GREENING COMMUNITIES IN TROPICAL SUB-SAHARAN AFRICA

"Greening Communities in Tropical Sub-Saharan Africa (TSSA)" is a study which investigated the dynamics of developing an existing Ghanaian settlement towards ecological responsiveness and energy efficiency and had made some relevant pragmatic proposals for the way forward in achieving this. Using the New Juaben Municipality, with a population of about 137,000 and occupying an area of about 110 square kilometres, as a main case to develop, various strategies of integrated urban planning were utilised to establish a model for other cities and communities in the sub-region.

Thus out of the findings, it was realised that though a leapfrog approach was expedient for TSSA Countries and communities towards Green development, caution need to be exercised to understand what strategy and system is being copied to leap from the so-called advanced countries status and latest projects. Proposals in the areas of Transport and Residential Energy efficiency as well as Green Infrastructure Network Development were identified as suitable strategies for TSSA to focus its community developments towards Energy Efficiency and Ecological responsive development. Amongst these strategies are Mobility Management, Land Use Planning, Development Control Enactment and Enforcement, Ecological Aesthetics and Connectivity and the Development of Catalyst Project and the Provision of Incentives for Green Developments. It concludes by stipulating that for these proposals to succeed, the implementation strategy ought to incorporate legal and financial measures that would provide both penalties and incentives, whilst information dissermination and capacity buildingare aggressively pursued.

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GREENING COMMUNITIES IN TROPICAL SUB-SAHARAN AFRICA:
"A Research on the Dynamics of Developing New Juaben Municipal Area in Ghana into an Energy-Efficient and Ecologically-Responsive Community"

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By

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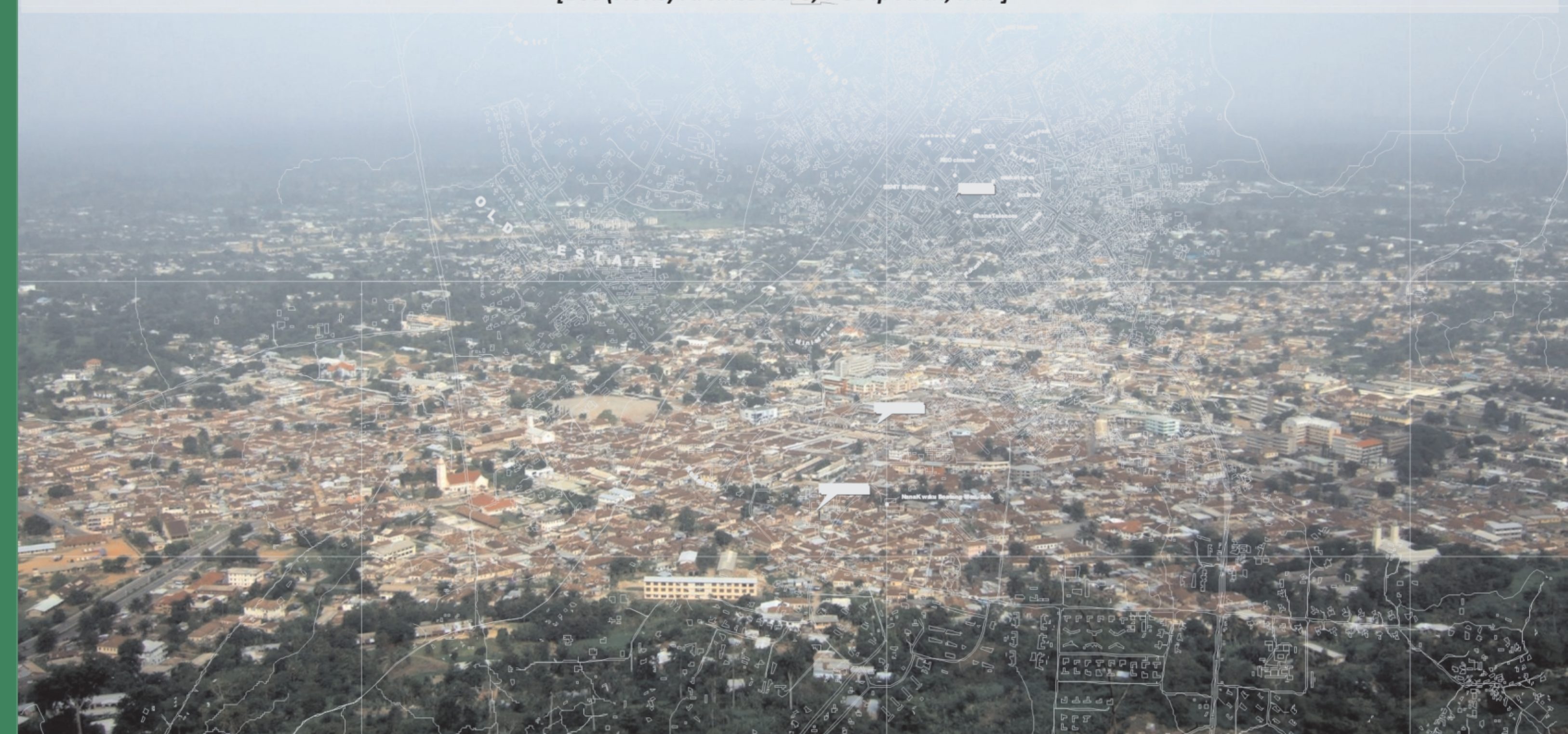
[Bsc (Hons) Architecture, PGDip Arch, MIP]



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"A Research on the Dynamics of Developing New Juaben Municipal Area in Ghana into an Energy-Efficient and Ecologically-Responsive Community"

Von der Fakultät Architektur und Stadtplanung
der Universität Stuttgart zur Erlangung der Würde
eines Doktors der Ingenieurwissenschaften (**Dr.-Ing.**) genehmigte Abhandlung

vorgelegt von

Alexander Boakye Marful
aus Agona Swedru, Ghana

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ABSTRACT

"In the pursuit of 'developed nation' status, the water and energy consumption trends of rich and industrial countries are being blindly adopted in the middle- to high-income sectors of most of the world's developing countries, of which sub-Sahara Africa is prominent"[1]. This trend is not only ecologically unsustainable but also poses a serious threat to the region's moral integrity , since large numbers of people have no access to potable water or electricity and live in very poor conditions. Thus, as Wolfgang Lauber explains in his book (Tropical Architecture), the majority of buildings show only a minimal response in terms of architecture and construction to the special conditions of the tropical climate, and also make little effort to develop ecological solutions to local problems. Regrettably, many examples reflect an uncritical acceptance of modern European settlement and building forms without considering the special climatic and social conditions of the tropical world (Lauber, Cheret and Ribbeck, 2005)[2].

Although guidelines, checklists, principles and even fora have been developed and organised in developed countries like Germany, Britain, America and Sweden to address the issue of building ecologically-responsive communities, these are largely absent in the SSA region. Despite the fact that large populations in the SSA are struggling for daily survival, the building industry and its professionals cannot look with apathy on cheaper practices which are detrimental to sustainability with regards to the environment, the economy and public health. The proposed research thus addresses a broad range of issues including community and site design, energy and water efficiency, materials selection, indoor air quality, construction management and building maintenance in the perspective of an authentic African setting.

According to Klaus Ferstl, the main concern of climatically-appropriate design and urban planning is to create an urban structure in such a way that an optimal climate is created using as little energy and technical equipment as possible. "Greening Communities in Tropical Sub-Saharan Africa" is a study which investigated the dynamics of developing an existing Ghanaian settlement towards ecological responsiveness and energy efficiency and had made some relevant pragmatic proposals for the way forward in achieving this. Using the New Juaben Municipality, with a population of about 137,000 and occupying an area of about 110 square kilometres, as a main case to develop, various

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[1] Marful,A.B.,Green Housing Infrastructure Planning for Sub-Saharan Africa: a paradigm of medium-low density green housing in Ghana,2005 pg1

[2] Lauber,W., Cheret,C. and Ribbeck, E., 2005,Tropical Architecture: Sustainable and Humane Building in Africa,Latin America and South-East Asia, Prestel, Munich

strategies of integrated urban planning were utilised to establish a model for other cities and communities in the sub-region.

The research was conducted descriptively and qualitatively in its approach of the analysis. The spatial analysis utilized typo-morphology analysis as well as historical (diachronic) and synchronic readings as its main research instruments. In-depth reading on relevant technologies was sought to address energy efficiency ecologically responsive communities and neighbourhoods. These readings helped to comprehensively trace the stages of city formation and its changes of both physical and non-physical (socio-cultural, ecological, economic, and perceptual) aspects, and help in understanding the process of transformation in the TSSA region. Thus out of the findings, it was realised that though a leapfrog approach was expedient for TSSA Countries and communities towards Green development, caution need to be exercised to understand what strategy and system is being copied to leap from the so-called advanced countries and latest projects. Proposals in the areas of Transport and Residential Energy efficiency as well as Green Infrastructure Network Development were identified and made as suitable strategies for TSSA to focus its community developments towards Energy Efficiency and Ecological responsive development. Amongst these strategies are Mobility Management, Land use planning, Development Control Enactment and Enforcement, Ecological Aesthetics and Connectivity and the Development of Catalyst Project and the Provision of Incentives for Green Developments. It concludes for these proposals to succeed, the implementation strategy should need to incorporate legal and financial measures that would provide both penalties and incentives whilst information and capacity building aggressively pursued.

KEY WORDS: eco-responsiveness, energy, efficiency, green, ecological, environment, Community, Afro-Green

ZUSAMMENFASSUNG

„Beim Streben nach dem ‚Industriestaat' Status" werden die Wasser- und Energieverbrauchstrends der reichen Industrieländer in mittel bis hochverdienenden Branchen in den meisten Entwicklungsländer der Welt blind übernommen; vor allem in Sub-Sahara Afrika"[3]. Dieser Trend ist zum einen ökologisch nicht nachhaltig und zum anderenauch eine Bedrohung für die moralische Integrität einer Region, da viele Menschen keinen Zugang zum Wasser oder Strom haben und in sehr armen Zuständen wohnen. Wie Wolfgang Lauber in seinem Buch *Tropical Architecture* erklärt, sind die meisten Gebäude hinsichtlich der Architektur und Konstruktion nur minimal auf die besonderen Zustände des tropischen Klimas abgestimmt und es gibt nur sehr wenige Bemühungen, ökologische Lösungen zu lokalen Problemen zu entwickeln.

Bedauerlicherweise zeigen viele Beispiele, dass moderne europäische Wohnungs- und Gebäudeformen kritiklos angenommen werden,ohne die besonderen klimatischen und sozialen Zustände der tropischen Welt mit einzubeziehen (Lauber, Cheret and Ribbeck, 2005)[4].

Obwohl Richtlinien, Checklisten, Prinzipien und sogar Foren in Industrieländern wie Deutschland, Großbritannien, Amerika und Schweden zum Thema Aufbau von ökologisch-empfänglichen Gemeinschaften geschaffen wurden , fehlen diese größtenteils in der SSA Region. Trotz einer großen Bevölkerung im SSA, dieums Überleben kämpft, können die Bauindustrie und ihre Experten nicht zusehen, dass kostengünstigere Methoden angewandt werden, die die Nachhaltigkeit im Hinblick auf Umwelt, Wirtschaft und Gesundheit der Öffentlichkeit gefährden. Von daher befasst sich die vorgeschlagene Forschung mit einer großen Reihe von Themen, inklusive Gemeinschafts- und Baugeländendesign, Energie- und Wassereffizienz, Materialselektion, Qualität der Innenraumluft, Baumanagement und Bauerhaltung aus der Sicht einer authentischen afrikanischen Situation.

Nach Klaus Ferstl besteht das Hauptanliegen von klimagerechtem Design und Städteplanung darin, eine Urbanstruktur so zu schaffen, dass ein optimales Klima mit Hilfe von möglichst wenig Energie und technischen Anlagen kreiert wird. „Greening Communities in Tropical Sub-Saharan Africa(TSSA)" ist eine Studie, die die Dynamik für die Entwicklung einer ökologischen Reaktion und Energieeffizienz einer existierenden ghananischen Siedlung erforschte und einige pragmatischen Vorschläge zu deren Verwirklichung gegeben hat. Indem man den neuen Juaben, einem Stadtbezirk mit einer Bevölkerungszahl von ca. 137 000 und einer Oberfläche von ca. 110 Quadratkilometern als Beispiel eines entwicklungsbedürftigen Ortes verwendet wurde, wurden unterschiedliche Strategien integrierter Städteplanung angewandt, um ein Modell für andere Städte und Gemeinschaften in der Subregion zu schaffen.

