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The nexus of climate change, urban infrastructure and sustainable development in developing countries

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Abstract. This study weighed in on the topical issue of climate change impacts and sustainable urban development in developing countries. Climate change is a global challenge that is much discussed at national and international fora. The study reflects on the lot and plight of cities and peri-urban communities in developing countries in the face of lopsided attention on climate change. Extant studies, articles, local and international reports on climate change, urbanization and infrastructure, extant literatures were reviewed to establish the perspective and position of the study. The study examined the global threats of climate change and the local impact of disasters to urban dwellers in developing countries like Nigeria. It further shed light on urbanization process and the state of infrastructure in developing countries. Vulnerability of cities in the areas of infrastructure was brought to the fore with a view to improving the capacity and preparedness against climate change impact. Concepts of climate change, urbanization challenge, urban infrastructure, sustainable development were reviewed to contextualize the study. The study concluded by advocating for positive urbanization to mitigate the effect of climate change and foster sustainable development agenda in developing countries.

Key words: infrastructure, climate change, sustainable development, urbanization, developing countries

1. Introduction



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The manner, magnitude and frequency of occurrence of extreme weather events in the 20th and 21st century have pushed debates about the changing climate to the front burner. Around the globe, there has been increase in occurrence of diverse ecological calamities such as hurricane, flooding, landslide, droughts, heat wave, heavy rains, snowstorms, storm surge, volcanic eruption etc. Climate change related disaster threatens world economy, environment and humanity generally. Consequently, reports often present a global perspective of the phenomenon. According to the [1], climate poses serious threats to urban infrastructure, quality of life and the entire urban systems. The report further acknowledged that all nations of the world are increasingly affected by the abnormal trends of extreme climate events. Beyond the qualitative description of the magnitude of impact, the phenomenon has been supported with scientific evidence of its occurrence as well as quantitative measure of the impact. [2] have shown that prior to industrial revolution, the amount of carbon-dioxide (CO₂) in the atmosphere was between 260 – 280 part per million by volume (ppmv), but have increased by approximately 36% to about 380 ppmv in the last (20th) century. Corroborating this, the [3] concluded that since the onset of the industrial era, concentrations of CO₂ and methane (CH₄) have increased by 70percent during the 1970 to 2004 period. The intergovernmental Panel on Climate Change [4] averred that warming of the climate is unequivocal as is now evident from observation of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level. The report further affirmed that average global temperature has increased by 0.76°C and sea level has risen by 17 cm since the 19th century. In the same vein, a study in 2008 by some world's leading climate scientist strongly advocates urgent reduction of CO₂ emission [2] to avert catastrophe. According to the experts, “*paleoclimate* evidence and ongoing climate change suggest that CO₂ will need to be reduced from its current 385 ppmv to at most 350 ppmv, otherwise, there is possibility of seeding irreversible catastrophic effects” [5].

While climate change disaster constitutes a major economic setback to urban elite, it pushes the highly and most vulnerable populace further down the pit of poverty, thus widening the elite-poor gap. The cost of climate change disaster across the globe is usually huge. According to [6], flooding in Sante Fe, Argentina displaced one-third of the city population and affected 27,928 households. Economic losses were estimated at approximately US\$ 1billion: US\$ 752,000,000 from losses in agriculture, cattle production, industry and commerce; US\$ 180,000,000 from infrastructure and US\$ 91,000,000 in the social sector [6]. In Nigeria, the aggressive trend of weather elements has resulted in increasing damage and loss. [7] found that an average of US\$ 45million per year was lost in 12 states of the federation to irregular winds and rainstorm in 16years. Invariably, this amounts to US\$ 2.2billion across the federation within that period. The study claimed that the total cost of damage as a result of increasing rainfall and windstorm rose from US\$23.6 million in 1992 US\$ 82.2 million in 2007 with the peak of USD91.5 million in 2006 and least of US\$ 17.97 million in 1994. Around the world, coastal cities are exposed to a rise in sea level and face the impacts of flooding, increased storm damage, coastal erosion, changes in sedimentation patterns and saltwater intrusion [8]. According to the report, tropical storms and cyclones affect 1.4 billion people, or 24 percent of the world's population that live in densely populated coastal areas. As indicated in the [9], floods disaster in Pakistan and Chile in 2010 affected a total of 18,102,237 and 134,000,000 people, caused 1,985 and 1,691 deaths and a whopping sum of US\$ 9.5 billion and US\$ 18 billion in damages respectively. In the same vein, the Hurricane Katrina that ravaged New Orleans, US in 2005 led to the death of 1,833, the displacement of 500,000 people and a loss of US\$ 125 billion. In Dakar, the World Bank estimates

the value of “flood-vulnerable” assets at around €40 billion (Forty billion Euro), double the GDP of Senegal [10]. Summed up by [11], over the past ten years, climate change has caused about 3,852 natural catastrophes that claimed the lives of more than 780,000 persons and affected more than two billion people with property worth more than US\$ 960 billion lost in the process.

