the design of an ecological settlement clear to them. The most glaring design failures of industrial/technologically driven societies are the loss of diversity of all types, impending climate change, pollution and soil erosion.

However, industrial civilization was not designed but imposed by single-minded individuals, guided by one doctrine of human progress or another, each requiring the homogenization of nature and society. These individuals had no knowledge of ecological design arts – the set of perceptual and analytic abilities, ecological wisdom and practical tools to make things that fit into a world of microbes, plants, animals and energy laws.

Good ecological design entails the comprehension of how nature works into the ways we design, build and live. This should be part of our designs of farms, houses, neighbourhoods, cities, transportation systems, technologies, economies, energy policies. Good design of human artifacts and systems are in harmony with ecological patterns in which they are embedded. When poorly designed, they undermine those larger patterns, creating pollution, higher costs and social stress. Bad design is not just an engineering problem, though better engineering would often help.

Good ecological design has features of correct scale, simplicity, efficient use of resources, a close fit between means and ends, durability, redundancy and resilience. These characteristics are place specific or what Todd and Nancy (1993) term "elegant solutions predicated on the uniqueness of place". This is why two settlements must be treated uniquely. Good design solves more than one problem at a time and promotes human competence, efficient and frugal use of resources and sound regional economies. This explains the integrated design approach where all stakeholders and perspectives should participate. This is the beauty that Climate Change Council (as provided for in the National Climate Change Act 2021) seeks to achieve.

When good design becomes part of the social fabric at all levels, unanticipated positive side effects multiply. The reverse is also true. The prevalence of pollution, violence, social decay and waste everywhere in our cities is evidence of poor design. Three primary reasons can explain this situation. One, the cheapness of land and energy, the vast landmass available, insensitivity to ecological consciousness enabled the non-mastery of the discipline of good design. This led to sprawling cities, wasteful economy, waste dumping everywhere, bigger and less efficient automobiles and buildings and conversion of forests into junk mail – all in expression of economic growth and convenience. Two, design intelligence does not thrive when greed, narrow self-interest, corruption and individualism are endemic. Good design is a cooperative community process requiring people sharing common values and goals that bring and hold them together. Nigerian cities, with extremes of poverty and opulence are characteristics of people who hold nothing in common with one another. Greed, corruption, suspicion and fear undermine good community and good design alike. Finally, poor design is the product of poorly equipped minds. Good design can only be done by people who understand harmony, patterns and systems. Good design requires a breadth of view that causes people to ask how human artifacts and purposes fit within a particular culture and place. It requires ecological intelligence of how nature works. Ecological design standard approach to transportation, for example; would create better access among housing, schools, jobs, markets, recreation areas, better public transit systems, improve railroads, and create bike trails and walkways.

The faculty could provide education in ecological design arts that would foster the ability to see things in their ecological context, integrating firsthand experience and practical competence with theoretical knowledge of how nature works. It could equip our students to build households, institutions, farms, communities, corporations and economies that:

(1) Do not emit CO_2 or other heat trapping gases;
(2) Operate on renewable energy;
(3) Preserve biological diversity;
(4) Recycle material and organic wastes; and
(5) Promote sustainable urban and regional economies.

The faculty can get through Senate to establish a Centre or Institute of Environmental, Human Settlement and Population Studies on which platform you can compete for research on population, settlement and environmental issues particularly from research establishments abroad. The faculty can also compete for environmental impact studies within the country. It can also be a veritable platform for short-term certificate studies from private and public sectors. The platform will also get grants from Tetfund and external bodies to conduct conferences on critical issues on the environment.

7.0 PLANNING IMPLICATIONS AND CONCLUSION:

Our discussion has a number of implications for planning.

One is the unreliability of demographic data arising from the politicization of census in Nigeria. Only on accurate data can accurate population projections be made. Only on accurate projections can realistic projection of urban land needs be based and with access to accurate geo-referenced data will help support informed decision and policy making be based regarding the actual needs of urban expansion. Because population data is the basis for resource allocation, creation of jurisdictions (State or Local government), representation in local, state and federal institutions census projects in Nigeria have become wars. The ubiquitous insecurity in Nigeria has further complicated demographic census in the country. Managing urban growth and expansion is expressly acknowledged in the National Urban Development Policy of 2012 as a foremost priority.