Die Durchführung der Forschungmethode wurde mit der deskriptiven und qualitativen Analyse umgesetzt.Bei der räumlichen Analyse wurden die typomorphologische , die historische

3 Marful,A.B.,Green Housing Infrastructure Planning for Sub-Saharan Africa: a paradigm of medium-low density green housing in Ghana,2005 pg1

4 Lauber,W., Cheret,C. and Ribbeck, E., 2005,Tropical Architecture: Sustainable and Humane Building in Africa,Latin America and South-East Asia, Prestel, Munich

(diachronische) sowie die synchronische Methode als Hauptforschungsinstrumente verwendet. Die detaillierte Lektüre über relevanteTechnologien wurde angestrebt, um Energieffizienz und Ökoreaktion in Gemeinden und Nachbarschaften zu addressieren. Die Lektüre ermöglichte zum einen die Etappender Stadtbildung und derenVeränderung derhinsichtlich physikalischen und nicht-physikalischen (sozio-kulturell, ökologisch, wirtschaftlich, und wahrnehmend) Aspektenumfassend nachzuverfolgen und zum anderen den Transformationsprozess in der TSSA Region zu verstehen. Bei den Forschungsergebnissen wurde festgestellt, dass obwohl der „Leapfrog"-Ansatz für TSSA Länder und Gemeinden gen „Green Development"(**Entwicklung von umweltgerechten Technologien)** ratsam ist, muss man umsichtig vorgehen, damit man versteht welche Strategie und welches System übernommen wird, um sich (dann) von den sogenannten fortgeschrittenen Ländern und aktuellen Projekten abheben zu können. Vorschläge in den Bereichen Verkehrs- und Siedlungsenergieeffizienz, sowie Grüne Infrastruktur Netzwerkentwicklung wurden ermittelt und als passende Strategien angenommen, die das TSSA braucht, um sich auf seine Gemeinschaftsentwicklung in Richtung Energieeffizienz und einer Entwicklung zu einer Ökoreaktion hin zu konzentrieren. Zu diesen Strategien gehören: Mobilitätmanagement, Grundstücknutzungsplanung, Verordnung zur Entwicklungskontrolle und Durchführung, ökologische Ästhetik und Konnektivität, ebenso wie die Entwicklung von beschleunigenden Projekten, und die Bereitstellung von Anreizen für ‚Green Developments'. Daraus lässt sich schließen, dass für den Erfolg der Vorschläge es wichtig ist, bei der Dürchführungsstrategie rechtliche und finanzielle Maßnahmen zu ergreifen, die sowohl Sanktionen als auch Anreize bereitstellenund dabei Informations- und Kapazitätaufbau dynamisch anstreben.

Schlüsselwörter: Ökoreaktion, Energie, Effizienz, grün, ökologisch, Umwelt, Gemeinschaft, Afro-Green.

DEDICATION

I dedicate this study to:

Tilly *with whom;*

Jesse and Josiah *for whom;*

W.T Ablakwa *from whom;*

This piece of work had become a reality.

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To all my family, Tilly, Jesse and Josiah, I say thanks for your moral support, love and the patience you had for me throughout this period. I am also highly indebted to my dear Mum and Dad for the good foundation they gave as well as always inspiring and praying for me. To my lovely Sister, Hilda, I say thanks for everything. To all the wonderful friends at African Good Governance Network (AGGN) and colleagues in CLEAN-AFRICA e.V., I say thank you for the friendship. Finally I also wish to say thanks to Ms Joy Adesua and Daniela Ukatz who helped with the German translations. To all those who contributed in various ways to the successful completion of this work, I say-

vielen herzlichen DANK!

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LIST OF ACRONYMS

CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CSP	Concentrated Solar Power
DC	Direct Cooling
DISS	Direct Solar Steam
DNI	Direct Normal Irradiance
DOE	Department of Energy
ECOSTAR	European Concentrated Solar Thermal Road Mapping
EIA	American Energy Information Administration
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse Gases
GIS	Geographic Information Systems
HCFC	Hydro-Chlorine-Fluorine Carbon
DH	District Heating
GoG	Government of Ghana
LEED	Leadership in Energy and Environmental Design
MDG	Millennium Development Goals
NMT	Non-Motorised Transport
NMV	Non-Motorised Vehicle
ppmv	parts per million by volume
REE	Residential Energy Efficiency
RMA	Resource Maintenance Approach
TEE	Transportation Energy Efficiency
TSSA	Tropical sub-Saharan Africa
UGI	Urban Green Infrastructure
USA	United States of America
UTE	Urban Transport Energy
UV	Ultra-Violet

LIST OF DEFINITIONS

Total primary energy demand

Total primary energy demand represents domestic demand only and is broken down into power generation, other energy sector and total final consumption.

Africa

Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Democratic Republic of Congo, Côte d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, United Republic of Tanzania, Togo, Tunisia, Uganda, Zambia and Zimbabwe.

North Africa

Algeria, Egypt, Libyan Arab Jamahiriya, Morocco and Tunisia

Sub-Saharan Africa

Africa regional grouping excluding South Africa and North Africa regional grouping

Energy Use by Fuel Type

This is how much petrol, gas, electricity etc. is consumed by a given city.

Carbon emissions by fuel type

This also explains how much carbon is emitted by each of the different fuels (this can also include local air quality emissions such as nitrogen and sulphur oxides).

Energy use by sector

Amount and what type of fuel is used by the residential sector, the transport sector, industry, local authority operations etc.

Carbon emissions by sector:

Amount of carbon is emitted by each sector.

Particulate matter (PM)

This is a growing problem in many urban areas in developing countries. Collectively, particulate pollution is often referred to as total suspended particulates. Fine particulates that are less than 10 and 2.5 microns—referred to as PM10 and PM2.5 —have the strongest adverse impact on human health because they can penetrate deep into the lungs. PM emissions are a key health concern, with estimated economic damage costs much higher than for other pollutants. The major sources of particulate pollution in urban areas are likely to be industry and commerce, the re-suspension of road and construction dust, and vehicles. In nonurban areas, practices such as agricultural burning contribute significantly to overall particulate pollution, and their impacts are also felt in urban areas (Kwon, et al., 2006).

Carbon monoxide (CO)

It is an odourless, invisible gas resulting from the incomplete combustion of carbon in fuel. The inhalation of CO can disrupt the supply of essential oxygen to the body's tissues, thus posing a major health risk, especially for those who suffer from cardiovascular disease. At high levels of inhalation, CO can be fatal. Automobiles are the largest source of CO emissions. Lesser sources include industrial processes, non-transportation fuel combustion, and fires (Kwon, et al., 2006).

Nitrogen oxides (NOx),

Including nitrogen dioxide (NO_2), are mainly produced by fossil fuel (petroleum and its derivatives) combustion. They play a major role in the formation of ozone, particulate matter, and acid rain. Short-term exposure to low levels of NO2 (even less than 3 hours) may impair lung function in individuals with pre-existing respiratory illnesses and increase the incidence of respiratory illnesses in children. Long-term exposure to NO2 may increase susceptibility to respiratory infections and cause permanent alterations in the lung. Diesel-powered vehicles are major contributors to NOx emissions (Kwon, et al., 2006).

Hydrocarbons (HC) and other volatile organic compounds (VOCs)

They are compounds with low molecular weight that have unpleasant effects such as eye irritation, coughing, sneezing, and drowsiness. On the other hand, compounds with heavy molecular weight may have carcinogenic or mutagenic effects. Some hydrocarbons have a close affinity to diesel particulates and may contribute to lung diseases (Kwon, et al., 2006).

Ozone (O_3)

It is a highly reactive gas, formed by VOCs and NOx in the presence of heat and sunlight? Ozone can cause a range of acute health problems, including eye, nose, and throat irritation; chest discomfort; coughing; and headaches. Children are most at risk because they are active outdoors when ozone levels are high. Ozone also affects vegetation and ecosystems, decreasing yields of commercial crops and plantations, and lowering the aesthetic value of national parks (Kwon, et al., 2006).

Neighbourhood Life Cycle[5]

This is a generalised pattern that describes the physical and social changes that residential areas experience over time.

Land Use Succession

This is a change in the predominant use of a neighbourhood or area over time. *Example:* As the neighbourhood aged, it began to make a transition from large single-family housing to apartment buildings through the process of land use succession.

Urban Renewal

The process of redeveloping deteriorated sections of the city, often through demolition and new construction. Although urban renewal may be privately funded, it is most often associated with government renewal programs.

Example: Most large cities have experienced some *urban renewal* in the last 20 years. The typical program attempts to demolish concentrations of dilapidated housing and attract developers of middle income or mixed housing. Often, however, urban renewal areas become sites for new public buildings, such as civic auditoriums, sports arenas, and universities.

Abandonment

This is voluntary surrender of property, owned or leased, without naming a successor as owner or tenant. The property will generally revert to a person holding a prior interest or, in cases where no

[5] http://www.allbusiness.com/glossaries/neighborhood-life-cycle/4963971-1.html_accessed on August 8th, 2011

owner is apparent, to the state. This however does not occur in the Ghanaian context and its rare in TSSA region.

Reflection coefficient

This is the diffuse reflectivity or reflecting power of a surface. It is defined as the ratio of reflected radiation from the surface to incident radiation upon it. Being a dimensionless fraction, it may also be expressed as a percentage, and is measured on a scale from zero for no reflecting power of a perfectly black surface, to 1 for perfect reflection of a white surface. (Wikimedia Foundation, 2007)

Albedo

Albedo is the fraction of solar energy (shortwave radiation) reflected from the Earth back into space. It is a measure of the reflectivity of the earth's surface. Ice, especially with snow on top of it, has a high albedo: most sunlight hitting the surface bounces back towards space. Water is much more absorbent and less reflective. So, if there is a lot of water, more solar radiation is absorbed by the ocean than when ice dominates.

Urban Growth Boundary

An urban growth boundary, also called an urban service boundary, is an officially adopted and mapped line beyond which the local or regional government does not support development for a specified period of time. Growth is supported inside the boundary with utilities and development-friendly policies. Growth is discouraged outside the boundary. Urban growth boundaries typically include enough land for development over a twenty (20) year period and are typically reviewed periodically (every five years) to ensure that adequate land remains within the boundary. If the urbanized area includes multiple jurisdictions a regional agency may be needed to manage the boundary[6].

[6] http://www.in.gov/indot/div/projects/i69planningtoolbox/_pdf/Urban%20Growth%20Boundaries.pdf_accessed_11-11-2011

PART - 1

Research Overview and Theoretical Studies

1 INTRODUCTION

1.1 BACKGROUND AND DEFINITION OF TOPIC

The ecological role of land, long overlooked, is again dawning on humanity at the global, continental, national, regional and local levels (Songsore, 2003 p. 242). Major cities in Ghana as well as in other developing nations in sub-Saharan Africa (SSA) are now demonstrating that the carrying capacity of the land cannot be exceeded without causing damage, deterioration and decreased productivity.

"In the pursuit of 'developed nation' status, the water and energy consumption trends of rich and industrialised countries are being blindly adopted in the middle- to high-income sectors of most of the world's developing countries, of which sub-Sahara Africa is prominent"[7]. This trend is not only ecologically unsustainable but also poses a serious threat to the region's moral integrity , since large numbers of people have no access to potable water or electricity and live in very poor conditions. Thus, as Wolfgang Lauber explains in his book (Tropical Architecture), the majority of buildings show only a minimal response in terms of architecture and construction to the special conditions of the tropical climate, and also make little effort to develop ecological solutions to local problems. Regrettably, many examples reflect an uncritical acceptance of modern European settlement and building forms without considering the special climatic and social conditions of the tropical world (Lauber, Cheret, & Ribbeck, 2005,p. 10)

Although guidelines, checklists, principles and even forum have been formed in developed countries like Germany, Britain, America and Sweden to address the issue of building ecologically-responsive communities, these are largely absent in the SSA region. Despite the fact that large populations in the SSA are struggling for daily survival, the building industry and its professionals cannot look with apathy on cheaper practices which are detrimental to sustainability with regards to the environment, the economy and public health. This research thus addresses a broad range of issues affecting planning and development of sustainable communities including; site design and planning, community energy efficiency, outdoor air quality, participatory planning framework in context with the realities in a typical SSA setting.

According to Klaus Ferstl, the main concern of climatically-appropriate design and urban planning is to create an urban structure in such a way that an optimal climate is created using as little energy and technical equipment as possible (Lauber, Cheret, & Ribbeck, 2005,p. 85). "Greening Communities

[7] Marful,A.B.,Green Housing Infrastructure Planning for Sub-Saharan Africa: a paradigm of medium-low density green housing in Ghana,2005 pg1

in Tropical Sub-Saharan Africa" is a research proposal which will investigate the dynamics of developing an existing Ghanaian settlement towards ecological responsiveness and energy efficiency and would illustrate it through a proposal for the way forward in achieving this. Using the New Juaben Municipality, with a population of about 155,000 and occupying an area of about 110 square kilometres[8], as a case to develop, various strategies of integrated urban planning will be utilised to establish a model for other cities and communities in the sub-region. With Curitiba, Brazil, as an inspiration and international model for sustainable tropical urban planning, the research aims to place Ghana on the map of best examples of sustainable community development if consideration is given to the final recommendations. Greening a given community involves the design of buildings, groups of buildings, spaces and landscapes, and establishes the processes that make successful, ecologically-responsive development possible.

