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URBAN DEVELOPMENT THROUGH SUSTAINABLE WETLANDS MANAGEMENT – A STUDY OF OGBA-IWAYA GREEN CORRIDOR IN LAGOS MAINLAND

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ABSTRACT

Adopting a new paradigm in the urban planning process helps to create a resilient metropolitan city and functional urban open spaces. Lagos State Government is worried about the increasing volume of greenhouse gases emission in the metropolis, hence there is a need to remedy the degrading settlements. Mitigation

Introduction

Liveable landscapes are designed as public spaces that allow people to get from point A to B, but also support and encourage the activities people pursue in public spaces. Such habitats are resilient, inclusive, multicultural, socially cohesive, economically vibrant, and full of life (UNEP, 2017). The Lagos State Government has commenced some environmental measures to curb the increasing volume of greenhouse gases within the metropolis. An estimate of about 40% of all new vehicle registration in Nigeria is in Lagos and accounts for 40% of the total national petroleum products consumption (Loricamp, 2007). Loricamp (2007) further states that about 95% of these motorised vehicles were manufactured over ten years ago and without catalytic converters to minimize noxious and toxic carbon effluents. Vehicular density is estimated at 220 vehicles per kilometre compare to the national average of 1.1 vehicles per kilometre (LSG,

measures traceable to over-reliance on hydrocarbon-based facilities and equipment call for the redevelopment of the green corridors and wetlands. These green corridors are the existing thin strip of land within Lagos Mainland which are habitats for wildlife and biodiversity. They include wetlands and canal routes which fall within the setbacks of Agidingbi, Opebi, Oregun, Maryland, Yaba and Iwaya rivers flood plain with a distance of about 17km. Urban development in the past has not articulated these sustainable components in the environmental design but this paper is guided by the use of afforestation and urban greening solutions. The study examines and identified the various land uses existing in the study area to evaluate their level of compliance with the Global Climate Change policies that address low carbon emissions through eco-friendly green infrastructures that enhance the environmental air quality for a more sustainable Lagos. The study is underpinned by the green urbanism dictum. Following the qualitative and descriptive analysis of the on-site data collection, observations and evaluations, the developmental and adaptive strategies were mapped out through GIS-based network mapping. The land use data were obtained from various analyses conducted by the use of Geographic Information Systems (GIS), used to take twenty-six (26) Points at about 500m intervals along the green corridors and wetlands. The socioeconomic information and details were gotten through various observations, interviews and personal deductions. The well-being of a city cannot be separated from the well-being of its environment therefore the study recognised the role of a healthy ecosystem and reduced reliance on fossil fuel, increased green open spaces, restoration of habitats, water and air purity. The study proposed carbon sequestration through restoration, conservation of existing wetlands and other strategic adaptive solutions toward a sustainable and resilient city development in the form of; urban green infrastructures, non-motorized transportation mode, urban agriculture along the wetlands, restoration of the wetlands and waterways, conservation and inclusive landscape regeneration of the open spaces and concludes by stressing the reality of sustainable low carbon philosophy within the landscape and built environment pedagogy.

Keywords: greenhouse gases; green corridors; climate change; landscape regeneration; urban green infrastructure.

2006). Sustainable Urban Green Infrastructures are needed as remediation and restoration tools for enhancing the environment and the primary local air quality in the Lagos Metropolis (LASEPA, 2001).
Commuters need adequate infrastructure in the forms of slow-speed shared walkways, vegetated walls (green walls), roof garden/green roofs, nature's walkway, footpaths, cycling routes and green—on which to travel. Following the Lagos state government NMT policies involve two simple methods; Systematic traffic calming to ensure that smaller streets are safe places for the mixing of pedestrians and other modes - shared lanes; and pedestrian and cycle infrastructure that is physically separated from motor vehicle traffic (by raised medians, vehicle parking lanes, bollards, landscaping, etc.) on larger streets (Lagos NMT Policy, 2017). Streets are public spaces for socialisation and commerce as well as mobility. The slow zone—whether the entire right-of-way of a small street or a separate space on a larger thoroughfare—is a space for liveability for people to walk, talk, interact, for doing business, and for children to play. The provision of an adequate slow zone recognizes that streets are destinations. It also enables streets to provide safe and uninterrupted mobility for all users regardless of their travelling speed (Lagos NMT Policy, 2017). The open spaces are for public use. Therefore, their design must not discriminate against users by their age, ability, gender, income, race, ethnicity, or religion. An equity-based approach to NMT policy must ensure that providing services and infrastructure meet the needs of all users. Nigeria's Intended Nationally Dependent Contributions (INDC) as a part of the agreement signed by the federal government of Nigeria in Paris during COP 21 to reduce greenhouse gas emissions by 20% conditional and 45% unconditional is key to achieving environmental sustainability through low carbon transportation mode (Puncher et al, 2008). Environmental benefits of walking and cycling are achieved through reduced motor vehicle use leading to reduced congestion and vehicle emissions, improved local air quality and reduced carbon emissions into the atmosphere. The urban dwellers are in dire need of safe and pleasing places to walk, cycle, jog and connect to nature within Lagos metropolis, this study proposes the integration of the

available green corridors and wetlands with all the inherent ecosystem services and biodiversity to include the stretch of river wetlands and canal routes which fall within the setbacks of Agidingbi, Opebi, Oregun, Maryland, Yaba and Iwaya rivers flood plain from Awolowo Way in Ikeja through Maryland to the Iwaya Community across the *16.6km* (17km approximated distance) close to the communities, providing ecological and recreational facilities such as skating board, basketball court, lawn tennis, football field, boardwalk, children play area, nature skywalk and bicycle training tracks. Establishing bike corridors all through the city enables both residents and visitors to enjoy local parks and nature scenes. Within the context of this study, open space includes green spaces (or greenfield developments) such as regional and local parks and reserves, sports fields, and other recreation areas, blue spaces such as the region's waterways and harbours, grey spaces such as civic squares, streets and transport corridors.