The foregoing, no doubt affirmed the reality of climate change and the huge cost often associated with the impact. Reports on climate change all over the world according to [12] reveal a worrying trend of climate change and the resultant effects. However, global and national discourse have attached disproportionate level of urgency to issues of climate change thereby prioritizing it above other critical economic and environmental challenges confronting human existence. [13] noted that about 70 member states of the United Nations (UN) overwhelmingly prioritize climate change security risks as contained in their statements in the Paris conference of 2015. Nations have practically attributed the various environmental, economic, political and security problems to climate change. [14] was of the view that most countries face economic, political, and social hardship resulting from the uncertainties caused by climate change and its associated negative impacts. Corroborating this [15] reported that countries like Turkey, Brazil, Egypt and Iraq are faced with security threats caused by the discord between the armed forces due to consequences of climate change. A notable example of security challenge of national and international dimension is the herders’ militancy in Nigeria whose violent clashes with farmers always result in loss of lives and properties.

Whilst not underrating climate change risk, it is important to realize that the hostility induced by climate change events in recent times is a by-product of industrialization and urbanization which has witnessed tremendous activities in the last two centuries across the world. Moreover, there are challenges in rural and urban areas that are critical to human existence which climate change has aggravated in recent times. The environmental, economic, social, political and security challenges that exist in different countries are first, evidences of policy failure, poor governance, lack of political will and mismanagement of resources especially in developing countries. These are being compounded by climate change events. In the same vein, the global picture of climate change disaster tends to obfuscate the experience at regional and local level. Therefore, prioritizing climate change problems above fundamental human problems leaves the risk of wrong characterization, misplaced focus and efforts, waste of time and resources, loss of lives, properties and natural environment. Arguably, climate change is inextricably linked to urbanization, but it is not the most serious environmental issues facing humanity today [8]. [16] averred that climate change contributes another level of stress to already vulnerable cities and populations and that there are so many problems that there is an urgent need to address them in an integrated way. Chronic problems facing many developing countries include poverty, illiteracy, insecurity, gender inequality, pollution, lack of basic infrastructure, unemployment and bad governance to mention a few. It is therefore pertinent to contextualize the problems facing developing nations and come up with inclusive strategies to tackling them. Addressing these challenges engender the resilience of human settlements against the impact of climate change in developing countries.

2. Challenges of Urbanization in Africa

Previous section has shown that climate change is one of the several consequences of intensified urbanization process. Urbanization means the ratio of urban population relative to the total population

of a nation or region. It is the rate at which urban population is growing. Normally, urbanization is caused by natural population growth, rural-urban migration and reclassification of rural into urban areas. However, industrialization has revolutionized and accelerated the process of urbanization around the world. And to a large extent, this has affected and redefined the global perspective of urbanization. For instance, [17] defined urbanization as the process by which rural areas become urbanized as a result of economic development and industrialization. This implies that urbanization is a transition from predominantly rural society to a more urban society. Where there is good planning, good governance and efficient management of resources, urbanization brings about opportunities for economic growth and development. It creates employment opportunities and provide veritable platform to practically evolve sustainable urban development. Urbanization in many developing nations is population growth driven by natural birth and rural-urban migration. This growth has been rapid but not backed up with corresponding investment in urban infrastructure, human capital development and entrepreneurship. Hence, it has been more of liability than prosperity for the developing world. According to the [8], urbanization in Africa has not yet brought the economic development and degree of prosperity that might have been expected. Inadequate education and physical infrastructure combined with poor governance have constrained the efficient use of productive resources as well as the industrial development that accompany it. The report further attributed the current urban economic momentum in Africa to the prosperity in other regions of the world. Despite the surge in urban population in many African countries over the last few decades, various economic and environmental challenges are still prevalent ranging from underdevelopment, lack of infrastructure, pollution, congestion, inadequate shelter, and poverty [17]. The riotous, uncontrolled, haphazard, and unplanned urbanization has caused serious socio-economic, cultural and environmental issues for African countries [18, 19, 20].