A "green" building or community places a high priority on health, environmental performance and resource conservation over its life-cycle. These new priorities expand on and compliment the traditional concerns of economy, utility, durability, and delight, as set out by Alberti in his Four Books on Architecture. A green community may also be termed as sustainable community aim to create environmentally-friendly, energy-efficient buildings and developments by effectively managing natural resources. It thus has many facets and its interaction may not only be complex but challenging to achieve all. Trade-offs need to be made and in assessing them a scale need to be used to determine the relative greenness of the society under consideration. This includes passively and actively harnessing solar energy and using materials which, in their manufacture, application, and disposal, do the least possible damage to the so-called 'free resources' water, ground, and air. "Green design emphasizes a number of new environmental, resource and occupant health concerns:

- Reduce human exposure to noxious materials;
- Conserve non-renewable energy and scarce materials;
- Minimize life-cycle ecological (Real Estate Research Corporation, 1974) impact of energy and materials used;
- Use renewable energy and materials that are sustainably harvested; and
- Protect and restore local air, water, soils, flora and fauna. Support pedestrians, bicycles, mass transit and other alternatives to fossil-fuelled vehicles."[9]

[8] http://www.ghanadistricts.com/districts/?r=4&_=146&sa=4527_accessed_January_30_2010

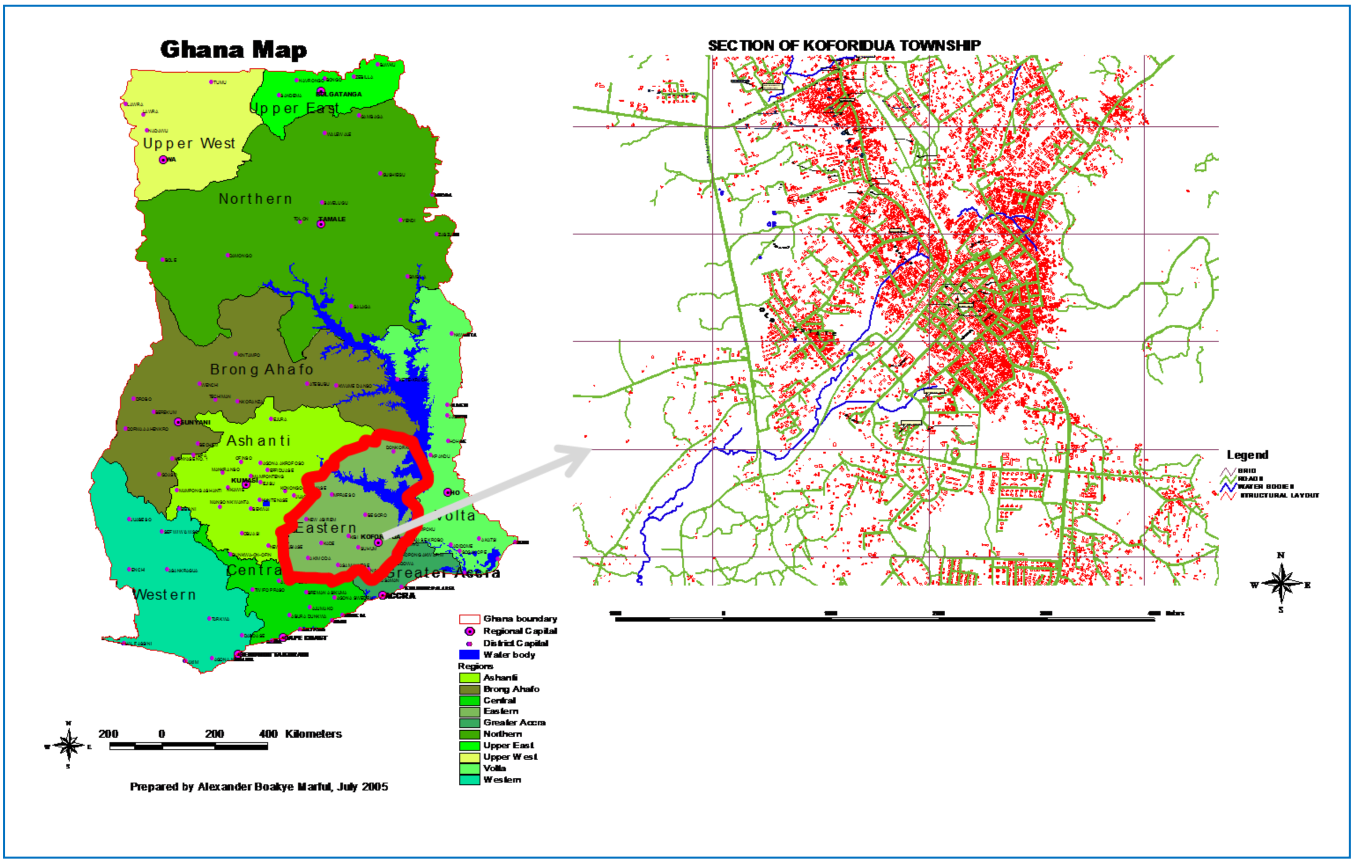
[9] Sam C M Hui,Aug 2002

Since buildings have a profound impact on our health, economy and natural environment, and use large amounts of energy and materials while accounting for 30% of all waste in landfills, building green is crucial if cities in sub-Saharan Africa are to offer attractive and sustainable environments for people to invest, live and work. Thus Greening communities in the context of this research in agreement to the view opined by Peck et al[10] , in their research for Canada mortgage and Housing Corporation on Barriers to Sustainable Community Development, refers to implementation strategies, principles or policies that can be utilised to prepare a new community or transform an existing community to become a sustainable community.

1.2 MAIN (FOCAL) CASE STUDY

1.2.1 Location Profile

Figure 1-1: Location Map of the focal Case Study Area



Source: (Marful, 2005, p. 22)

10 http://www.cein.ca/nua/ip/ip01.htm

New Juaben is the only municipality out of seventeen districts in the Eastern Region of Ghana and it covers a land area of about 110 square kilometres. It shares boundaries on the northeast with Akyem Abuakwa district, on the South east with Akuapem North, Yilo Krobo on the East and Suhum Kraboa Coaltar on the west. The population in the municipality is about 155, 000 inhabitants with Koforidua the regional and municipal capital contributing about 65% of the municipal population[11]. Detail information on the municipality is expatiated in chapter 7.

Figure 1-2: A View of the relief of Koforidua-(Obuotabiri Hills)

Source: Author

1.2.2 Definition of Urban in the Ghanaian context

The definition of an urban area varies from one country to the other. The parameters for defining urban areas have included among others, the population of the area, availability of social and economic infrastructure and functionality of the settlement. Within the Ghanaian context, the Local Government Act, 1993 (Act 462) stipulates the establishment of urban, town and area councils within the institutional framework for local governance in Ghana. The law further stipulates that a settlement shall be classified as urban when it has a population of over 15,000. Besides this definition, district capitals are also perceived as urban centres by virtue of the functions they perform (Republic of Ghana, no date). These two positions offer legal and functional definitions of urban areas in Ghana (Water Aid Ghana, 2009, p.23). This therefore makes the district capital of New

[11] http://www.ghanadistricts.com/districts/?r=4&_=146&sa=5793_accessed_january_15_2008

Juaben Municipal Area with a population of about 85,000 inhabitants an urban area to be considered.

1.2.3 Why New Juaben Municipal Area?

Figure 1-3: Aerial View of Koforidua City-Capital of New Juaben Municipal Area

Source: Author

There are quite a few reasons why Koforidua city has become the focal case study area of this research. In the advent of Accra the capital city of Ghana bursting to transcend from the urban metropolis to a megacity, urban sprawl have become the growth pattern of the city and its environ. Koforidua is only 85 kilometres from Accra and about an hour's drive by car. The expansion of Accra has also translated some of the urban problems to all the surrounding town and cities. Koforidua still possess a lot of pristine natural resources with a very conducive micro-climate due to the natural surroundings. The city which used to be the commercial hub of the Eastern Region of Ghana is virtually dead with no night life and neglected rich eco-tourism sites. "A predominant natural feature in Koforidua is the 'Obuo Tabri' Mountain, which is considered sacred. Nearby is Akosombo Dam which holds Lake Volta, the world's largest man-made lake. Waterfalls in the area such as Akan Falls and Boti Falls and the Umbrella Rock attract tourists to the region"[12]. The New Juaben Area with Koforidua as its capital, still have a lot of ecological features which though is at risk can be remedied as compared to Accra which is on the brink of total ecological collapse due to pollution and urban

[12] http://en.wikipedia.org/wiki/New-Juaben_Municipal_District_accessed January 20th, 2010

heat effect. An aerial view of Koforidua brings to mind the persistent lack of planning guidelines that adhere to the protection of the environmental integrity of the area. The unavailability of businesses and jobs in area (although it has a great potential for reviving the past glorious commercial and business activities in the region) depict that city is on its verge to suffer migration of its youth to Accra. Demonstrating how New Juaben Area can be transformed to become a sustainable community in an African context will bring to bear a great example of how dormant cities can be revived using Afro-Green Community Planning Principles.

1.3 PROBLEM STATEMENT

As stated by Lauber et al, 2005, architects in the tropics are confronted with the challenges of heat, strong solar radiation, high levels of air humidity and torrential rainfall in their quest to develop spaces that are socio-culturally appropriate in the day-to-day lives of their societies. Lack of guidelines and physical development plans at various district and national levels, cause urban development to be more rampant and haphazard and almost uncontrollable. This is not so different with the existing scenario at the proposed area for the research in the Eastern Region of Ghana.

Box 1-1: CHALLENGES FACING THE ENERGY SECTOR IN GHANA

The key challenges facing the energy sector are the following:

i. Rapidly growing demand for energy by all sectors due to the expanding economy and growing population.

ii. Risk of significant imbalance between energy production and indigenous sources of supply.

iii. Inadequate investments to match the growing energy demand due to lack of capital.

iv. Risk of over reliance on imports to meet local shortfalls of conventional fuels, which could threaten the country's supply security, making it vulnerable to external pressures.

v. High levels of end-use inefficiency culminating in waste of final energy forms.

vi. Inefficient pricing of energy services resulting in poor financial positions of the energy providers, but also high cost of tariff, which would not encourage maximum use of energy for wealth creation and could threaten the country's growth in prosperity and modern way of life.

vii. Operational inefficiencies of the utilities leading to high energy losses and consequently increasing cost of supply and distribution.

viii. Over reliance on wood fuels which could threaten the country's forest cover ix. Solar energy, which is relatively abundant, is barely exploited to supplement the commercial energy requirements of the country.

Source: Ghana Energy Commission, 2006, p. 7-8

The increasing population and rapid urbanisation of Ghanaian cities is seldom coupled with sufficient corresponding infrastructural development. Waste disposal and treatment have become a nightmare in the New Juaben Municipal Area (NJMA), resulting in a mosquitoinfested community which cannot enjoy its outdoor open spaces during the evening for fear of the insects.

Ghana as a whole during 2007 had about 45 cumulative days of electrical blackout that year and with the first 10 months of 2011 about 50 days of black-out have been experienced. Nevertheless the demand on the Akosombo Dam Hydroelectric Station and its supporting power plants can be reduced drastically if all the municipal and metropolitan centres are adapted as green communities which have energy efficiency adopted into its planning and management. Due to energy waste and inefficiencies, many developing countries including Ghana are struggling to keep their few industries running on the insufficient energy output. "In Ghana for instance, whilst industry grew at 2 – 4% per annum between 1989 and 1997, energy consumption over the same period grew at 10 – 14 percent. Currently, it is estimated that that the level of energy waste in the use of electrical energy by consumers is over 20 percent, implying that consumers waste more than the entire generation of the Kpong Hydropower Plant"[13] (a 160MW Hydro power plant in Akuse, Ghana).

The average potable water provision is only 49 percent, which should encourage communities to utilise green initiatives to conserve water resources. This wastage is aggravated by bad town planning and urban design principles utilised in the various cities in Ghana which result in increase in the travel time and consumption of fossil fuels from various origins to other destinations. This gradual deplorable situation is being reflected by the deforestation in the NJMA due to construction and other economic activities, as well as absence or properly designed green and urban spaces. Consequently, the resultant development of the municipal area is affecting not only the environmental sustainability of the area, but also the socio-economic vitality.

In a time of architectural revolution and rapid urbanization in the SSA, it is the responsibility of urban planners, architects, engineers and allied professionals to make use of new technologies, highly efficient production processes and vernacular knowledge to find innovative solutions which are socio-economically and ecologically compatible for the sub-region.

[13] http://www.wikieducator.org/Lesson_5:_Energy_Efficiency_and_Conservation- 18th February, 2009.