This study aims to assess the extent to which Urban Green Infrastructure can be used as a tool to remediate and enhance the environmental air quality for a more sustainable Lagos metropolis. The following are the objectives of this study: To explore the restoration of the wetlands and transforming it into productive and attractive green space for ecotourism, encouraging urban agriculture through food production in a sustainable way is more nutritious and less toxic, benefiting consumers and farmworkers; To address Sustainable urban farming methods to help regenerate and restore rather than contaminate the soil; To determine if bio-remediated green spaces in urban areas improves air quality, reduces polluted water run-off from paved areas, can moderate the atmospheric temperatures thus reducing energy costs, restores biodiversity, healthy habitats, reduces soil erosion and to explore the introduction of plants for phytoremediation, with the ability to remove some toxins from contaminated soil and water adhering to every planning process towards the implementation of the global climate change policies that addresses low carbon emissions through eco-friendly infrastructures while also focusing on the United Nation's Sustainable Development Goal 11- Sustainable Cities and Communities on the metropolitan scale so as to reduce the effects and menace of climate change.

LITERATURE REVIEW: SUSTAINABLE ENVIRONMENTAL AND GREEN INFRASTRUCTURE PRINCIPLES

Green Infrastructure refers to a strategically planned and delivered network comprising the broadest range of high-quality green spaces and other environmental features. It should be designed and managed as a multifunctional resource capable of delivering those ecological services and quality of life benefits required by the communities it serves and needed to underpin sustainability (Natural England, 2009). Its design and management should also respect and enhance the character and distinctiveness of an area concerning habitats and landscape types (Natural England, 2009). Green Infrastructure includes established green spaces and new sites and should thread through and surround the built environment and connect the urban area to its wider rural hinterland. Consequently, it needs to be delivered at all spatial scales from sub-regional to local neighbourhood levels, accommodating both accessible natural green spaces within local communities and often much larger sites in the urban fringe and wider countryside (Beer, 2010).

The quality of life for NMT users has much deteriorated; they can never relax when they are at or close to a street. Mobility induced city air pollution is evident in the metropolis where governments annual budgets emphasized road transportation and car ownership to the detriment of ferry, rapid and light rail transit systems (World Bank, 2016). Alternative mobility framework advocates for circulatory facilities including sidewalks, walkways, paths and bike lanes. These facilities minimally impact the cityscape, rely on renewable energy, use less urban space, reduce traffic congestion, improve physical fitness and are cheaper (Adejumo, 2010). Leisure cycling is compatible with the non-motorized and car-free planning philosophy. Non-motorized modes are either developed along roadways or off-road trails along urban natural corridors including parks and urban wilds. Uduma-Olugu et al, (2018) opined that the university's open spaces need to better meet the psychological comfort of the students, staff and visitors through the use of available spaces to experience plants and trees in a more biophilic manner. She went further to state that open space networks should encourage more active lifestyles by offering a variety of safe and

attractive spaces that are well distributed throughout a neighbourhood and are accessible, catering for the sporting, and recreational needs of the students within the university's community and preferably public open space should attempt to cater for multiple users (Uduma-Olugu et al, 2018).

There is no single agreed definition of open space nationally or internationally. There is an agreement, however, that there are many types of urban public open space. Our region's open space network is not just about playgrounds, parks and reserves, but incorporates diverse aspects of our wider environment, for example, neighbourhood streets, city centres, walkways, greenery, waterways, structures and views. For this study, we will use a broad understanding of open space. It also includes the open vistas and views that surround the city (RPH, 2010). Open space is also often referred to by the narrower term 'green space'. Green spaces can be defined as 'any vegetated land or water. This includes natural habitats, green corridors such as paths and rivers, parks, gardens, playing fields, children's play areas, cemeteries, and countryside immediately adjoining a town. Open spaces also include contaminated or vacant land, often called "brownfields", which can be developed into green spaces or parks. Undeveloped or poorly developed brownfields are not considered to be quality open spaces and can harm health and wellbeing. Under the Local Government Act 2002, local authorities are required to 'promote the social, economic, environmental and cultural wellbeing of communities, commonly called the "four wellbeings". Social, economic, environmental and cultural factors are the four cornerstones of the sustainability framework. They also represent the four major factors that influence health (Percival, 2017).

The green corridors which serve as a riparian buffer zone in some parts of the metropolis are thin and sometimes used as linear parks and converted to recreational use within the urban setting that is substantially longer than it is wide and these areas are often described as greenways (Kennedy, 2003). While others use the strips of public land next to the canal, streams, extended defensive wall, electrical power lines, highways and shorelines in some urbanised cases. Some scholars also often describe these greenways as riparian forests or

riparian woodlands. It is a forested woodland area of land adjacent to the body of water such as rivers, streams, swamps, ponds and lakes (Kennedy, 2003). There is a strong incentive to manage and protect riparian land because disproportionally large benefits can be gained by repairing a relatively small tract of land and because many restoration actions, such as revegetation, are simple and affordable (Wong et al, 2009). The ecological composition predominant here provides critical habitat for different species of butterflies, birds, reptiles and mammals. The forest is a natural body of water that sometimes serve the purpose of riparian buffer zones for residential neighbourhoods and the forest is important in preserving air and water quality, maintaining stream integrity and purity, acting as a filter for the sediments and other toxic pollutants. The buffer zone can be made up through restoration and revitalization of the wetlands which are made up of trees, shrubs and grass plantings (Kennedy, 2003). Sustainability is one of the newest degree subjects that attempts to bridge social science with civic engineering and environmental science with the technology of the future. When we hear the word "sustainability" we tend to think of renewable fuel sources, reducing carbon emissions, protecting environments and a way of keeping the delicate ecosystems of our planet in balance (Percival, 2017). Sustainability looks to protect our natural environment, and human and ecological health, while driving innovation and not compromising our way of life (Kennedy, 2003).

