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Green Infrastructure for Climate Change Amelioration in Nigeria

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ABSTRACT

Climate change has become an inevitable global problem, affecting almost every part of the world, in which Nigeria is not left out. Various evidences in the scientific literature indicates that in the coming decades the world will witness higher temperatures and changing precipitation levels. Although no region of the world will be entirely spared, the negative impacts are likely to fall most heavily on developing countries and in particular low-income countries in tropical and sub-tropical regions like Nigeria. However, green infrastructure has been proposed as one approach to mitigate and adapt the built environment consequences of increased temperatures resulting from climate change. This paper therefore assesses the impact of green infrastructure towards mitigating the various challenges imposed on the environment by climate change in Nigeria. Qualitative literature review methodology was used to evaluate available evidences on whether green infrastructure interventions, such as tree planting or the creation of parks, green spaces or green roofs, affect the air temperature of an urban area. The study observed that the presence of green infrastructure as carbon sink and multifunctional ecosystems capability will go a longer way to tackle various challenges emanating from climate change. It recommended more programm for green infrastructure planning and implementation in Nigeria urban centres by the government and other stakeholders, more stringent measures by the government to control deforestation and more awareness campaign for the citizens to desist from activities that depletes the ozone layer and as well encourage the protection of available greenery in the environment. With this, the on-going global warming will seriously decline.

Key Words: *Adaptation, Climate Change Challenges, Global Warming, Green Infrastructure, Mitigation*

1. INTRODUCTION

There are growing evidences in the scientific literature that climate change has become an inevitable global phenomenon that every region of the world has to tackle. Scientists have declared that in the coming decades the world will witness higher temperatures and changing precipitation levels more than before (Churkina, 2008; Apata, 2012; Chang et al., 2014). Although no region of the world will be entirely spared, the negative impacts are likely to fall most heavily on developing countries and in particular low-income countries in tropical and sub-tropical regions like Nigeria and other African nations. According to IPCC (2007), climate change refer to changes in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and /or the variability of its properties, and that persists for an extended period typically decades or longer. Following the same trend, The Institute for Security Studies cited in Zewdie (2014) defines climate change as long term changes in average weather conditions covering all changes in the climate system, including the drivers of change, the changes themselves and their effects.

African region in which Nigeria is a part has been commonly identified as a region highly vulnerable to climate change (FAO, 2005) and projections indicate warming will be greater than global annual mean, with an average increase of 3–4°C over the next century (Boko, 2007). Due to the foregoing scenario, urgent attention is needed to arrest the daunting challenges posed on the earth by the climate change. This can be achieved through the planning and implementation of green infrastructure facilities which can keep the built environment cool, green and mitigate against further increases in temperatures in urban areas.

Green infrastructure provides a wide range of environmental services. Research has shown that green infrastructure like trees and green spaces helps to maintain a healthy urban environment by providing clean air, improving the urban climate, preserving the natural balance of the city and even providing clean water and fertile soil (Baycan-Levent and Nijkamp, 2009). The positive health effects of urban green infrastructure have further been discussed in a range of literatures including landscape architecture, environmental psychology, descriptive epidemiology and public health (Bell et al,. 2008; Dipeolu and Fadamiro, 2013; Hartig et al., 2003; Grahn and Stigsdotter, 2003; Maas et al., 2006; Orsega-Smith et al., 2004) and proximity to green areas has been found to be associated with soundness of body health systems (DeVries et al., 2003; Morita et al., 2007; Nielsen and Hansen, 2007).

This study therefore aimed at analysing the core values of green infrastructure strategies at mitigating and adapting Nigerian urban centres to climate change challenges. The study attempt to answer questions such as: (1) what are the attendant problems of climate change in Nigeria; and (2) how can green infrastructure strategies be used to adapt or mitigate these climate change challenges. The study was carried out through qualitative literature review method. Relevant information were collected from published and unpublished articles, consulting journals database resources like the Hinari initiatives and others freely available on the internet and personal desktop research. Information gathered were reviewed, discussed and presented descriptively with appropriate recommendations and conclusion.

2. CLIMATE CHANGE AND ITS ATTENDANT PROBLEMS IN NIGERIA

Urbanisation, industrialisation, unsustainable agriculture and various other activities which release greenhouse gases into the atmosphere is becoming alarming in Nigeria. These GHGs are constituents of the causes of climate change challenges which have been predicted to have a range of consequences for human health arising from the direct and indirect impacts of changes in temperature and precipitation as well other environmental menaces (McMichael et al., 2003; Patz et al., 2005). Climate change is definitely a global problem; however, studies have shown that certain countries like those in sub-Sahara Africa have a greater vulnerability to the impact of Climate Change than others. Nigeria is particularly vulnerable due to a long (800km) coastline prone to sea level rise and increasing storms and therefore potential for increased drought and desertification in two-thirds of Nigeria's land mass; threat to food security and livelihood because agriculture in Nigeria is largely sustained by rainfall and can be adversely affected by changes in rain patterns; threat to health security because of the prevalence of diseases such as malaria, cholera, cerebro-spinal meningitis and other diseases which could be exacerbated by extreme weather events such as flooding, and changes in temperature and humidity patterns. Also energy and infrastructure are susceptible to disruption from extreme weather events (Olujimi, 2007; Adelekan, 2010; Apata, 2012).