1.4 OBJECTIVES OF THE RESEARCH

The objectives of this research project were to:

1. Establish guidelines and standards for green community infrastructure and planning towards sustainable community principles and practice in the SSA;
2. Create awareness among the various professional bodies in the building industry practising in the SSA on the need to adopt green building principles into local building regulations;
3. Develop a sustainability assessment procedure to assess the green performance(with regards to energy efficiency and eco-responsiveness) of existing built environments and new community developments in Ghana;
4. Stimulate a forum for discussion in the search for an authentic African Architectural practise which is responsive to the climate and environment
5. Develop a basis for the preparation of guidelines and principles for planning energy efficient and eco-responsive communities in SSA
6. Create awareness of the various facets of sustainable community issues relevant to be researched on and documented for the benefits of the planning and building industry of the region.

> **'The case for including an energy dimension in the urban development is compelling. Not only is energy a crucial resource, but it is associated with serious environmental effects at all scales.'**
>
> *Susan Owens, Cambridge University* (U.S. Department of Energy, 1996,p. 1)

1.5 JUSTIFICATION OF RESEARCH

"Environmentally-oriented planning has much more to do with reflection and integration of specific local conditions and needs than with any programmatic normative precepts, which can quickly lead to uniformity and aesthetic impoverishment"[14].The New Juaben Municipal Task force Committee, as part of their action plan in implementing the priorities of the Medium Term District Development Plan (MTDDP) for New Juaben Municipality (2006-2009), has began urban greening and design activities. Lia Gudaitis[15] points out in her recommendations for the

[14] Thomas Herzog in his forward to the book 'Solar Energy in Architecture and Planning' 1998. Prestel, Munich

[15] Lia Gudaitis is a 2006-2007 Canadian World link intern to the New Juaben Municipal Assembly

development of a growth management strategy for NJMA that the Social Investment Fund's Urban Poverty Reduction Project (UPRP) should include socio-economic infrastructure such as urban aesthetic and green town initiatives, tree-planting, sidewalk embellishment, commercial street renovation and revitalisation through boutique beautification. She goes further to postulate that as Ghanaians become increasingly prosperous and rise to the middle-income status, priorities will begin to shift towards improving lifestyles through a focus on the environment. Furthermore, tourists and investors are attracted to many of the same things that improve the lifestyles of residents, including beautiful scenery, a sense of place and city image, a friendly character of the urban fabric, a clean and healthy environment, fun and interesting activities to participate in and stress-free movement around town.

Outlining the key developmental issues at the 13th public hearings of all 13 zonal councils of the municipality, the Municipal Planning Officer mentioned, among other issues, the problems of haphazard spatial development, increased rates of waste generation in the municipality and the inadequate management capacity for solid and liquid waste, as well as the inability to facilitate the development of tourism potentials and infrastructure[16]. Without a guiding master plan and growth management strategy in place for New Juaben, the achievement of a sustainable community is no more than a dream. It is thus imperative that the proposed research be undertaken now, to collate and analyse existing data whilst a collaborative proposal is made to salvage the situation and direct the allocation of resources by the Municipal Assembly.

1.6 SCOPE OF RESEARCH

Apart from researching into the theoretical background and framework of what sustainable community development is in Africa, careful analysis of selected aspect of the final strategies that leads to sustainable community development was done. However the following issues or task were done to assist in the elucidation of the topic with its intended objectives;

1. Analysis of case studies of green cities; Curitiba in Brazil, Ecological City, Kronsberg; Masdar City Project, Masdar; Sino-Singapore Tianjin Eco-City Project, Dongtan Project, China;
2. Preparation of baseline profile of the New Juaben Municipal Area;
3. Situational study and analysis of existing green practices (if any) within the sub-region;
4. Development of an analysis strategy for community development projects which is responsive to environmental conditions and green consciousness;

16 New Juaben Municipal Assembly, Medium Term District development Plan For the New Juaben Municipality(2006-2009), September 2006

5. Development of the requirements and strategies for the policy framework and urban design guidelines in planning sustainable communities in Tropical SSA
6. Development of a methodology of assessing the 'Greenness' of a proposed or existing Afro-Green community Project in Tropical SSA;
7. Replication by adaptation of important strategies that can make Communities in SSA Green.

1.7 RESEARCH QUESTIONS AND EXPECTED OUTPUT

In developing the hypothesis for this research the guiding questions to be considered included;

1. Which urban planning and design strategies were most effective in reducing energy demands and increasing the use of renewable and high-efficiency supply technologies?
2. How could the building professionals practicing in SSA design and plan more with less?
3. How could and should professionals design and plan their communities 'with' and 'like' nature?
4. How could one identify or assess the 'greenness' of an existing or proposed new community in Ghana or SSA?
5. How does an existing community incorporate green principles and strategies to achieve eco-responsiveness and energy efficiency in Tropical SSA?
6. What are green infrastructure and its relevance in planning communities in developing countries?

The research output will be a PhD thesis containing 10 chapters of comprising theoretical research, case study analysis and proposals. Furthermore, based on the findings and discussions, strategies for replication by adaptation of the lessons, were made as guidelines for preparing communities in Tropical SSA to be Green and hence expatiate what Afro-Green Community meant.

1.8 METHODOLOGY AND APPROACH

The underlying method to be used for the research was the exploratory method. There were some major constraints to the successful execution of this study and key amongst them were:

- Availability of validated data on the traditional structures and spaces in most of the study areas were scanty. Proper documentation and reliable information on the performance of the existing and emerging housing stocks and communities were could not be accessed or obtained from the authorities;
- Travel cost and time made it quite difficult to access the required data.

The execution of the research necessarily included a careful reading of urban aspects from the past and present. To fulfil the mentioned objectives, some approaches and methods were utilized to support this research and to achieve the aims of the study.

The research was conducted descriptively with a qualitative approach in the analysis. The spatial analysis utilised typo-morphology analysis as well as historical (diachronic) and synchronic readings as its main research instruments. In-depth reading on relevant technologies sought to address energy and eco-efficiency systems as well as energy efficient strategies that create comfortable micro-climatic conditions. These readings helped to comprehensively trace the stages of city formation and its changes of both physical and non-physical (socio-cultural, ecological, economic, and perceptual) aspects, and helped in understanding the process of transformation.

To precede the investigation the data collection had been developed as follows:

1.8.1 Literature Studies

Literature studies was conducted by reading from studies in related areas such as the theory, concepts, methods and techniques of urban typo-morphology analysis and green infrastructure. The theories of systems and urban settings, as well as urban anthropology and sociology helped the research to appreciate the process of formation and transformations of urban structure and architecture as well as energy-efficient planning methods and approaches, which were the main focus of the research. The secondary data however were collected both from official and unofficial sources like archives, ancient writing on related subjects, municipal leaflets, magazines, and articles in newspapers or journals.

1.8.2 Field Survey

Field visits and observations were conducted to get a clear idea of variables in the case study. Direct appraisals were also conducted by collecting urban maps, photographs, sketches, and other physical traces. Consequently, measurements, documentation, observation and questionnaires were needed as the survey tools. These also helped in obtaining clear information of the transformed elements of the case studies and the current situation.

Qualitative surveys were also be utilized in the case study to identify local perceptions of space. Direct interviews with inhabitants and other resource persons will be used as cross–checking in order to give clearer and deeper understanding of all aspects of the localities that might affect the physical changes in the area of case studies.

This research also uses the phenomenological approach, meaning that survey and interview were carried out by using structured list and questionnaire, with some open questions to allow for urban facts that have not been included in the prepared lists. The open questions originating from the inhabitant or related resource person were recorded as additional information in prepared questionnaires.

More so, Geographic Information System (GIS) and other mapping tools were used to develop an understanding of existing conditions and how planned interventions might affect the municipal area.

1.8.3 Interactive / participatory observation and workshops

In order to get local government agencies involved in the field survey as resource persons, an attempt for participatory observation and workshops was planned to be organise but aborted later due to cost. The aims were to identify and understand both the potential and weaknesses in the case studies from the community and stake holder side, and to find information that might missed by the interview list or questionnaires prepared by the researcher.

Through comprehensive information-gathering and data analysis processes the groundwork as well as platform for a sustainable green space strategy had been laid for New Juaben Municipal Area as per this study.

1.8.4 Baseline Information

"Creating sustainable communities depends on taking equal account of the design of buildings, their location, and the quality of the outdoor space, at strategic local and site scale."[17] Thus the baseline information to be collected included:

- Demographic profile of the population and future trends;
- Climatic , geo-physical, hydrological and drainage data of the area;
- National, regional and local physical development policies and plans;
- On-going physical development projects that have key impacts on the quality of life;
- Landscape / townscape / visual characteristics of area;
- Ecological resources, including designation and target from local biodiversity actions;
- Spatial planning context such as regeneration initiatives;
- Transport networks, including public transport links, pedestrian and cycle routes;

[17] CABE , Start with a Park, 2005 pg 6

- Assessment of the quality, quantity and accessibility of current green space supply relative to demand;
- Assessment of key building structures to ascertain their energy and water demands and other green features to measure the level of greenness and develop strategies for their improvement.

1.8.5 Disposition of Report

The report for this study was constructed in four main parts, with discussions in ten chapters.

Part One has five chapters with Chapter One being the Project Preview. This first chapter discusses the thesis framework and background as well as the location of the study. It also has a glossary to explain most of the technical words used in the other chapters, and establishes the problem statement. The objectives and the scope of study as well as the justification are also presented here. The chapter ends with a description of the research method used and the disposition of study.

Chapters Two and Three deal with the extensive literature review that would be done to substantiate the argument of the research. This involves a review of literature on sustainable development. The second chapter expatiates the meaning of sustainable community development and further expatiates what it means to develop sustainable African communities. However the third chapter looks into the history of the urban strategies in SSA as a theoretical background to understand the morphological development of the communities in SSA. The trend of community planning strategies that is utilised in Tropical SSA is also looked at whilst the ideological background of setting up of the community spaces is also explored. In the fourth and fifth Chapters, the concepts of energy efficiency and ecologically responsiveness are explained respectively. Examples of communities which have or trying to implement such concepts are also described and analysed.

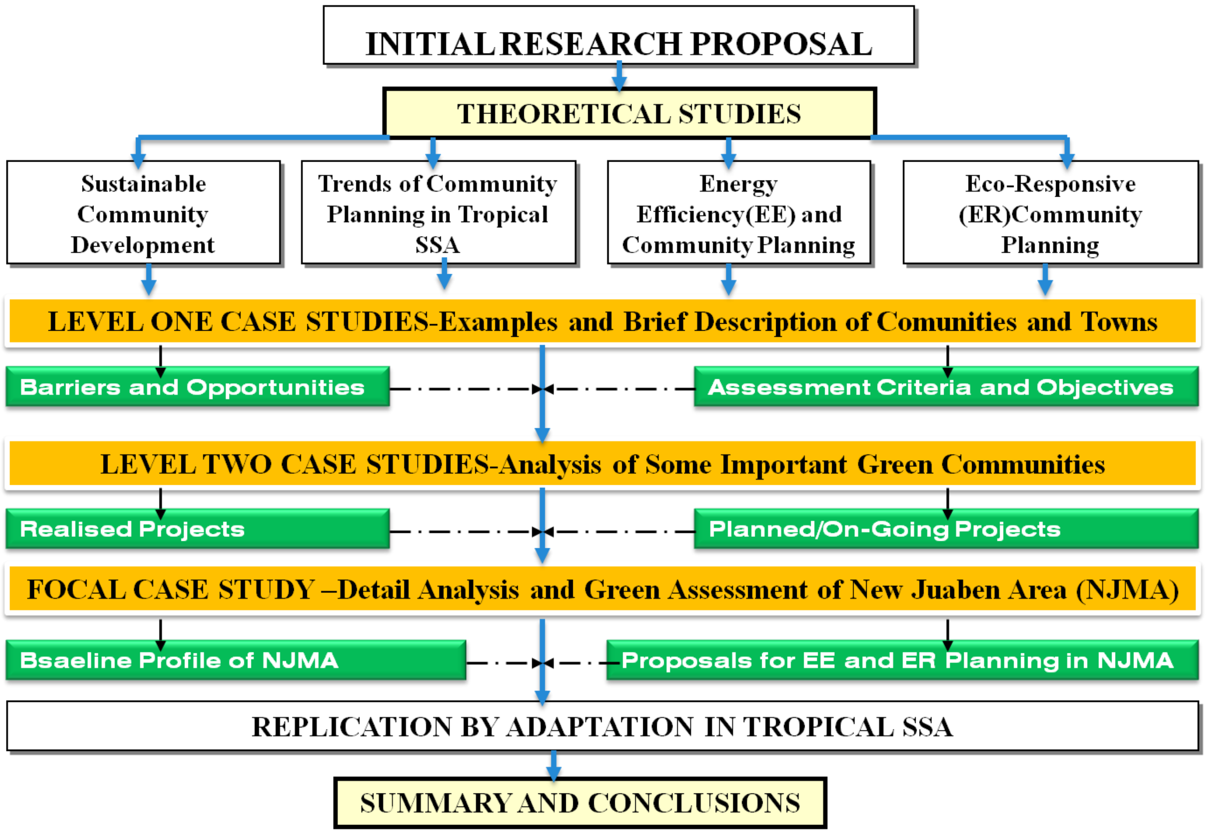
Part Two is dedicated for the sixth chapter which is the comprehensive analysis of realised and on-going projects with the concept of 'Greenness' or Sustainability. This part really looks at relevant case studies across the world and it opens with the development of assessment criteria to analyse the various communities chosen. This is used to critically analyse aspects of the communities and they are highlighted to emphasise the lessons worth repeating and those that need to be discouraged. Thus, the first aspect deals with the analysis of realised projects like Curitiba in Brazil and the Ecological City of Kronsberg, Germany. Some of the ongoing projects that were looked at are; Dongtan project, Masdar City Project, and the Sino-Tianjin Project. A summary of what is gleaned from the analysis is done at the end of the chapter to ascertain the lessons learned.