The Theories of Ecological and Green Urbanism

Spirn (1985) opined that the theory and practice of ecological urbanism has a long history, a foundation of knowledge to support it and built ecological works that demonstrate its environmental benefits (Spirn, 1985 & Lowenthal, 2009). The roots of this tradition in Western culture are deep: from Hippocrates' treatise of Airs, Waters, and Places to contemporary authors (Spirn, 1985 & Lowenthal, 2009).

Many countries are rapidly approaching a situation in which most people live in urban settlements sometimes mega-cities. Human improvidence is fast depleting and degrading the earth to such a condition of impoverished productiveness, shattered surface, of climatic excess as to

threaten the extinction of the living species (Marsh, 1865 & Lowenthal, 2009). Ecological-green urbanism theory proposes that in restoring, reclaiming and reoccupying lands laid waste by human improvidence or malice the task is to become a co-worker with nature in the reconstruction of the damaged urban fabrics and urban landscapes through the integration of urban green infrastructure. It is surprising, therefore, that in the burgeoning literature on the theories of ecological-green urbanism, the urban environment is often neglected or forgotten as attention is now focused on "global" problems like; landscape degradation, climate change, deforestation, desertification, wetland encroachment and greenhouse gas emissions. Similarly, much of the urban studies literature is symptomatically silent about the physical-environmental foundations on which the urbanization process rests.

The city is part of nature, a fact that has profound implications for how cities are designed, built, and managed(Lowenthal, 2009). The theory further stipulated that city planners/designers have exploited nature to promote human purposes and the roots of this tradition are as diverse as the many ways in which nature contributes to human health, safety, air quality and welfare. An overview of that tradition is also well outlined, along with an assessment of existing knowledge and prospects for cities designed in line with urban nature (Spirn, 1985).

A Review of the Three Pillars and Fifteen Principles of Green Urbanism

Lehmann, (2010) discussed both the three pillars and the fifteen basic principles of ecological green urbanism and their interactions which are energy and materials, water and biodiversity and urban planning and transport having in mind the various socio-cultural features (see figure 1). Figure 2 shows the 15 Principles of Green Urbanism as a conceptual model and a framework for how we might be able to tackle the enormous challenge of transforming existing neighbourhoods, districts and communities, while prioritizing how we can re-think the way we design, build, operate and maintain our urban settlements and its infrastructures (Lehmann, 2010). These principles are partly universal, but there is no single formula that will always work. To achieve more sustainable cities, urban designers must understand and apply the core

principles of *Green Urbanism* in a systematic and adapted way (Lehmann, 2011). These principles can be effective in a wide variety of urban situations, but they almost always need to be adapted to the context and the project's/city's scale, to the site's constraints and opportunities. We need to develop a specific approach for each unique site and situation, adapting the principles to the particular climatic conditions, site context, availability of technology, social conditions, project scale, client's brief, diverse stakeholder organizations, and so on.

Figure 1(left): The three pillars of Green Urbanism, and the interaction between these pillars. (Lehmann, 2010). Figure 2(right): The 15 principles of green urbanism and their interconnections. (Lehmann, 2010)

The green urbanism theory is a scientific approach to urban design and city planning that requires an optimization process and a solid understanding of the development's wider context and its many dimensions before the designer can produce an effective design outcome. With all this technological progress, we should not lose sight of the fact that a key component in any society's sustainability is more than its carbon footprint. The 15 guiding principles of Green Urbanism, for local action and a more integrated approach to urban development' (Lehmann, 2010). Our city's development is not just merely a technical or scientific matter of finding more eco-friendly energy solutions, but a question of holistic social sustainability and identifying principles for healthy and cohesive communities. Since green infrastructure is the

network of green spaces and water systems that delivers multiple environmental, social and economic values and services to urban communities (Ely & Pitman, 2014). This network includes parks and reserves, backyards and gardens, waterways and wetlands, streets and transport corridors, pathways and greenways, farms and orchards, squares and plazas, roof gardens and living walls, and sports fields and cemeteries. These ecological theories help green infrastructure to secure healthy, livable and sustainable urban environments. It strengthens the resilience of towns and cities to respond to the major current and future challenges of growth, health, climate change and biodiversity loss, as well as water, energy and food security (Pitman et al, 2015).

METHODS

The study pursued a descriptive and qualitative analysis of the information gathered during the research and deductive approach, building on the available literature on the green city, the authors' knowledge and experience with the environment, infrastructure, sustainability and green city. Primary data formed the basic source of information used in this study. This was obtained through the conduct of surveys using the Global Positioning System (GPS) and Geographic Information System for both the mapping, database analysis and presentations. Some landmarks, open spaces and commercial hubs were identified and their geospatial locations gotten and the points were taken after every calculated distance of 500m along the wetland/green corridor during the survey. The land use was classified into Administrative, Commercial, Educational, Health, Public, Recreational, Religious and Transportation. The second set of data was gotten from the Physical Planning Development Control Department of the State and through various interviews were conducted with some environmental enthusiasts and stakeholders. Information on statutory setbacks and minimum requirements for greening before building development approvals. The available descriptive and inferential statistical techniques were used in the collation and analysis of the data. The main hypothesis in this study is that the incorporation of green infrastructure into the urban forms and geospatial configurations will enhance the environment. This study employed a descriptive survey design of the existing site conditions in which the existing status of the independent situations was gotten during data collection without any manipulation of

the variables. To achieve this, a stratified random sampling technique was used to identify and phase the green corridors and the neighbouring street roads within the proximate Five Local Government Areas of Lagos State. There are five predominant land use typologies namely; Commercial, Educational, Residential, Public, Recreational and Religious land use which are further categorized into three zones– High, Medium and Low Density.