Nigeria is the most populous African country and one of the rapidly urbanizing nations in the continent. In Nigeria, as it was in many African countries, urbanization predates colonization and industrialization in the 19th century when trading, marketing and administrative expediency played crucial roles in the development of urban centres [21]. In the 20th century, the continued growth in urban population and emergence of more urban centres was attributed to the evolution of wheeled transportation, i.e. rail and road, categorization of settlements by hierarchy, transition to monetized economy, periodic geopolitical restructuring for administrative efficiency and lately, industrialization process between 1960 and 1975 [22]. Moreover, the oil boom in the 1970s gave impetus to physical development in major urban centres and resulted in tremendous rural-urban pull across the country. Consequently, urban growth in Nigeria have been rapid, unplanned and uncontrolled [23] leading to all sorts of environmental disorderliness and breakdown. Several studies have shown that inadequate planning of urban land use in Nigeria and intense land use in the urban areas has exacerbated urban problems [24; 25; 26]. Corroborating this, [27; 28] were of the opinion that the pace and pattern of urbanization in Nigeria has caused more harm than good to the country. The problems as highlighted by these studies include environmental degradation, proliferation of slum, high flood risk, high crime rate, pollution, diseases, poverty, traffic complications and squatter settlements. The situation is common to virtually all urban centres in Nigeria. For instance, [30] averred that Ibadan is plagued by diverse problems which are mostly consequences of population growth, macro-scale economic conditions, environmental challenges and weak urban development policy. Arising from the above, few salient points come to the fore. These include:

- (i) urbanization in Africa predates industrialization
- (ii) there is direct relationship between urbanization and urban challenges in Africa

- (iii) urbanization in Africa does not necessarily translate or culminate in industrial growth and development

3. Urban Infrastructure in Africa

Urban problems in developing continents like Africa are enormous, complicated and interwoven. The challenge ranges from pure lack of infrastructure, inadequate infrastructure to decay of existing infrastructure. Urban centres across Africa suffer greatly from infrastructure deficiency and this is a major hindrance to economic growth and development. Across the world, about 1 billion urban residents live in slums, lacking in basic infrastructure and services. More than half of urban population in sub-Saharan Africa lack access to basic sanitation while close to 20 percent does not have access to safe water, proper drainage and waste management [31]. Generally, there is gross inadequacy of essential services and infrastructure which include housing, water and sanitation, drainage, solid and waste water treatment facilities, transport, rail and road infrastructure, power and health infrastructure [8]. [31] also averred that cities in developing countries are characterized by lack of economic dynamism, governance failure, severe infrastructure and service deficiencies, inadequate land administration and social breakdown. Despite the severity of these challenges, urban areas continue to grow thereby culminating into a weak relationship with economic development and a strong direct relationship with socio-economic and environmental challenges associated with developing countries. Urban areas in advanced economies have experienced rapid growth before due to population increase. What makes the experience different is that in developed countries, urban growth was occurring hand in hand with economic development [32]. In those countries, the problem there is more of sustenance of infrastructure than lack of it. Foundations had been laid for good governance, strong economic development policies, thus creating the right atmosphere for positive urbanization and enduring physical transformation of urban areas. The economic conundrum of urban centres manifests in rising poverty index among urban dwellers. For instance, the official statistics of Nigeria's poverty profile showed that while relative poverty index was 54.4% in 2004, it increased to 69% in 2010 [33]. The road networks in cities groan under heavy traffic on daily basis, lack pedestrian sidewalk, proper drainage and are poorly maintained [33]. The peri-urban neighbourhoods often lack motorable roads and are difficult to access especially in raining season. Pipe borne water is practically non-existent even in city centres and many households do not have or cannot afford proper treatment of their solid and waste water. Slums are found at virtually all the nooks and crannies of urban areas while housing deficit continue to rise. This is the current state of infrastructure in urban and peri-urban areas in most developing countries, showing the plight and afflictions of the populace on daily basis, aggravated by the occasional rage of climate change.

4. Sustainable Urban Development

Urbanization and climate change are inextricably connected and the link is the anthropogenic activities, significant of which is industrialization. Industrialization and urbanization process in the last two centuries have triggered climate change culminating in frequent climate events/disasters in recent times. Climate change is a global phenomenon, just like urbanization. However, the event and the impact are largely local in nature. This implies that climate change can unleash its disruptive potency on any part of the earth. It is not gainsaying that the developed countries, through their large scale activities in industrialization and urbanization, contribute significantly to the emission of greenhouse gases that causes global warming. The erratic climate events triggered by the global warming often wreak havoc regardless of whether it is a developed, developing or less developed nation, urban, peri-

urban or rural communities. The only difference between developed and developing countries is in their resilience and recovery. Urban resilience is a function of the level of infrastructure cum economic development while recovery depends on good governance, good planning and strong development policy. It is estimated that 95 percent of population growth in developing countries will take place in urban areas in the next two decades [8]. The report therefore submitted that the unprecedented rate of urban growth in the developing world is increasingly exposing the population and economic assets to the potential impacts of climate change and natural hazards. Climate change risk and disaster expose the vulnerability of the urban areas in developing countries and aggravate the existing urban challenges. Table 1 shows the global frequency and risk of natural hazards between 2002 and 2010.