Part Three has two chapters and it primarily deals with the issues concerning the focal case study. Chapter Seven discusses the baseline information of New Juaben Municipal Area (NJMA) as well as its urban form and structure. Existing physical and social infrastructure will be described as well, including the existing transportation and traffic situation. The green assessment of the NJMA area was covered in chapter 8 with the existing vision and goals of the area elucidated. This chapter concludes with a summary of and brief commentary on existing planning guidelines. An assessment of the community energy efficiency and eco-responsiveness using criteria and indicators proposed is looked up in this chapter.

Part Four also has two chapters which discuss the proposals derived from the research as well as some recommendations and conclusions. Thus, Chapter nine details out the proposals for implementing energy efficient and ecologically responsive strategies in NJMA. Chapter 10 elucidates on the replications strategies in TSSA and highlights on some other important recommendations and conclusions for the study.

1.9 RESEARCH FRAMEWORK

Figure 1-4: General Methodological Framework



The Methodology and process for the entire research frame work have been diagrammatically shown in figure 1-4 above, which serve as a summary of the plan for activities and actions which were undertaken. In agreement to Berke, et al. (2006), 'Planning is not simply a process, but is a process guided by a plan' this framework seeks to guide the overall process of planning an environmentally responsive and energy efficient community in Ghana. Theoretical studies, as indicated, was done after the research proposal have been accepted by the main supervisor and the academic Board. This studies form the initial input into the comprehension of the basis for the entire concept under research and it includes; identifying and exploring the meaning of sustainable community planning and development, Trends of community planning in SSA as well as the concepts of energy efficiency. This also goes further to discuss the strategies needed to be adopted for community planning and development in tropical as well SSA countries.

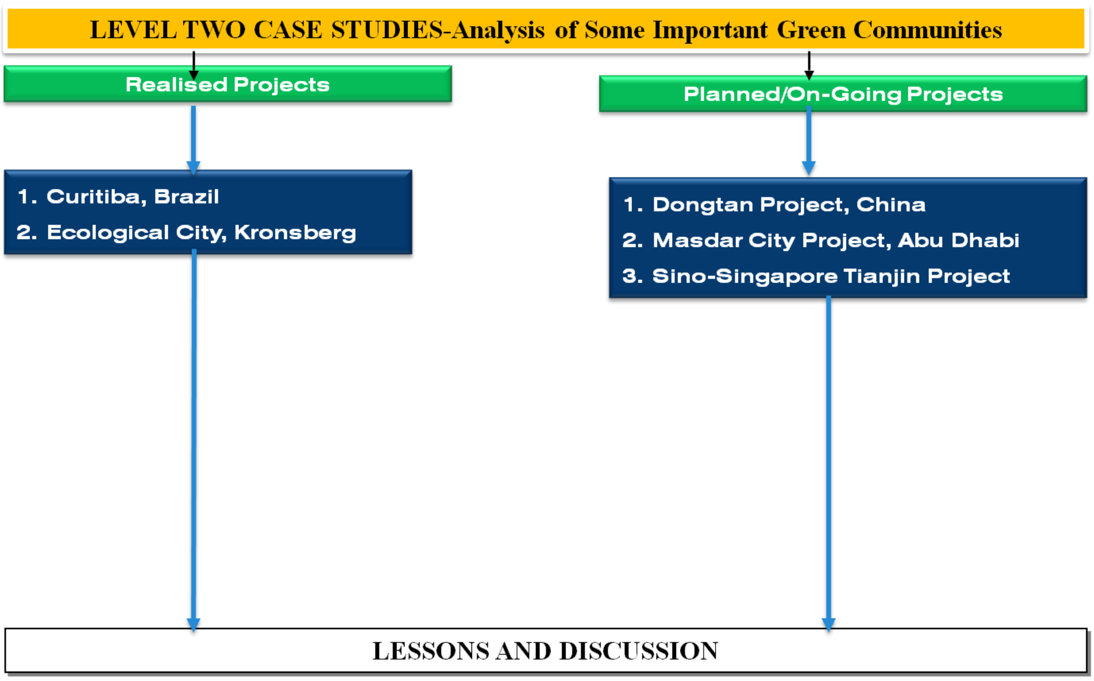


Figure 1-5: Detail Methodology for the Level two Case Study Analysis

Just at the end of the theoretical studies, begins the analysis and evaluation of the various selected case studies. The completion of each aspect of theoretical studies is the first level of case studies. The Level two Cases are examples of important green communities that are realised and are either planned or on-going. As shown in figure 1-5 above, the two realised projects would be analysed whilst 3 of the planned/on-going project would be discussed. In other to ascertain the relevance to the research, the lessons from these cases would be summarised and discussed.

As part of the analysis of the focal Case study (i.e. NJMA) preparation of a comprehensive baseline profile of NJMA after the lessons from the case studies, baseline information was collected and audited through further literature review. As indicated in figure 1-6 below, the workshop which form part of the data collection process at the NJMA, was done in Ghana. The community was also assessed for its energy efficiency and Eco-responsiveness as per the criteria that had been prepared from the lessons from the theoretical studies. This documentation helped develop the urban design and planning culminated in the preparation of proposals for most of the important and vital objectives of a Green community.

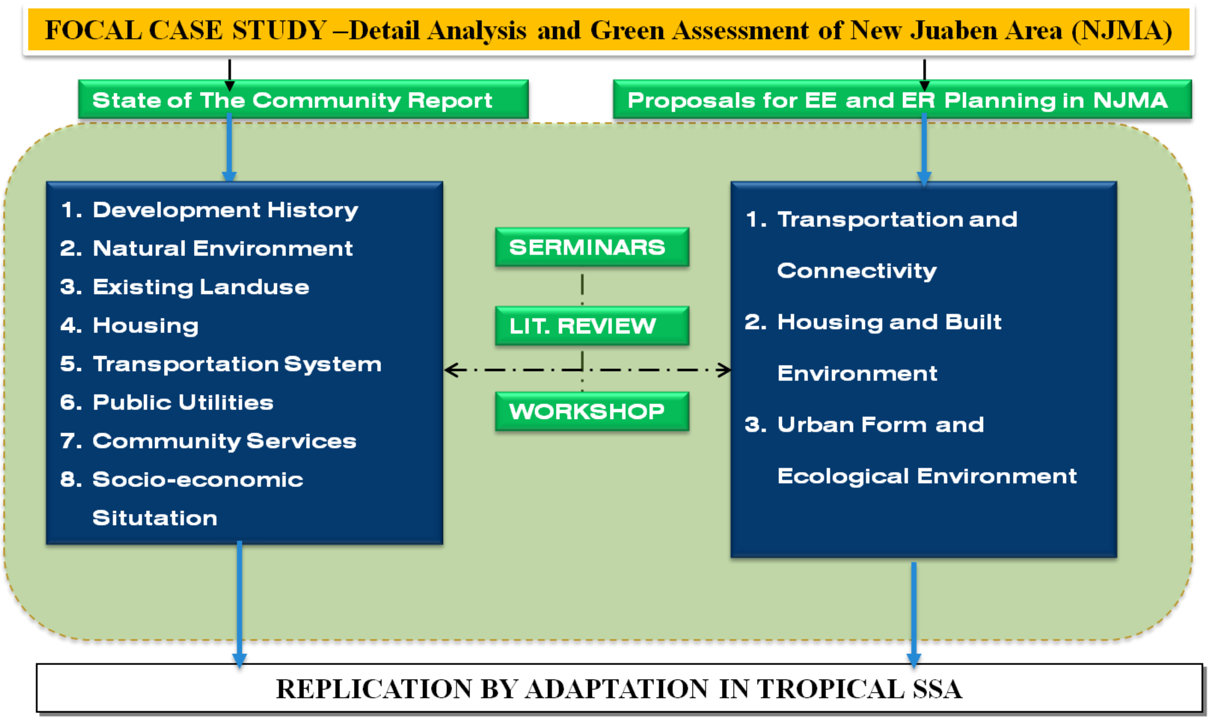


Figure 1-6: Methodology for the Analysis of- FOCAL CASE STUDY

Consequently, after these proposals, an attempt was made to explain how they could be replicated by adaptation to the various regional climatic and socio-economic milieus. Then final summary discussions, analysis, recommendation and conclusion were drawn and expatiated after this stage.

2 SUSTAINABLE COMMUNITY PLANNING AND DEVELOPMENT

2.1 DEFINITION OF SUSTAINABLE COMMUNITY DEVELOPMENT (SCD)

'Green Communities which is another way of describing sustainable communities'[18] has become very important issue of discourse among diverse professional bodies. This can be attributed to how interesting the sustainable development topic had become in the developmental circles and agencies. Sustainable developments like many new ideas and concepts have great potentials with varying definitions and meaning depending on whom and where it is being used. 'During the 1980s, the concept of sustainable development emerged as a popular solution to the thorny issue of meeting the material needs of the present population, while simultaneously maintaining the integrity of the environment (Bridger and Luloff,1998).'[19]

2.1.1 Conceptual Definition of Sustainable Community Development

According to Bridger and Luloff (1998), any definition of "the sustainable community" depends on the definition of sustainable development chosen and subsequently, Lele (1991) and Korten (1992) had observed, that sustainability has become a standard component of development rhetoric. This confirms the existence of varying definitions with corresponding diverse context which fits best. Bridger and Luloff (1998) further explains that most definitions of sustainable development are based on intergenerational equity, which is captured by the idea that "...the current generation must not compromise the ability of future generations to meet their material needs and enjoy a healthy environment" (Batie, 1989; p.1084).Two most popular schools of thought that try to explain the basis and fundamentals are the Constraint Economic Growth (CEG) and the Resource Maintenance Approach (RMA). According to Bridger and Luloff (1998), advocates of Constrained Economic Growth argue that sustainable development is "...the pursuit of growth subject to environmental constraints"; (Batie, 1989; p.1084).

However , Korten(1992,p.161), says in his view, 'continued growth, even if planned with ecological considerations in mind, ignores the mounting evidence suggesting that the economic demands we have placed on the environment now exceed what the ecosystem can sustain'. In this light the CEG concept when applied to planning of communities would also mean that one can utilise or consume as much resource for developmental purposes as long as the process is subjected to an environmental scrutiny and constraint. Possible challenge includes who sets the criteria and how

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[18] Peck et al, 2000, *"*Implementing Sustainable Community Development: Charting a Federal Role for the 21st Century*", Canada Mortgage and Housing Corporation (CMHC) Research Report*

[19] Bridger J. C. and Luloff A.E, 1998 Sustainable Community Development: An Interactional Perspective, Northeast Regional Centre for Rural Development,publ.no.73-http://nercrd.psu.edu/community/Legacy/bridger_community.html,accessed march 2009.

uniform would that be in the advent of prevalent socio-economic inequality within and between nations.

On the other hand, the Resource Maintenance Approach requires a fundamental rethinking of our relationship to the environment, consumption patterns, and standards of living (Bridger and Luloff, 1998). Batie (1989,p.1085) had opined that with this approach, efforts are focused on minimizing our impact on the environment and use of natural resources while simultaneously meeting the material needs of people. This approach actually explains the basis for the explanation CABE[20] (2000, p.17) gives for sustainable development. The group says SD is a balance, inclusive approach that seeks to meet the needs of the present generation without compromising the ability of future generations to meet their own need. However, Rydin (2007) goes further to say that sustainable development is not simply about raising priority accorded to Environmental or ecological issues, however the nirvana of local sustainability would be, achieving environmental and socio-economic objectives simultaneously (Atkinson et al, 2007;p.351) this development must synchronise with the improvement of the quality of lives of the inhabitants by taking actions and attaining material growth and social fulfilment overtime (Riddell;2004,p.51).