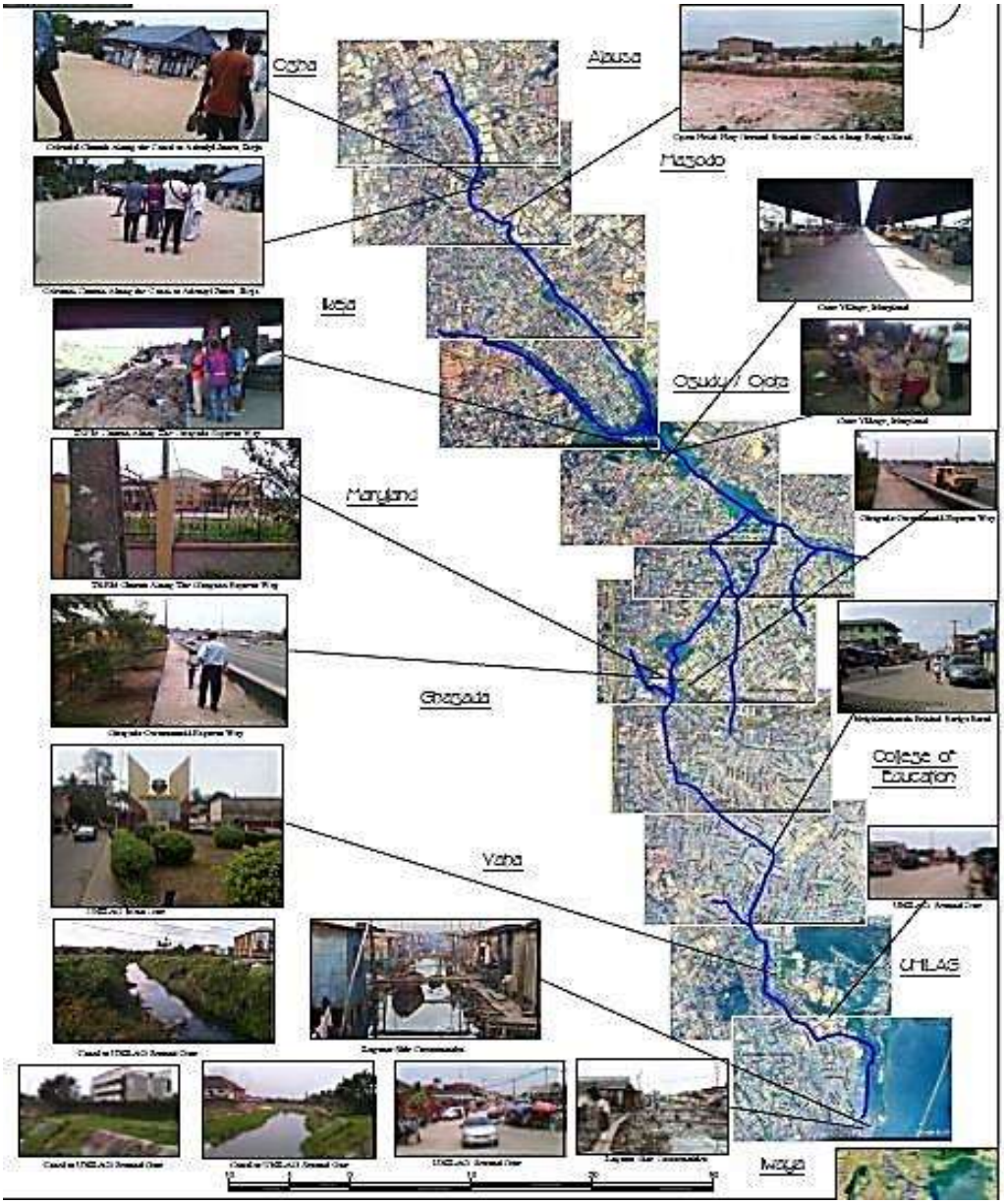
THE STUDY AREA

The study area covers the green corridors and wetlands through a distance of 17.2km along the Agindingbi-Obafemi Awolowo Road at Ikeja through the Opebi and Oregun link bridges connecting Ojota-Maryland and continuing through Bariga and ending at Iwaya where the University of Lagos is located. The green corridor connects different neighbourhoods, communities and districts in Lagos State such as; Yaba, Bariga Gbagada, Anthony, Maryland, Mende, Somolu, Oworonshoki, Ogudu, Ifako, Ojota, and Ikeja.

These areas cut across five different central-local government areas and Local Council Development Areas (LCDA) of the Metropolitan Lagos in Nigeria. The site was selected after careful analysis of a set down criteria based on the literature review and the relevant guidelines for the establishment of green urbanism in the selected wetlands within Lagos metropolis using the following parameters set down as site selection criteria.