The Table showed information that buttress the perspective of this paper. The frequency of occurrence, mortality risk and vulnerable urban areas all indicates that climate change hazards are often localized. For instance, there had been about 228 incidences of earthquake across the globe between 2002 and 2010. However, only 7 of such actually happened in Africa based on the record of [38] and affected countries like Mozambique (2006), Tanzania (2005), Algeria (2003), Morocco (2004), DR Congo (2002), Malawi (2009) and DR Congo (2008). In similar vein, the [39] list of volcanic eruptions in the 21st century revealed only two African countries was affected namely Democratic Republic of Congo (2002) and Eritrea (2011). The problems of drought, flooding and extreme temperature being experienced in inland cities and northern regions are significantly moderated and managed with modern technology and appropriately infrastructure. Unlike other economic, environmental challenges that has plagued African countries for generations such as poverty, unemployment, inadequate infrastructure, housing shortage, pollution, etc.

Table 1: Global frequency and Risk of Natural Hazards between 2002 – 2010

Classification of Hazard	Nature of Hazard	Freq. of occurrence	Mortality risk	Vulnerable urban areas
Geophysical	Earthquake	228	High	Cities on or near fault lines
	Volcano	53	Low	Cities near volcanoes
Geophysical and hydrological	Tsunami	19	High	Coastal cities
	Mass movement (landslide, rockfall, avalanche, subsidence)	167	Low	-
Hydrological	Flood	1,501	Medium	Coastal cities
	Storm surge	25	Low	Coastal cities
Meteorological	Storm and cyclone	899	High	Coastal cities tropical cities
Climatological	Drought	133	Low	Cities in or near desert & dry areas
	Extreme temperature (heat and cold)	173	Medium high	- Inland cities
	Wildfire	101	Low	-

Source: EMDAT, OFDA/CRED International Disaster Database (2011) cited in IBRD/WB, (2012)

Whilst grappling with the ills of urbanization and infrastructure deficit, an important and encouraging development is that sustainability has found its way into the present and future development of man's physical environment. Sustainability is being promoted in every aspect of human activities. According

to the [34], sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. In order not to expend scarce resources on rectifying urban misnomer at the expense of future development, it is important to embrace the concept of sustainable development whole-heartedly and wholesomely. Sustainable urban development holds the key to positive urbanization. According to [35], the UK political agenda has centered on the need for sustainable development, particularly over the last three decades where global issues such as combating climate change has been considered paramount. Sustainable urban development is the panacea to the current pattern of urbanization in developing countries. Sustainable development combines infrastructure development with economic growth and employment opportunities thereby converting population growth to economic advantages. For instance, the UK Government's sustainable development agenda for residential development is based on four concurrent objectives [36 cited in 35]:

- Social progress which meets the needs of everyone;
- Effective protection of the environment,
- Prudent use of natural resources, and
- Maintenance of high and stable levels of economic growth and employment

The UK department of Community and Local Government (CLG) recognizes that sustainable community should comprise “...places where people want to live and work, now and in the future, meet the diverse needs of existing and future residents, are sensitive to their environment and contribute to a high quality of life. Such communities are safe and inclusive, well planned, built and run and offer equal opportunity and good services for all” [37].

5. Conclusion and recommendation

Arguably, climate change is rampaging but not the most serious problem facing developing countries presently. Climate change threatens the existing structure of urban and rural settlement, but of more paramount is the paradox of urbanization patterns being witnessed in many developing countries. There is urgent need to reverse the trend and change the pattern of urbanization. There is the need for positive urbanization. Positive urbanization implies population growth coupled with economic growth and infrastructure development such as witnessed in developed countries. Positive urbanization is at the core and the result of sustainable urban development. Sustainable urban development is an inclusive development strategy that addresses climate change risks, disaster preparedness and go further to absorb and absolve the extant ills of past and present urbanization anomalies. Hence, what developing nations need is positive urbanization, whether as a result of natural birth, rural-urban migration, industrialization or combination of all, such that people are economically empowered, conducive atmosphere is created for entrepreneurship to thrive, employments opportunities are created and investment is made in infrastructure development. Embracing sustainable urban development in developing countries engenders urban resilience and enhances recovery peradventure disaster eventually occurs. Addressing urban infrastructure deficit through the framework of positive urbanization goes a long way to achieving the United Nations' sustainable development agenda, particularly the SDG Goals #10, #11 and #13. It will eventually reduce economic and infrastructure inequalities within and among countries, make cities and human settlements across the world inclusive, safe, resilient and sustainable and position developing nations to combat climate change and its impact articulated in the United Nations 2030 Agenda.

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Dr. Oluwatayo A.A.	Co-Author	Conceptualization, reviewing and editing
Dr. Adagunodo T.A.	Co-Author	Supervision and validation,
Dr. Akinwumi I.I.	Co-Author	Resources, writing original draft
Dr. Amusan L.M.	Co-Author	Supervision, reviewing and editing

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