Interestingly, within the RMA which is popular with many advocates of the Green concept of development there are two sub-groups which Daly and Cobb (1989, p.72) call Strong sustainability and Weak sustainability. The weak sustainability according to Daly and Cobb (1989, p.72) promulgates that the total stock of human and natural capital can be easily substituted in most production functions. Thus as natural capital gets depleted; it must be offset by gains in human capital (Bridger and Lullof, 1998).Nevertheless, the strong sustainability argues on the other hand that Human and Natural capital must be maintained separately because '….they are complement rather than substitutes in most production functions' (Daly and Cobb, 1989,p.72). Strong Sustainability has serious implications for urban form, for the material basis of urban life, and for community social relationships that must be expressed as practical measures in planning communities. (Bridger and Luloff, 1998). Sustainable development is a balanced, inclusive approach that seeks to meet the needs of the present generation without compromising the ability of future generations to meet their own needs[21]. Technically, ecological economists define sustainable development as choices and actions regarding all kinds of "stocks" and resources that attain non-

[20] Committee for Architecture and Built Environment

[21] CAB (00) M 17/1D(1) refers; also The Bruntland Commission, 1987.

declining welfare [well-being] over time[22]. To speak of a "sustainable society" or a "sustainable world" requires a level of abstraction that is meaningless to most people (Bridger and Luloff, 1998).

However, as Yanarella and Levine (1992a;p.769) observe, sustainable community development may ultimately be the most effective means of demonstrating the possibility that sustainability can be achieved on a broader scale, precisely because it places the concept of sustainability "...in a context within which it may be validated as a process." These processes must emphasize the efficient use of urban space, reducing consumption of material and energy resources, improving administrative and planning processes sensitively with the attendant socioeconomic and ecological complexities (Bridger and Luloff, 1998). More so, "understanding the qualities of nature in each place, expressing it in the design of communities, integrating it within our towns and respecting its balance are critical to making the human place sustainable and spiritually nourishing" (Calthorpe, 1994; p.xii).Thus by MACED's[23] definition," A sustainable community uses its resources to meet current needs while ensuring that adequate resources are available for future generations. It seeks improved public health and a better quality of life for all its residents by limiting waste, preventing pollution, maximizing conservation and promoting efficiency, and developing local resources to revitalize the local economy."

To be able to capture the root meaning of Sustainable Community Development, it quite necessary to expatiate which meaning of 'Community' one intend to utilise in the research as it seeks to help bring the definition in focus.Communities differ in terms of environmental problems, natural and human resource endowments, levels of economic and social development, and physical (i.e., geological and topographical) and climatic conditions (Bridger and Lullof, 1998). By description, community is a network of people and organizations linked together by different factors. It may refer to;

- a geographic community (e.g. neighbourhood, city, village, town or district)
- a community of common interest, identity or sociological ideology (race ,ethnicity, etc.,)
- an administrative or political community (e.g. state, federation)
- Virtual community and cyberspace forum, internet groups, etc

[22] Amartya Sen and Sudhir Anand 1996. "Sustainable Human Development: Concepts and Priorities." UNDP Office of Development Studies, Discussion Paper Series. New York. P. 16.

[23] Mountain Association for Community Economic Development (MACED): Hart Environmental Data (http://www.subjectmatters.com/indicators/Sustainability/DefinitionsCommunity.html)

These are more than just interpersonal network but may take on routine social pattern, roles, functions and organizational structure. According to Anthony P. Cohen, community is one such boundary marking symbol which separates a group of people according to space, interest, ideology, culture etc. (Cohen 1985:12). Communities come into existence and assume their particular form through the interactions among their populations and organizations as well as with their surrounding environment (political, economic and natural). Strong communities provide the essential social infrastructure necessary for individuals and families to attain wellbeing (Government of New Zealand, 2002)[24] Personal networks, employment, social services, local government, community events, recreational pursuits, and voluntary organisations all provide individuals and families with opportunities to generate wealth, find security, meet their needs and be involved (Government of New Zealand, 2002). A community is as strong as the individuals, relationships and institutions that comprise it. Institutions mediate individual decisions and actions, and convey capabilities to individuals. Nevertheless, since the advent of internet, the concept of community identification has moved beyond geographical limitation. People can now gather around common interest and no matter their physical location. However, within the framework of this research, the spatial boundaries which significantly distinguish New Juaben from other communities in the eastern region of Ghana would be emphasized. The NJMA is so diverse that one can only identify its uniqueness when spatial boundaries are used as the criteria for distinction. Though emphasis would be laid on the spatial community, attempt would be made to explain the use of the virtual community to sustainable plan and develop NJMA.

A number of attempts to explain what sustainable community is had been experimented and postulated at different forums. Most of these explanations have its roots in the 1987

Report from United Nations World Commission on Environment and Development (WCED) which says 'Sustainable Development is the development that meet the needs of the present generation without compromising the ability of future generations to meets their own needs' (Berke, et al., 2006;10).Thus according to Berke (2002), varying combinations of societal values referred to as 3E's (Environment, Economy and Equity) are being pursued. However a fourth value, livability has been realized to also be a very important factor that has been omitted (Berke, et al., 2006).This fourth

[24] Discussion paper which resulted from the discussion with officials of the Department of Internal Affairs (Community Development Group Policy Team), Ministry of Social Development (Community Policy Unit), Child Youth and Family, and the Community Employment Group. It is based on the experiences of New Zealand communities and community workers, as well as published research.

dimension explains human interaction with the physical environment with focuses on making places that fit the needs and aspirations of residents.

After analyzing about 30 high quality plans adopted between 1985 and 1995, Berke and Manta-Conroy (2000), discovered that the plans do not take a balanced holistic approach to guiding development and moving towards sustainability (Berke, et al., 2006;p.16). After their analysis, Berke and Manta-Conroy (2000), suggested that land use plans ought to be developed based on the under listed six long-range development principle;

a. Harmony with nature: Land use and development support ecosystem processes
b. Livable Built Environment: Development enhances fit between people and people and urban form.
c. Placed-Based economy: Local economic activities operate within natural system limits and meet local needs.
d. Equity: Land use pattern provide equitable access to social and economic resources.
e. Polluters Pay: those who cause pollution bears its cost.
f. Responsible regionalism: Communities minimises harm to other jurisdictions in pursuit of local goals.

According to Berke, et al. (2006), experience has shown that conflicts among the sustainability goals are not superficial ones arising from abstract notions about utopians societies that are socially just, ecologically harmonious and economicaly viable.Rather,they are grounded in differences in deeply held values that frame how people believe that alternative visions of development and landuse change will affect them and their community.

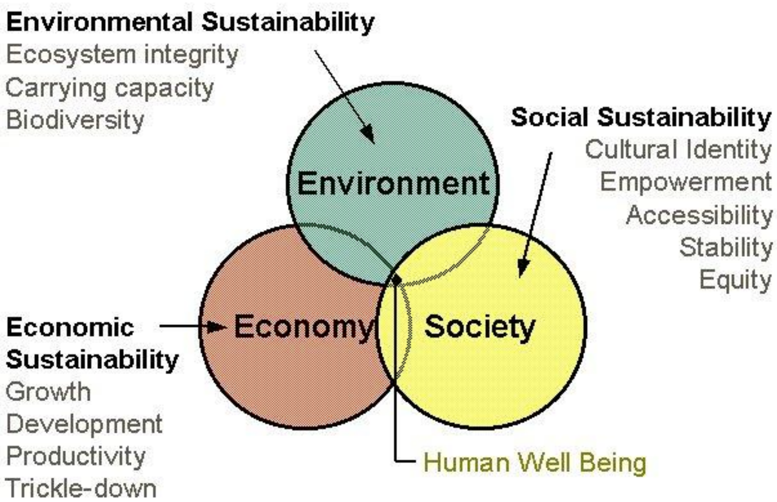

Figure 2-1: Sustainability and Human Well Being or Development

Source: (Hui, 1996)

As indicated by Hui (1996) in figure 7 above, these visions can be economic sustainability,Social sustainability and environmental sustainability but all depends on the type of lens with which the development is being look at. The only ideal case which become difficult to achieve is the centre of the three visions and that can also creat tensions.However, as indicated by Berke et al. (2006), Campbell (1996) attempts to explain the various tensions and difficulties that exist among the primary goals of sustainable development.He illustrates these tensions in a triangular diagram(as shown in figure 8 below)

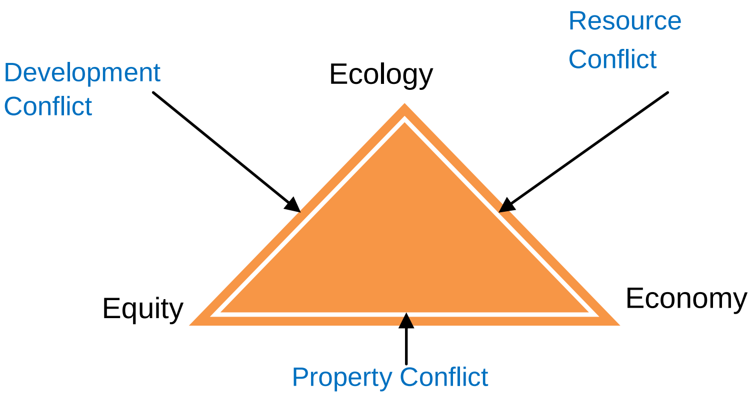

Figure 2-2: The three primary contradictions among goals of sustainable development.

Source:(Godschalk, 2004)

The 'Property Conflict', 'Resource Conflict' and 'Development Conflict' which Campbell (1996) used to critique planning for sustainability shed more light as to how to look at the entire concept well.

a. The 'Property Conflict' between economic growth and equitable sharing of opportunities arises from competing claims on uses of property. Typically is the scenario where a private property like a land to be used for profit is subjected to government intervention to provide public good like community school. (Berke, et al., 2006)
b. The 'Resources Conflict' between economic development and ecological sustainability is due to the competing claims for natural resource consumption and the preservation of its ability to reproduce.The issue of timber consumption in the developing countries for developmental projects and the rate of re-afforestation. (Berke, et al., 2006)
c. The 'Development Conflict' between social equity and environmental preservation arises from competing needs to improve the quality of life for the poor through economic growth. Bullard, et al. (2000) opined that this form the basis of environmental injustice which is the core of the conflict as poor marginalised and minority communities are faced with the choice between economic survival and environmental growth.

The triangular model thus tries to explain that if planners do not look at the broader picture but narrow down to a single conflict, they would miss a range of other conflicts. This may then prevent the development plans that are comprehensive to account for interdependency among negotiated policy situation (Berke, et al., 2006). Thus though this model had made a great attempt to consider the various tensions that exist within the three fundamental goals in sustainable community development it fails to consider the implications of livable communities. In making communities livable, associated conflicts which encompasses 2-dimensional features of the built environment emphasised by the 3 E's (economy,ecology and equity) and the 3-dimensional aspects of public space, movement systems and building design is then introduced. (Berke, et al., 2006). Hence subsequently, livability of communities thus expands the landuse disposition of the triangular model of sustainability to encompass urban design which ranges from the microscale of the block, street, and building to the macroscale of the city, municipality, metropolis and the region. (Berke, et al., 2006).

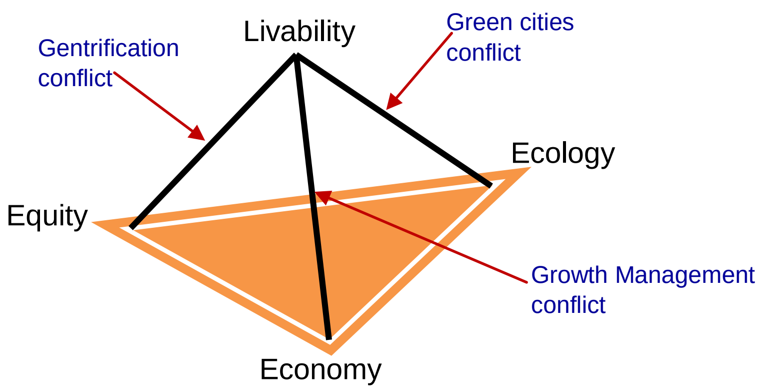

Figure 2-3: The sustainability prism illustrating the primary values of equity, economy, ecology and livability.
Source: (Godschalk, 2004)

It is in the heart of the above prism where according to Berke et al.(2006),lies the ideal sustainable (and livable) urban area. This prism emphasises why landuse planning needs to deal with 3-dimensional spatial world and offers a structure for identifying and dealing with value conflicts ideal in the different visions. Apart from the previous tensions and conflicts mentioned in Figure 2-2,there is also prevalent conflict on the axes of the prism shown in Figure 2-3. The probable conflict thus exist between livability and the the economy,environment and equity values (Berke et al., 2006).

These conflicts as indicated by Berke et al., (2006) which are 3-Dimensional include;

a. Tensions between livability and economic growth resulting in the 'Growth Management Conflict'
b. Tensions between livability and ecology resulting in the 'Green Cities Conflict'
c. Tensions between livability and equity resulting in the 'Gentrification Conflict'.

Thus though the prism model of sustainability seeks to bring out most of the important issues for consideration to enable one understand sustainable community development,it still lacks the real strategies that need to be followed to arrive at that type of development (Berke et al., 2006). They also concur that it is one matter to locate sustainability in the abstract but another to change interest group politics,plans,rules,conventional development, decision-making practices and ultimately landuse patterns to attain it.