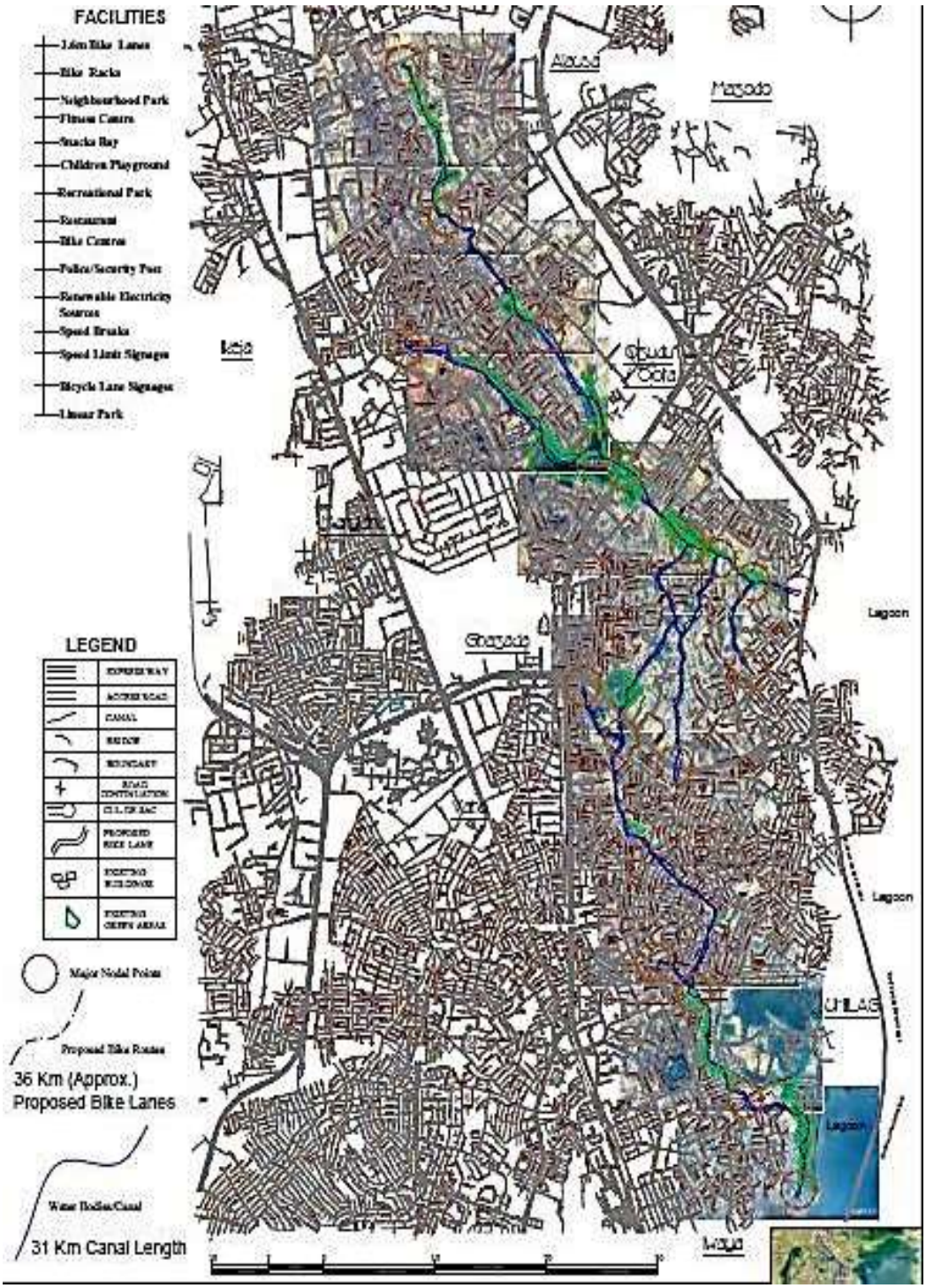
1. *Location and accessibility to the users;* the ease of ingress and egress to and out of the site for vehicles, cyclists and pedestrians.
2. *Size of site and possibility for future expansion potentials*; enough land to accommodate the various functions as well as give room for future development and expansion.

3. *Land use compliance*; the site has to be within the land use for recreational development on the state's Master Plan.
4. *Environmental features*; like landforms, rocks, crops, hills, valleys, streams/rivers, natural vegetation and any other special character that makes the site unique and can be utilized for the intended project.

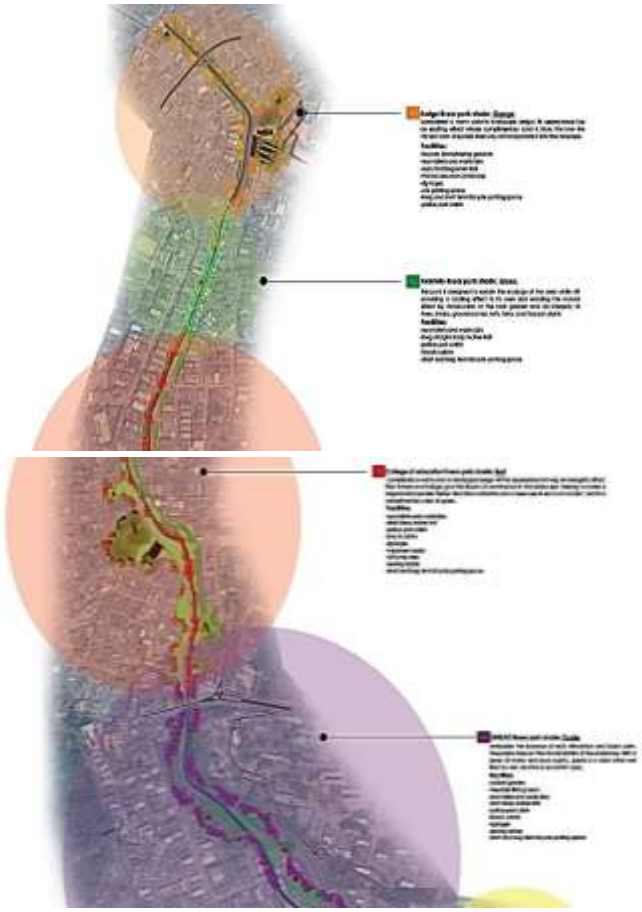


Figures 3. Location map showing Ogba - Iwaya Townships (17.2km), the wetlands (blue line), the pictures of the major landmarks, the connecting streets and transit hubs.