In the chapter on "Urban Planning". The adoption of land use plans is seen as a priority to the emergence of "non-functional, disorderly, unhealthy, unsafe and aesthetically unappealing cities and urban areas". There is need to enforce the capabilities of spatial and land use planning authorities to adopt instruments orienting the growth of cities to contribute to overall economic performance in the context of overriding ecological infrastructure.

Two, is the mismatch between urbanization, spatial expansion and urban governance. There is a visible mismatch between the extent of land cover occupied by the built fabric and existing administrative and institutional boundaries of Nigerian Local Government Areas (LGAs). Spatial expansion is not constrained within municipal limits, but generally overlaps between various LGAs. Existing urban areas grow and attach to themselves adjacent peri-urban or even rural areas or as cities or rural towns grow into greater urban centres which cover different municipalities or frequently states as between Lagos and Ogun States or Abuja and Niger and Nasarawa States or into LGAs as in Lagos, Enugu, Calabar, Ibadan, Onitsha, Zaria, Owerri etc. While the 1999 Constitution (as amended) establishes three levels of government (local, state and federal), there are no dispositions for establishing institutional structures able to encompass an overall metropolitan area when it spreads across various LGAs. Existing urban governance structures are often unable to provide the strategic guidance needed for it.

Within this structure states appear to govern metropolitan areas, albeit unsuccessfully. States have been asking for greater devolution and decentralization of powers from the federal government to the states. With the promulgation of the National Urban Policy and the 1992 Urban and Regional Planning Act, it looks as if the Federal Government would legislate for states on urban planning issues. However with the challenge of this by the Lagos State Government, the Supreme Court ruled that States could situate governance as entities with appropriate capabilities to address emerging challenges in urban growth and expansion. Consequent on this the Rivers State Government set up Port Harcourt City Development Authority in 2009, to implement a master plan for the wider metropolitan areas, as well as to support the delivery of the New City real estate development project to usher in the transition of the city to a world class metropolitan area. Kano State established in the 1960s the Metropolitan Kano Planning and Development Board to deal with larger-scale planning issues in the metropolis. Ironically while the Board holds power in development control and physical planning, it is denied the technical and coordination capabilities to truly implement policy at the metropolitan level. In 2009 Enugu State government set up the Enugu Capital Development Authority (ECDA) incorporating the various LGAs that comprise Enugu as an urban area. The ECDA operating under the mandate of Enugu State Government, is responsible for updating Enugu Master Plan and proffering advice

on development of Enugu Capital Territory. It doesn't have a separate budget to deliver and enact policy. All ministries in the state have to agree to work with and allocate resources accordingly with the ECDA.

In Anambra State, the state government set up the Awka Capital Territory Development Authority (ACTDA) to accelerate infrastructural development of Awka Capital Territory, prepare and implement a Master Plan for the capital territory and land use with respect to town planning within the capital territory and provide infrastructural service in accordance with the master plan.

However, since inception the Authority has been having a running battle with Anambra State Physical Planning Board (ASPPB) domiciled in the Ministry of Lands, Surveying and Urban Planning. The ACTDA has authority to prepare its budget for approval by the House of Assembly through the Governor's Office. While the Authority prepared the development control manual, it is struggling with the ASPPB over development control activities.

Three, is the cost of the great push to realize the energy transition plan into what appears to amount to a new industrial resolution in a developing country like Nigeria reputed to be the poverty capital of the world and as the worst electricity generating country in the world, the third most terrorized nation in the world and perceived as the most corrupt country in the world according to the World's Growth Indices in the 2017 – 2018. The procurement of new low-carbon technologies means money at a time of profound global economic and financial stress that makes it harder for poor and vulnerable countries to shift to a new economic and technological paradigm. The global Commission on Growth and Development (2008) charged with identifying policies and strategies to support economic growth and poverty reduction has argued that an impasse has been reached on how to cut down carbon emissions, while allowing developing countries to grow. Nigeria has borrowed heavily to execute its annual budgets while almost all infrastructure in all sectors have virtually collapsed. The Commission recommends that to overcome the impasse for a big push, requires blending pro-investment macroeconomic and industrial policies in order to move to a transformative low-emissions growth path. It argues too that the integrated development strategy needed to drive the transition, requires a strong and dynamic developmental state to manage it and sufficient policy space to be able to adapt climate measures to local needs and sensitivities.