2.1.2 Definition of Sustainable Development with Spatial Dimension

There is no universally acceptable definition of Sustainable Community Development since each development site is unique with its own challenges and opportunities. (Peck, Dauncey, Hercz, & Tomalty, 2000).With the obvious diversity associated with project sites ranging from socio-economic profiles to geo-physical structures, attempts have been made to elevate the abstract definition of SCD to practicable and implementable level. Given such heterogeneity, it makes little sense to advocate a one-size- fits- all approach to sustainable development (Bridger and Lullof, 1998).

Amongst the various groups and professionals that had attempted to explain what a practicable definition of SCD is includes Steven Peck and his team (Peck, Dauncey, Hercz, & Tomalty, 2000), and Sir John Egan and the committee set up by the Deputy Prime Minister of Great Britain (Office of the Deputy Prime Minister, 2004).

Thus as per Peck, et al. (2000), one has to incorporate multiple features to attain successful holistic SCD. Twelve(12) main features which when fully incorporated into the implementation process would lead to the development of a sustainable community were suggested by Peck, et al.(2000). These features as represented in Figure 2-4 below includes; Ecological Protection,Density and Urban design, Urban Infill,Village Centres,Local Economy,Sustainable Transport, Affordable Housing,Livable Community,Sewage and Storm Water,Water Conservation, Energy Efficiency and the 3 'R's (Reduce,reuse and Recycle).

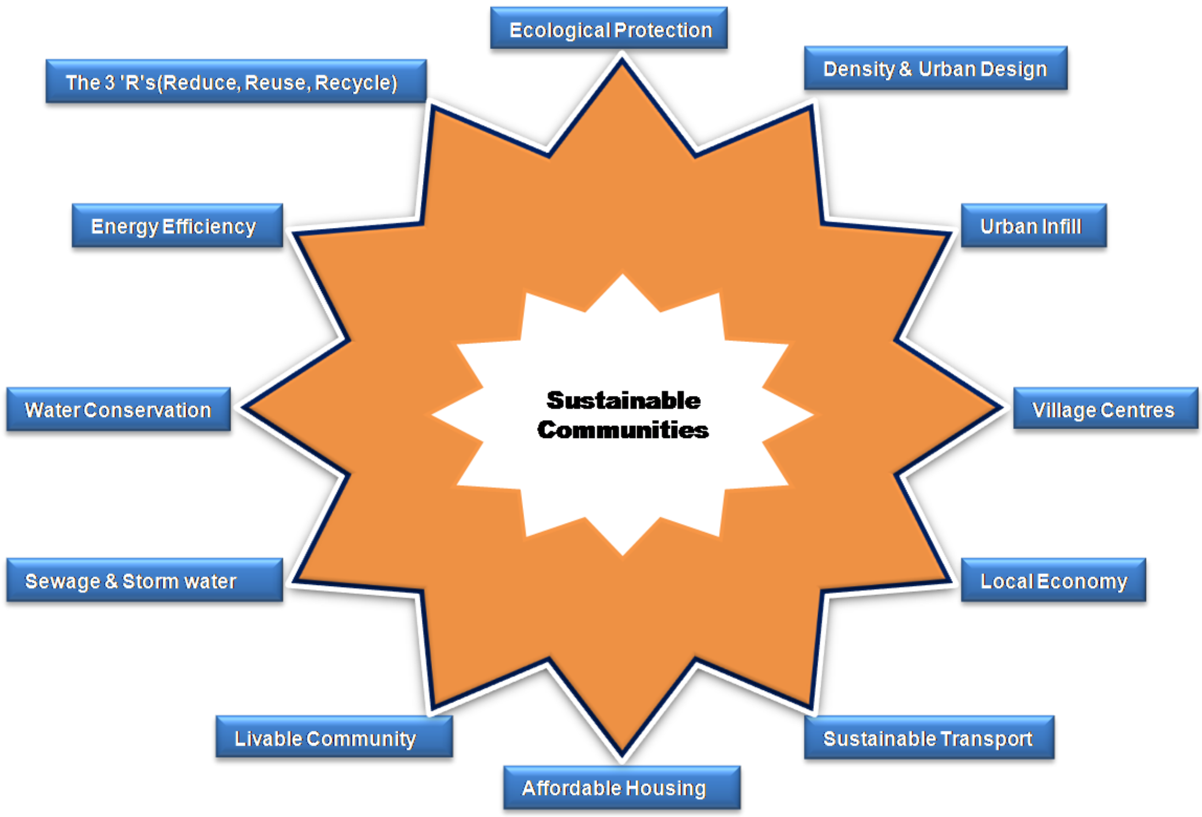

Figure 2-4: 12 Major Features of Sustainable Community Development

Source: (Peck, Dauncey, Hercz, & Tomalty, 2000)

From figure 5 above, the features of a sustainable community elucidate and demonstrate the level of effort needed for a community to be developed sustainably.It is obvious that trade-offs are necessary if the greater number of the features are to be introduced into the community development. Usually, the existing well known sustainable cities and communities always depict more of the features but others also major its developemnt on one of the features but call itself ssutainable. These features[25] means;

a. Ecological protection:

Ecological protection involves activities that protect, conserve and restore agricultural lands, wetlands, forests, meadows, riparian zones and other natural ecosystem types

b. Higher Density and Transit-Supportive Urban Design:

Achieving higher densities of development and more transit-supportive urban design are two critically important features of sustainable communities because they help determine the feasibility of achieving goals related to ecological protection, transportation and local

[25] Adapted from Peck et al.(2000)

economic development. They also have an impact on the production of greenhouse gas emissions, air quality, long term food security, and the productivity and international competitiveness of cities.

c. Urban Infill:

Greenfield developments always require new land, whereas urban infill (including brownfield redevelopment) initiatives are inherently more sustainable because they re-use land that already been urbanized and often has the required infrastructure in place. Urban infill can make use of existing infrastructure and help to financially support existing public transit systems and commercial activities.

d. Village Centres :

Village centres offer a social gathering place, which has a positive effect on neighbourhood life, facilitating opportunities for people to meet each other and create and sustain network of relationships that define a true community. Commercial centres in close proximity also encourage people to walk or cycle instead of using their vehicles to purchase goods and services (e.g. groceries, dentist, etc.)

e. Healthy Local Economy:

Sustainable communities should promote integrated commercial and village areas that offer a variety of economic opportunities for businesses and employment.

f. Sustainable Transportation:

Transportation networks should be designed to incorporate narrow roads, with less paved surface to improve storm-water management, protect habitat, and lower construction costs, and should be designed to encourage bicycling and walking as safe and efficient modes of transport (network of bicycle lanes or off-road paths.). Public transit systems should be safe, efficient, accessible, with convenient schedules and routes to encourage reduction in auto use.

g. Mixed Housing Stock/Affordable Housing:

A sustainable community should offer a mix of different housing options that accommodates a range of incomes, family sizes and ages. Development standards should be modified so that minimum lot size, permit setback requirements, housing type constraints and density limits do not eliminate more affordable housing options. Compact development reduces house prices and promotes sustainable public transit options; this in turn reduces automobile dependency, reduces a further barrier to affordability, and reduces emission and land use issues.

h. Livable Community with Facilities and Programs :

Sustainable communities should provide ample opportunity for sociability, personal development and community participation. They should include identifiable neighbourhoods, incorporate multi-task accessible green space, community meeting spaces with programs to address cultural and recreational needs, and make people of all ages feel comfortable and alive. Social and economic diversity, walking-distance amenities and convenient public transportation are also elements conducive to enhancing the "livability" of a community.

i. Low Impact Sewage and Storm-water Treatment:

It is critical that communities provide sewage treatment, and that such treatment employs technologies that minimize the entry of chemical pollutants into the local or regional ecosystem. Appropriate technology and design includes the use of constructed wetlands or systems that incorporate the use of a series of large tanks inside a greenhouse to recycle liquids and sludge together using various plants and grasses to purify the effluent. Stormwater management plans should comprise strategies to minimize runoff through appropriate road design, and minimize the use of impermeable surfaces, and include landscaped runoff control and/or treatment areas such ponds, swales or constructed wetlands to retain stormwater.

j. Water Conservation:

Water management strategies should aim to reduce the demand for potable water by promoting the use of low flush toilets and by using closed-loop grey water recycling systems, as well as by other innovative initiatives to conserve and/or treat water in a benign manner. Strategies to reduce and recycle water should also address ways to reduce the heavy dependence on water for lawn maintenance, by promoting alternative landscaping techniques.

k. Energy Efficiency:

By designing a community with energy efficient homes, where the residents can walk or cycle to local shops and jobs, this can be reduced by up to 45%

l. Reduce, Reuse, Recycle:

The key element here is "the reduction, reuse or recycling of construction wastes, the use of environmentally sound or green building materials from local sources, and the provision of in-house recycling areas."

Thus it can be said that whilst Peck, et al. (2000), couldn't come out with a simple definition for a sustainable community, but rather developed the features and characteristics that a Sustainable Community needs to possess. On the other hand,the Egan Review Committee (ERC) was able to develop both characteristics and a uniform practical definition which encapsulate the spirit and ethos of a sustainable community.

The ERC after much deliberation concluded on a concisive definition of what a sustainable communities should be;

"Sustainable communities meet the diverse needs of existing and future residents, their children and other users, contribute to a high quality of life and provide opportunity and choice. They achieve this in ways that make effective use of natural resources, enhance the environment, promote social cohesion and inclusion and strengthen economic prosperity." (Office of the Deputy Prime Minister, 2004)

The ERC admitted that sustainable communities do not just happen because of the communities wishes and aspirations but its actually the results of conscious efforts, planning and creation that requires relevant skills, tools and policies to achieve them. They also emphasised that the definition they postulated does not seek to prescriptively define the physical area or size of the population that constitute a sustainable community (Office of the Deputy Prime Minister, 2004). Nonetheless, the definition above was used to develop seven key components which can be utilised in implementing a holistic sustainable community development. These components was summarised diagramatically by the ERC and also explained that it as well represents their 'common goal' (Office of the Deputy Prime Minister, 2004).

Figure 2-6: Components of Sustainable Communities

Source: Office of the Deputy Prime Minister (2004)

As per the reported submitted to the office of the Prime Minister of Great Britain,th ERC indicated that there is no hierachy or scale of importance with regards to the components of a sustainable community. Neverthess, for practicability, all the components and its sub-components cannot be achieved at once given that resources are limited and human interest are diverse. Trade-offs in the short term to conform to the priority of the governing policy of the community needs to be permitted but in the long term all the components are essential for the holistic development of a sustainable community. Moreso, further supplements in the area of strategies to reflect a given local community priorities and the views of the people need to be considered and incorporated as well.The table 1 below, shows the detail expanded sub-components of the components shown in figure2- 6 above.

Table 1: Components and Sub-Components of Sustainable Communities

Source: (Office of the Deputy Prime Minister, 2004)

	COMPONENT	SUB-COMPONENT
1	**ENVIRONMENTAL – Providing places for people to live in an environmentally friendly way**	Efficient use of resources now and in the future in the built environment and service provision (e.g. energy efficiency, land, water resources, flood defence, waste minimisation etc)
		Living in a way that minimises the negative environmental impact and enhances the positive impact (e.g. recycling, walking, cycling)
		Protecting and improving natural resources and biodiversity (e.g. air quality, noise, water quality)
		Having due regard for the needs of future generations in current decisions and actions
2	**HOUSING AND THE BUILT ENVIRONMENT – A quality built and natural environment**	Creating a sense of place (eg a place with a positive 'feeling' for people, and local distinctiveness)
		Well-maintained, local, user-friendly public and green spaces with facilities for everyone including children and older people
		Sufficient range, diversity and affordability of housing within a balanced housing market
		A high quality, well-designed built environment of appropriate size, scale, density, design and layout that complements the distinctive local character of the community
		High quality, mixed-use, durable, flexible and adaptable buildings
3	**TRANSPORT AND CONNECTIVITY – Good transport services and communication linking people to jobs, schools, health and other services**	Transport facilities, including public transport, that help people travel within and between communities
		Facilities to encourage safe local walking and cycling
		Accessible and appropriate local parking facilities
		Widely available and effective telecommunications and Internet access

2.2 AFRO-GREEN COMMUNITIES-A MIRAGE OR REALITY

2.2.1 Definition and Concept of Afro-Green Community

The concept of Afro-Green Community is a customisation of the concept of 'GREEN' or 'SUSTAINABLE' community development in the African context. The 'Afro-Green' term which was used by Marful (2005) was encapsulated and animated in a poem to describe what a Green Housing project in Africa ought to be.Though the principles and intentions of what a Green Community or Building in Africa might not be diffrent from what is happenning in Europe and America, the significant differences which exist , according to UNEP ,between developed and developing countries and these realities cannot be ignored (United Nations Environment Programme (UNEP), 2008, p. xiv-xv). Making existing cities and new urban development more ecologically based and liveable is a one central component of the quest for African community sustainability.