General study of the site microclimatic conditions and its features considering its potentials and treats in an attempt to utilize the advantages.



Figures 4. Layout showing Ogba - Iwaya Townships (17.2km), the wetlands (blue line), the connecting streets and transit hubs.



Figures 5(left) & 6(right). Map showing the proposed green infrastructural plan at the 2.7km first phase (three zones) and the 1.5km second phase (two zones).

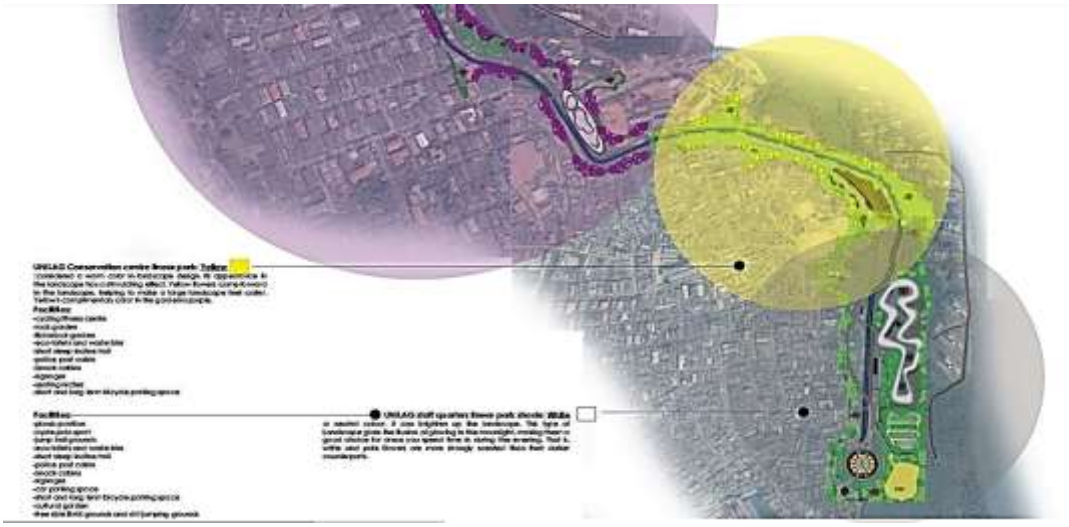


Figure 7. Map showing the proposed green infrastructural plan at the 2.0km third phase (three zones).

Table 1. Table showing the geographical coordinates of selected transit hubs and landmark points (26 Points)

S/N	Classification of the Landmarks	Use	Street/Area Name	Eastings	Northings
1	Commercial	Hotel	De Ritz Deluxe Hotel	3°21'10.36"E	6°35'38.70"N
2	Commercial	Hotel	Westown Hotel	3°21'36.73"E	6°35'0.05"N
3	Public	Transportation	Sheraton Link Bridge	3°21'46.44"E	6°35'7.11"N
4	Residential Estate	Housing Estate, Onigbongbo	Ajanaku Steet	3°21'57.77"E	6°35'8.81"N
5	Public	Transportation	Maryland Cane Village	3°22'19.47"E	6°34'42.32"N
6	Religious	Church	Our Lady Queen of Peace Catholic Church	3°23'20.46"E	6°34'0.49"N
7	Public	Transportation	Lagos –Ibadan Expressway-Third Axial Link Road	3°21'55.72"E	6°34'0.83"N
8	Residential	Housing Estate, Kosofe	Folarangba Street	3°23'28.00"E	6°34'1.87"N
9	Residential	Housing Estate, Kosofe	Adewale Kuku Street	3°22'33.92"E	6°33'24.29"N
10	Public	Transportation	Apapa Oworonshoki Expressway	3°22'21.94"E	6°33'16.54"N
11	Religious	Church	TREM Church	3°22'20.31"E	6°33'10.80"N
12	Residential	Obanikoro	Buraimoh Street	3°22'18.08"E	6°32'53.69"N
13	Residential	Bariga	Bariga Road	3°23'0.16"E	6°31'59.92"N
14	Recreational	Neighbourhood Park	Ojo Square	3°23'2.29"E	6°31'38.34"N
15	Religious	Mosque	Akoka Central Moque	3°23'6.73"E	6°31'38.57"N
16	Educational	Federal College Of Education (Technical), Akoka	Abule Ijesha	3°23'4.69"E	6°31'22.09"N
17	Educational	St Finbarr's College	Abule Ijesha	3°23'9.37"E	6°31'22.30"N
18	Educational	Akpka High School	Abule Ijesha	3°23'9.81"E	6°31'16.00"N
19	Educational	University of Lagos	Akoka	3°23'7.06"E	6°31'30.64"N
20	Residential	Housing Estate	Johnson's Street	3°23'8.59"E	6°30'43.00"N

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21	Religious	Church	MFM Headquatres	3°23'16.92"E	6°30'37.27"N
22	Educational	University of Lagos	UNILAG Distance Learning Institute (DLI)	3°23'37.95"E	6°30'38.34"N
23	Residential	Iwaya Community	Owodunni Street	3°23'35.11"E	6°30'22.86"N
24	Residential	UNILAG Staff Quatres'	UNILAG High Rise	3°23'48.27"E	6°30'19.17"N
25	Public	Water Corporation, Iwaya	Lagos State Water Corporation	3°23'31.29"E	6°30'70.29"N
26	Residential	Makoko Slums	Makoko	3°23'39.02"E	6°29'44.23"N

Table 2. Table showing the various land-uses and existing buidings

Land Use	Commercial	Educational	Residential	Public	Recreational	Religious	Total
Visited	2	5	9	5	1	4	26
Percentage	8%	19%	35%	19%	4%	15%	100%