3. THE CONCEPT OF GREEN INFRASTRUCTURE

Green infrastructure has emerged as an essential ecosystem services for livable cities in the present century. It consists of spatially or functionally connected areas which maintain ecological coherence as an essential condition for healthy ecosystems. Its purpose is not only to reconnect species populations but also to strengthen the functionality of ecosystems for delivering goods and services and as well enhances the quality of life (Benedict and McMahon, 2002; Davis et al., 2012). Just as growing communities need to upgrade and expand their built infrastructure of roads, sewers, and utilities, they also need to upgrade and expand their green infrastructure, the interconnected system of green spaces that conserves natural ecosystem values and functions, sustains clear air and water, and provides a wide array of benefits to people and wildlife. Green infrastructure is a community's natural life support system, the ecological framework needed for environmental and economic sustainability (Bowler et al. 2010; Dipeolu, 2014).

The concept of green infrastructure could be traced to have a long history of development and shared principles in North America in the later 1800s when it was first originated as urban green spaces and urban forestry (Konijnendijk, 2006). Since then, urban foresters, city arborists, and municipal foresters have managed expanses of urban forests, but it was only in the early 1900s that legislation was developed to authorise centralised funding. In North America, urban forests are seen as the art and science of managing trees in and around urban centres for the social, economic and aesthetic benefits of local populations (Miller, 1997). Unfortunately, due to a lack of a clear definition for urban forestry, the concept was slow to be accepted by traditional foresters (Konijnendijk et. al., 2006). More recently, in North America the concept of urban forestry has been linked with the development of Greenways and has aimed to integrate professional forestry techniques with the sustainability agenda (Mell, 2010). By the mid-1990s, green infrastructure concept sprang up in the United States with the highlights on the importance of the natural environment in decisions about land use planning. In particular there is an emphasis on the "life support" functions provided by the natural environment.

4. NEED FOR GREEN INFRASTRUCTURE PLANNING IN NIGERIA

Green infrastructure planning is highly needed in Nigeria to facilitate development and reduce the loss of open space, agricultural and forest lands. Nigeria's demographic trends that influence the need for green infrastructure are very conspicuous with the present rate growth and development in every part of the nation. In 1921, 4.8% of Nigerian population was urbanized. This figure rose to 10.2% between 1952 and 1954. It further increased to 19.2% in 1963 and to 42% in 2002, Estimation however suggests further increase to about 68% by 2020 (Ademiluyi and Solanke, 2008).Various studies supported the fact that there are many urban dwellers in Nigeria today more than before. For example, Fadamiro and Adedeji (2009) acknowledge that in Nigeria presently, there is rapid influx of rural residents into urban areas especially in the bid to access basic infrastructure required for good standard of living and this has made many urban centres to outgrow proper planning and management. Natural habitats of plants and animals which contribute valuable ecological benefits to the environment are been depleted daily for the purpose of urbanization, industrialization and modernization (Dipeolu and Fadamiro, 2013; Ayeni, 2012). Thus, green infrastructure networks are highly needed in Nigeria urban centres to improve urban quality, environmental sustainability, provide opportunities for outdoor recreation and protection of cultural resources.

5. GREEN INFRASTRUCTURE STRATEGIES TO AMELIORATE CLIMATE CHANGE CHALLENGES

5.1 Green Infrastructure and Microclimate Regulation

Due to constant massive construction and developmental projects in urban centres, there is higher temperature compared to the surrounding sub urban or rural areas. When this higher temperature continues for a period of time, it results in a phenomenon called urban heat island effect (Dubbale et al., 2010; Escobedo et al., 2008). This phenomenon occurs because urban development results in large amounts of paved and tarred surfaces that absorb solar energy and radiate it in the form of heat causing surface and ambient air temperatures to rise (Dubbale et al., 2010; Escobedo et al., 2008). Trees lower temperatures by providing shade and by the transpiration of water vapor from leaves. When trees transpire energy is absorbed by the evaporating water so energy is removed from the leaf and its

environment, thus lowering local air temperatures (Davies et al., 2012).