This sustained accelerated growth usually requires rapid capital accumulation and shifts in the structure of economic activity towards high productivity sectors that would result in rising productivity, increasing wages, technological upgrading and social improvement. Infrastructural development in general and energy supply in particular are critical elements in this push. The question for Nigeria is how will the country transform the mass of the urban poor to highly productivity person? Can Nigeria embark on an investment like the Tennesse Valley Authority? What substantial improvements are attributable to the Kainji Dam, the Jebba Dam, the Bakalori and Bagauda and Tiga Dams? What of the corruption constraining the Kontagora and Gongola hydroelectric power stations that would have contributed to high food security, flood control, and electricity generation and creation of green jobs? How do we progress to low carbon emission when most urban dwellers cook with fuel wood energy? By 2030 will the national performance approximate the dismal MDG experience? What is the time table for a switch to LPG and CNG or electric battery for car owners and transport vehicle operators? How will our country move to compact housing development and orienting our urban centres to biking and walking? Nigeria needs to issue automobile producers abroad with the standard of vehicles for Nigerian roads as is done by developed industrial countries.

Four, definitive policies, not permissive population policies need to be in place. Population growth is one of several factors that drive climate change, because population size has direct relevance to human ecological

footprint. Programmes designed to improve access to reproductive healthcare and slow future growth of Nigerian population can serve as long-term mitigation and adaptation strategies at local urban level. Demographic and population dynamics (including fertility, mortality, migration, spatial distribution and age structure) should be built into climate change research.

Five, building construction and operations account for about 50% of national energy budget and a disproportionate amount of carbon emissions because electrical power is required to heat, cool and light buildings. Although numerous designs and construction practices, technologies and standards are currently available under the rubric of green buildings, Nigeria has an enormous backlog of millions of housing deficit. In spite of proclaimed great efforts to construct public housing, completion rates have been appalling often stalled by political party acrimony. With an estimated housing deficit of between 0.85 and 1.03 million per annum between 1975 and 1985 and rising to about 1.6million between 1985 and 2000 (Mabogunje, 1988 quoted in Ozo, 2005). The Federal Government stated that it would build 37million new housing units to satisfy housing demand, not need by 2000 (FRN, 1985). The three national housing programmes in the 1975 – 1995 period produced only about 76,000 units nation-wide (Ogu, 1999). The Federal Housing Authority (FHA) provided only 15,151 housing units in Lagos, Abuja and some state capitals between 1976 and 1993. State Housing Corporations provided only minimal proportion (AHNC, 1985). The private sector has been the major provider. For example, by 1987 over 95% of houses in Benin City were provided by the private and owners (Muoghalu, 1987a). Even in the publicly provided units, the urban poor were priced out (Muoghalu, 1987b). For example, of the 75 housing units provided by the FHA in Trans Ekulu and Abakpa Nike in Enugu only 17 units or 22.7% went to the poor and the rest of 77.3% went to those who could rent or build their own houses.

Housing allocation was based on balloting or chance method which did not reflect the Nigerian housing goals, nor is it problem-solving, nor does it fulfil the objective of housing every Nigerian in a comfortable, safe and secure environment. During the Second Republic public housing units were allocated on party patronage. The lesson from the above is that the poor have no choice than to resort to slum and squatter settlement living, which is a violation of their human rights. Yet they render critical services in the urban economy. All these do not include qualitatively and quantitative existing housing deficiency. Those who can build their own houses or remedy deficiencies in existing ones face super inflation, high cost of land, labour and materials, and unmanageable mortgage facilities. On these grounds, majority of Nigerians become permanent necessitarians locked in inadequate housing environment and prepared to experience the hazards and vulnerabilities of their urban location.

It must be recognized that the adaptive capacity of people and communities are affected by the resources, institutions of a country or region, the knowledge and information base, the infrastructure in place and the quality of their institutions and governance are necessary to launch into the requirements for a high growth low emissions age.

CONCLUSION

As of now the necessary institutional and policy resources to achieve sustainable urban resilient development are in place. What is lacking, judging from past experience, is dedicated honest human capacity and financial resources to embark on the journey. Our past experience with less daunting programmes of rural development, agricultural revolution, public housing construction, implementation of federal character

policy, DFRRI, river basin development authorities, transport infrastructure, etc have been marred by corruption. Solution to the global catastrophe of climate change lies in our politicians and bureaucrats striking a new balance within them about their relationship with nature and the type of future they want to leave for their children. They have to think of the hopelessness of robbing the commonwealth only to realize that sooner or later, climate change will destroy the civilization and economic personal empires they are building, all rendered desolate in an environment of primitive accumulation of business as usual.

Thank you for listening to me.

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