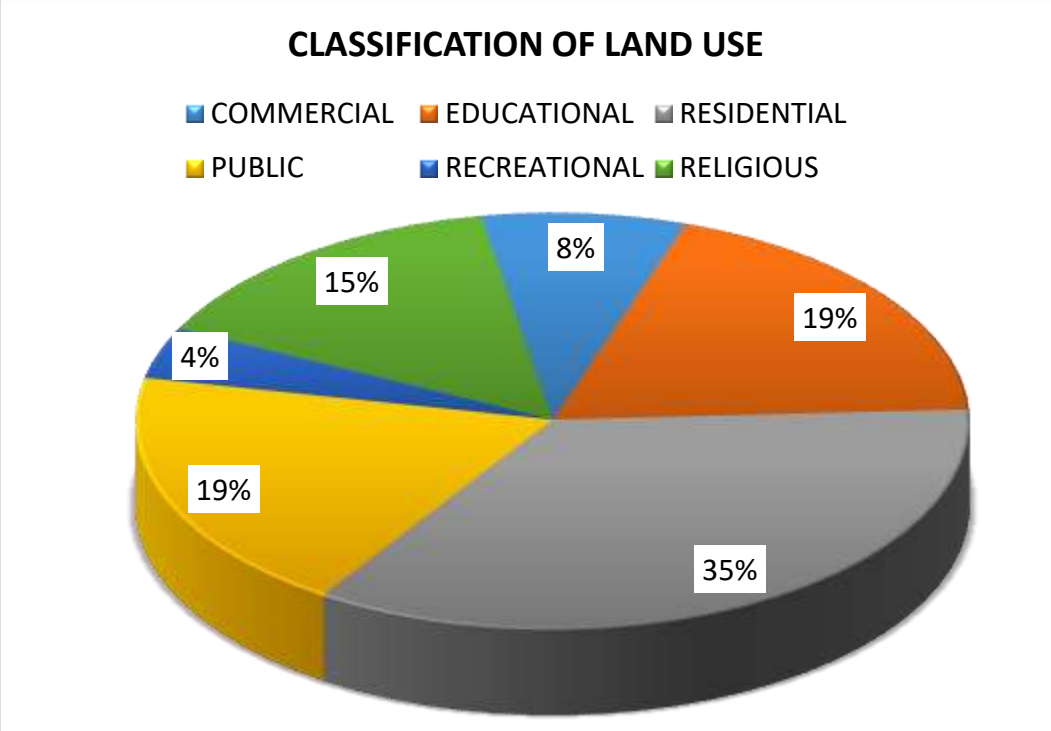

Figure 8. Pie Chart showing the land use analysis.

Table 1&2 above indicates that of the 26 transit hubs location and landmarks selected through random sampling the following analysis was obtainable: commercial (8%), educational (19%), residential (35%), public (19%), recreational (4%) and Religious (15%). This table further shows that most of the land use is for residential use followed by educational and public activities around the Lagos Mainland. Recreation has about 4% of the total land use which means that the study area has limited open spaces that are specifically for greenery. Religious activities occupy about 15% of the area. The studies identify that there are commercials shops, Churches and Mosques on every street within the neighbourhood with little or no regard for greenery and open spaces for recreational activities.

FINDINGS AND DISCUSSIONS

The study established that the green corridors and wetlands are vast land of an area of about 30km2 and it is mostly populated by land uses that are not planned hence the high level of abuse, disuse and misuse of the green corridors which have over the years led to the various land/wetlands encroachment, ecosystem degradation through air and water pollution, burning of refuses at the various dumpsites, loss of biodiversity, blockages of road drainages. This study confirmed that sustainable urban green infrastructures were not currently in place and use in these areas and therefore suggest the use of green infrastructures as a remediation tool for enhancing the environment and local air quality for Metropolitan Lagos. It was also observed that the following green infrastructure frameworks should be considered: Urban Ecological Farming, Garden Allotments and Urban Carbon Sequestration.

Introducing urban agricultural practices on wetlands as an approach to conserving wetlands in Lagos state offers tangible evidence of Lagos state's commitment to urban green initiatives as outlined by Lagos State Park and Garden Agency (LASPARK). Urban agriculture is a growing movement to bring the production, processing, and marketing of food into cities, closer to population centres and communities that often suffer from food insecurity through limited access to healthy food.

Plantlife captures and stores carbon found in the environment from sources like automobiles and industries. To achieve a climate-resilient Lagos through preservation, restoration and conservation of Lagos wetland, it is therefore paramount to activate and calculate the amount of CO_2 that would be sequestered by trees and shrubs over a year on the wetland. To populate the value of CO_2 captured for environmental benefits, there is a need for close enumeration of trees, type of trees, trees area and trees girth in the proposed urban green infrastructure master plan for the metropolis.

Since the well-being of a city cannot be separated from the well-being of its serene and habitable environments. A re-envisioned local food system restores health to an ecosystem degraded by pollution, contamination, and threats from climate change. Food production, distribution, and consumption now account for one-third of man-made greenhouse gas emissions. A sustainable food system produces food close to the consumers it serves, using renewable resources and avoiding methods and materials that contaminate the environment and the food.