5.2. Green Infrastructure and Carbon Sequestration

Due to rapid development at urban centres in most part of the world, there are greater attractions for people to live in urbanized areas. Coupled with different manufacturing activities at these urban centres , it is expected that CO_2 emission will be significant in these areas. It is also known that plants remove CO_2 (the major green house gas) from the atmosphere during photosynthesis. Therefore green infrastructures play a paramount role in carbon storage and sequestration. Studies suggest that forest stands in urban environments have the potential to sequester and store more carbon than rural stands of the same canopy species composition (Bowler et al., 2010). Similarly, a study by Richard et.al. (2006), confirms that urban soils at pervious areas sequester large amounts of CO_2. It can then be concluded that green infrastructures are very important in counteracting anthropogenic CO_2 emissions because they have capacity to store and trap CO_2 in their biomass also increase the soil surface of cities which otherwise would have been a non permeable surface.

5.3. Green Infrastructure and Water Quality

Green infrastructure also has the ability to reduce water runoff and improve water quality. The need for various grey infrastructure like tarred road network will result into high percentages of impervious surfaces in urban areas and these impervious surfaces, increases the amount and rate of storm water runoff. However, storm water can be directed into bioretention areas which act as pollutant filters and water retention zones. When grasses, street trees, various greening are encouraged at urban centres, the increased permeability of soil due to root growth allows for pollutants to infiltrate the soil and possibly be decomposed and/or absorbed by plant roots. Vegetation functions as a natural filter by retaining sediment and organic matter from overland flow. The reduction of flow volume and rate reduces flooding hazards and decreases surface pollutant wash off.

5.4. Green Infrastructure and Biodiversity Conservation

The interrelatedness of genes, species, and ecosystems and their interactions with the environment is a situation that should never be compromise. Green infrastructure help to restore and protect the organisms, species, and various populations which might have been depleted from an environment due to human practices like urbanisation, deforestation and various form of bush burning. Specific aspect of green infrastructure like urban agriculture, urban forests are not only important for forest genetic conservation but are also habitat for insects and wild animals (Benedict and McMahon, 2006). Therefore, green infrastructure are helpful for biodiversity conservation due to their ability to increase habitat connectivity. They also help species to migrate and survive hazards which may be caused by climate variability.

5.5. Green Infrastructure and Air Pollution

Air pollution is an environmental problem of developing cities. Trees and other plants have been labelled as the “lungs of cities” (McPherson, 2005) because they have the ability to remove contaminants from the air that is breathed. Acting as natural filters and reducing air pollution, it has been shown that plants generate health benefits by reducing the mortality rate and reducing visits to the hospital (Powe and Willis, 2004). Every tree helps fight global warming by reducing the amount of greenhouse gases in the atmosphere. By absorbing carbon dioxide and pollutants fuelling climate change, parks and green space offset the warming effects on cities, making them cooler.

6. SUMMARY, CONCLUSION AND RECOMMENDATIONS

This study has corroborated some other previous studies that the climate of the world is changing. Numerous reports in the scientific literature indicates that in the coming decades the world will witness higher temperatures and changing precipitation levels (Patz et al., 2005; Churkina, 2008; Chang et al., 2014). Nigeria being one of the most populous Africa countries, also emerging as an industrialized nation will continue to have its share of the impact of climate change. Climate change affects every aspect and sector of a nation’s socio-economic development and is cross-sectoral in nature.

It transcends the traditional focus on environmental issues but affects the overall well-being and economic growth of a nation. However, it is imperative to note that human activities in the emission of green house gases as well as deforestation and other unsustainable agricultural practices are the major causes of climate change globally. To tackle these challenges adequately, environmental scientist have proposed the strategies of green infrastructure as a concept capable of mitigating and adapting human environment against the daunting challenges of climate change.

Green infrastructure is an essential ecosystem services which is capable of linking natural areas to benefit biodiversity and counter habitat fragmentation. When urban areas are interconnected with a mix of street trees, parks, cultivated land, wetlands, lakes, and streams; it will produce an environment that is livable and resilient against climate change challenges. Green infrastructures can be direct source of income and food. They help in cleaning air pollutants, store and sequester carbon dioxide, provide biomass fuel which is renewable, reduce noise pollution, support biodiversity, reduce urban heat island and have general cooling effect, reduce water pollution, and reduce flooding.

Therefore, the development and management of green infrastructure should become the priority of Nigerian government. More programms for green infrastructure planning and implementation in Nigeria urban centres should be developed by the government and other stakeholders. Also and in order to multiply green infrastructure in the built environment, urban agriculture, urban forestry and street trees should be encouraged in Nigerian urban centres. At the same time, there should more stringent measures by the government to control deforestation and encourage afforestation. Finally, more awareness campaign should continuously be carried out by the government and professionals for the citizens to desist from activities that deplete the ozone layer such as bush burning, driving of high energy and fuel consuming vehicles and as well encourage the protection of available greenery in the environment. If

these measures are appropriately applied the various challenges from climate change as discussed in this study, will seriously decline.

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