The Integrated Linear Park, Social, Health and Fitness Impact is an off-road bike trail is an aim to create connected on-road cycling routes and an off-road trail network across Lagos state. Anthony to Maryland off-road bicycle trail system is seen as a high priority for this feasibility study as it connects to different neighbourhoods, communities and districts in Lagos state including Gbagada, Anthony, Mende, Somolu, Oworonshoki, Ogudu, Ifako, Ojota, and Ikeja. The plan is also a blueprint for creating a healthy and active environment encouraging people to participate in cycling for healthy living, cycling for low carbon transportation, sports, nature watch, play and relaxing parks. The Linear Park provides a bicycle path for transportation, tour and recreation through 16.6 kilometres. A desirable place to live and work includes walking and bicycling among the options for ways to get to work and other destinations. Carbon sequestration through restoration, conservation of existing wetlands and other strategic adaptive solutions toward a sustainable and resilient city development in the form of; urban green infrastructures, non-motorized transportation mode, urban agriculture along the wetlands, restoration of the wetlands and waterways, conservation and inclusive

landscape regeneration of the open spaces and concludes by stressing the reality of sustainable low carbon philosophy within the landscape and built environment. Some of the benefits of urban green infrastructure are discussed below:

Urban Carbon Reduction and Sequestration

Designed green walls, green roofs, bio-retention/rain gardens, and street trees provide carbon reduction benefits by sequestering CO_2 from the air as they grow (Molla, 2015). Recent researches show that GI/spaces purify and trap more than 12 million tons of dust, soil and other particulate matter (Molla, 2015). This is particularly important in urban areas due to the high incidence of air pollution and the inhalation of carcinogenic substances which are hazardous to the community's health and wellbeing. Various studies explored the links between urban tree cover and air quality (Escobedo et al., 2009). In a study carried out by McPherson (1994), the results of the 3-year Chicago Urban Forest Climate Project estimated that the trees removed 6145 tons of air pollutants (valued at $9.2 million), and sequestered 155 000 tons of carbon per year, in addition to providing energy savings for residential heating and cooling that, in turn, reduce carbon emissions from power stations (McPherson, 1994).

Improving Urban Air Quality

Green spaces in and urban settlement reduce the atmospheric temperature (urban heat island) and also act as a filter to improve air quality, in this case, vegetation has a great contribution to improving air quality by removing gas and dust-related pollutants (Bolund & Hunhammar 1999). Continuous improvements in air quality due to appropriate green infrastructure with adequate vegetation have a positive impact on physical health with such obvious benefits as a decrease in respiratory illnesses (Schucht et al, 2015). Various medical studies show that peoples just being in, or viewing, green space for a few minutes reduces stress which has been demonstrated by hospital patients and the general public meaning that green infrastructure enhances the psychological perception of the people. Thus, the

connection between people and nature is significant and strong for everyday enjoyment, work productivity and general mental health (Haq, 2011). Similarly, a review of literature linking health, wellbeing, urban air quality and green infrastructure, observed that there were several epidemiological studies linking proximity of green space and levels of physical activity (Hegetschweiler et al, 2017).

Urban Climate Change Mitigation and Adaptation

The introduction of green infrastructure into urban architecture plays an important role in reducing some of the impacts of climate change in our urban environments (Molla, 2015). Green infrastructure helps the adaptation of people who live in towns and cities to a changing climate, depending on location, type and extent, green infrastructure provides shade, cooling and wind interception and an insulation role in the winter (Johnstone et al, 2010). The findings reveal that the residential building (see figure 9) along the green corridors/ wetlands studied have more grey infrastructures than green infrastructure in the form of trees and vegetation. Green Infrastructure alleviates the impacts of climate change, such as flooding and the urban heat island possibilities and provides effective ecosystem services that are expensive and difficult to replace with man-made solutions. The study further reveals that urban areas within the Lagos metropolis have warmer air and surface temperatures compared with non-urban areas (suburbs). Buildings, roads and paved surfaces store heat during the day which is then released in the evening and night resulting in increased atmospheric temperature in both outdoor and indoor spaces.

Conclusion

This study summarizes and integrates the main findings which are presented in the urban greening strategies and technological innovations and how the benefits can be articulated in ecological, social and economic terms. Furthermore, the study scrutinized the relationship between green spaces, and social cohesion and discussed links between biological and cultural diversity. However, UGI is perceived as a comprehensive landscape approach acknowledging the various

ecological services and benefits from a coherent green, grey and blue network at different urban spatial configurations and levels, linking up neighbourhoods, districts and cities.

Securing the full services and benefits of UGI requires both green strategic planning as well as participatory synergies to address the variety of challenges associated with local sustainable developments and approaches to promote the social and economic wellbeing of urban residents. Appropriate government authorities and private institutions should recognize the role green infrastructures play in restoring a healthy ecosystem and in creating a more sustainable city through reduced reliance on fossil fuel, increased green open spaces, restoration of habitats, and increased soil, water and air purity.

Ministry of Agriculture and that of Environment should synergize to support the use of sustainable farming practices in urban agricultural settings. Support should be given to the establishment of waste treatment facilities to transform plant waste from gardens and farms into compost to be used in local gardens and farms.

This paper has illustrated that the quality and type of open space provided within communities can have a significant and sustained impact on community health and wellbeing. Adopting the following strategies will help to enhance the air quality:

1. The promotion of health and social benefits, as well as those related to the environment and the economy, are important in commending to decision-makers the significance of open spaces in shaping our communities now and in the future.
2. Maximize the use of existing space and use approaches that invest in community gardens, pocket parks, and multifunctional spaces designed for diverse communities.
3. Consider opportunities for rationalization of land as a way to increase the number of open space destinations.
4. Priorities green and open space development within urban settings over space for vehicle parking for example.
5. Involve communities in the design of spaces making them culturally and locally relevant. Focus on those areas most in need

of open space improvements e.g. some lower socio-economic areas, and areas with existing poor-quality open space.

6. Consider street greening initiatives and improvements to street connectivity, road design and traffic management that will increase the neighbourhoods' walkability.

Private Organizations, Local, State and Federal governments must also play a key role in recognizing the contributions that these make to public health well-being of individuals and the environment at large such as physically active lives, good mental health, socially cohesive and connected communities.

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