Interestingly when interviewed by the UNEP team, Ogar Assam Effa, 54, a tree plantation director and member of the state conservation board of Nigeria's South-Eastern Cross Rivers State is quoted as saying that, "The developed countries want us to keep the forests, since the air we breathe is for all of us, rich countries and poor countries. But we breathe the air, and our bellies are empty. Can air give you protein? Can air give you carbohydrates?" (United Nations Environment Programme (UNEP), 2008, p. xiv-xv). This viewpoint might not only be for Effa, but millions in Africa and this is one of the many setbacks that have to be considered when communities are being planned to be sustainable or Green.

Though the poem was used to elucidate an Afro-Green House (the Home of the African Child which was bequeath to it and used before colonisation), it still has the basic idea of sustainable community development in the African context. In the first part of the two part poetry, Marful writes;

"…Despite exploitation, I felt the breeze of the weather,
Enjoyed the health of the sun and refreshed by the brooks at summer
The scenery of the amazing landscape and vegetation suffice,….." (Marful, 2005,p. xiii)

In this instance, the author attempts to explain how the home of the African Child was energy efficient and environmentally responsive despite the exploitation by the colonial masters. The use of solar energy and natural ventilation as well as passive cooling effect and techniques was employed in the planning and design of the Afro-green House. It can thus be said that the Afro-Green Community is that community that decreases environmental burden/stress, improves living conditions and helps in achieving sustainable development through a comprehensive urban improvement system involving planning and management of land and its resources and implementation of environmental improvement measures. Further on Marful in the poem also confirms this by saying,

"...She has respect for the gift of nature and lives unseen…." (Marful, 2005,p. xiii). Even the biotopes and other species were at peace with the African child and had a symbiotic relationship. By this one can say that the structures or buildings in the Afro-Green Community have almost all the properties[26] of today's eco-buildings which include, but not limited to the underlisted characteristics;

- Innovative, non-conventional, practical and sustainable;
- Cost effective;
- Easily maintainable;
- Simple in design;
- Creating visible impact;
- Replicable;
- Providing multiplier effect;
- Using locally available materials and artwork;
- Adopting design concepts that appeal/suit the local people;
- Custom made state-of-art designs to suit local conditions;
- Play a catalyzing/demonstrating effect;

Box 2-1: Excerpt from Nobel Peace Prize Acceptance Speech By Prof. Wangari Maathai

"I reflect on my childhood experience when I would visit a stream next to our home to fetch water for my mother. I would drink water straight from the stream. Playing among the arrowroot leaves I tried in vain to pick up the strands of frogs' eggs, believing they were beads. But every time I put my little fingers under them they would break. Later, I saw thousands of tadpoles: black, energetic and wriggling through the clear water against the background of the brown earth. This is the world I inherited from my parents.

Today, over 50 years later, the stream has dried up, women walk long distances for water, which is not always clean, and children will never know what they have lost. The challenge is to restore the home of the tadpoles and give back to our children a world of beauty and wonder."

10 December 2004

Source: (United Nations Environment Programme (UNEP) 2008, p. x)

[26] http://www.urbanecology.org.au/topics/ecologicalcities.html, accessed on the 25th January,2010

As if Prof. Maathai was the African Child being talked about by Marful in his poem; she also expresses her disappointment of the type of Community she knew at childhood and what she sees now. The pressure from suburban development and uncoordinated planning had affected many of the pristine landscapes of Africa. To borrow from the American Planning Association (2006), one can say that an Afro-Green community would have to possess but not limited, the following attributes and guidelines;

1. Sustainable use of natural and energy resources
2. Ecological community form and function
3. Community-Based resource management
4. Land use optimisation
5. Social equity and economic vitality.
6. Anthropo-geographic and cultural identification
7. Incorporation of Agenda 21 in community development policy framework

a. Sustainable Use of Energy Resources:

It is envisaged that an Afro-Green Community should maximize the use of all available natural energy resources, across all end uses, while minimizing degradation of local and global environmental quality. In addition to reducing the emissions of CO_2 and other greenhouse gases, planning impacts on the aquatic and terrestrial environment and habitat and biodiversity

b. Ecological Community Form and Function:

Planning and Design should emulate nature to maximize the benefit of natural systems such as wind and water flows, sunshine, precipitation, and the absorbency of land and vegetation. Designs strategically aligned with these natural systems can dramatically reduce the energy consumption associated with artificial systems for space conditioning, lighting and the management of urban surface water. Planning and design should seek to create a balanced and supportive cycle of interaction between the built and the natural environment.

c. Community-Based Resource Management:

Planning and Design should seek to involve community residents in efficient use of energy and material resources. One approach is to decentralized resource management systems to the neighbourhood level. This can include design initiatives that encourage the use of neighbourhood- and distribution systems (including local waste-to-energy system) and mixed use and cluster developments that optimize the efficiencies of combined cooling heat and power technologies.

d. Land use Optimisation:

Minimisation of the consumption of energy, material, and natural resources by restructuring and more efficiently using existing urban footprint ought to be sought. In addition to increasing access to local goods and services, moderate densification of uses promotes a more 'walk-able' community and provides the minimum population densities necessary to support cost effective tri-generation and urban mass transit system will also dramatically reduce energy consumption, degradation of local ambient air quality, and the emission of greenhouse gases to the atmosphere.

e. Social equity and economic vitality:

Increment of access to affordable housing, public services, and employment and to stimulate local economic opportunities ought to be pursued rigorously. Since energy cost represent significant expenditures for families, municipal governments and private enterprises, energy efficiency standards should be incorporated into community planning, design and building requirements. Planning and design initiatives should seek to maximise energy efficiency through the development of industrial commercial, institutional, and mixed-use campuses designed around shared energy resources and material and process efficiencies. (American Planning Association 2006, p.485)

f. Anthropo-geographic and cultural identification

An Afro-Green Community ought to exhibit strong local context by adapting or responding to the local anthropogenic values as well as geographic characteristic of the area. It should have global principles adapted to the local context and respecting the African cultural values that affect spatial dispositions as well as the nature of the urban fabric.

Box 2-2: Main Urban Dimensions of Agenda 21 of the Rio Earth Summit

Provision of adequate shelter for all:
- Provide shelter for the homeless and the urban poor;
- Seek to reduce rural–urban drift by improving rural shelter;
- Introduce resettlement programmes for displaced persons;

Improve human settlement management
- Improve urban management.
- Strengthen urban data systems.
- Encourage intermediate city development.

Promote sustainable land-use planning and management
- Develop national land inventory and classification systems;
- Create efficient and accessible land markets, with land registers, etc.
- Establish appropriate forms of land tenure.
- Develop fiscal and land-use planning solutions for a more rational and environmentally sound use of the land resource;
- Adopt comprehensive land-use strategies;
- Encourage awareness of the problems of unplanned settlement in vulnerable areas;

Ensure integrated provision of environmental infrastructure: water, sanitation, drainage and solid waste management
- Introduce policies to minimise environmental damage
- Develop sustainable energy and transport systems in human settlements and Improve urban transport systems
- Develop and transfer technologies which are more energy-efficient and involve renewable resources;

Encourage human settlement planning and management in disaster-prone areas
- Promote a culture of safety.
- Develop pre-disaster planning.
- Initiate post-disaster reconstruction and rehabilitation planning.

Promote sustainable construction industry activities
- Encourage greater use of local natural materials and greater energy efficiency in design and materials.
- Strengthen land-use controls in sensitive areas;
- Encourage self-help schemes;

Meet the urban health challenge
- Develop municipal health plans and promote awareness of primary health care.
- Strengthen environmental health services and improve training.
- Establish city collaboration networks and Adopt health impact and EIA procedures;

Source: (Pacione, 2009, p. 607)

2.2.2 Examples of attempted Green Community Developments in SSA

Apparently there are very few documentation on the morphological metamorphosis of most African cities of which one can deduce the extent of sustainability principles that was utilised for its planning. Ebenezer Howard's Garden City concept was used to plan many African communities during the colonial period in attempt to create communities which are environmentally responsive. Howard hoped that the town site would be owned in common on behalf of the community. Increases in land value would then be able to fund community ammenities and services(American Planning Association 2006, p.71) Howard wanted to blend urban and rural advantages.However a city like Tema Metropolitan Area in Ghana which was planned by the Greek Townplanner Doxiadis, has a lot to be learnt from and a recent ongoing project in the TSSA is that of the Sseesamirembe Eco-City (SMEC) also known as the Lake Victoria Free Trade Zone in Rakai District of Uganda. The Tema Case would be an existing city whilst that of SMEC an example of most recent attempt. In this analysis the locational characteristics would be described apart from the definition of the city development as a project and the scope as of the time of commencemnet. The concept of the City planning and any special issues that was considered would also be looked at. Finally Lessons form each project as well as challenges that the city development is encountering would also be expatiated.

3 HISTORY AND STRATEGIES OF URBAN PLANNING AND DEVELOPMENT IN SUB-SAHARAN AFRICA (SSA)

3.1 DELINEATION OF TROPICAL SUB-SAHARA AFRICA

The delineation of the area called the Tropics have always been quite arguable and Bromberek (2009, p.11) agrees to that and asserts that definition of what constitutes the tropics can pose a considerable problem. He then goes further to attempt to explain what he sees the delineation to be by saying; "the world's tropical zone extends to approximately 4000 km north and 3500 km south of the equator and covers one third of the Earth's land surface: in total it takes in over 50 million square kilometres" (Bromberek, 2009, p.1). He goes on to explain that the tropical region is bounded in the northern hemisphere the by latitude 23.5°N called the Tropic of Cancer, while in the southern hemisphere it is the Tropic of Capricorn at 23.5°S. By this geographical delineation and taking the latitudes as boundaries of the Tropical zone, exclusion of (the climatic zone) large areas such as the South California Peninsula and North Mexico or South Africa is made (Bromberek, 2009, pg. 11). It is rather obvious that, for use in the built environment, a definition of the tropics based on broad 'geographical' terms of reference is unsatisfactory (Bromberek, 2009, p. 12). This because when one considers the continent Africa, the Tropic of Cancer and Capricorn encompasses a vast region which includes parts of the desert regions.

In a group of definitions based on human response rather than purely climatic factors, Atkinson (1953) [27]suggested a classification of tropical climates which has been widely accepted and proven useful (Atkinson, 153; Bromberek, 2009, p. 12). The classification is based on only two factors: air temperature and humidity as, seemingly, these two factors dominate human perception of comfort/ discomfort in the tropics (Koenigsberger, et al. 1973;Bromberek, 2009, p. 12).

Tropics, they suggested that based on the effects of variation in the extreme values of temperature and humidity, the tropical regions can be divided into the following three major groups and their three subgroups:

1. Warm–humid equatorial climate:

1a. Warm–humid island/trade wind climate;

2. Hot–dry desert/semi-desert climate:

2a. Hot–dry maritime desert climate;

3. Composite/monsoon climate – a combination of climates 1 and 2:

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[27] Atkinson, F. (1953) Style and tropical architecture.Proceedings of the Conference on Tropical Architecture. University College, London, 24 March 1953, pp. 41–59.

3a. Tropical upland climate ;(Koenigsberger, et al. 1973;Bromberek, 2009, p. 11) .

Bromberek however argues that for use in the built environment, one cannot define the tropical region based on geographical boundaries. Thus in agreement to what Koenigsberger, et al. 1973 also suggested, the TROPICAL CLIMATE according to Bromberek are climates where heat is the dominant problem, where for the greater part of the year buildings serve to keep the occupants cool, rather than warm, and where the annual mean temperature is not less than 20°C. The elements of climate influencing our comfort are solar radiation, temperature and humidity, as well as availability of wind and breezes to alleviate combined effects of the former three. Buildings in the tropics are also affected by temperature and humidity, but their integrity requires considering wind pressure and precipitation in the first instance (Bromberek, 2009, p. 12).

The tropical belt of the earth according to Lauber et al is characterized by extremes in both geographical and meteorological terms. The highest mountains with numerous active volcanoes, the longest rivers with the highest waterfalls and the largest desert are all the tropics. The climatic conditions that planners ought to contend with are equally extreme to enable one to create comfortable spaces for the people and users (Lauber, Cheret und Ribbeck, 2005, p.17).

Lauber separated the environmental conditions created by the climatic and geographic circumstances into 3 main categories;

a) Hot and Humid Climatic zones of the rainforest,
b) The Hot Dry Climatic Zone of the Savannah,
c) The edge of Tropical Climatic Zone of the Desert (Lauber, Cheret und Ribbeck, 2005, p.17-22).

The principal ecological quality of most tropical environments is their fragility. This characteristic is caused by a number of factors. Most importantly, the remnant pristine environments targeted by eco-tourism are nowadays disjointed and physically isolated. This situation is further compounded when they lack ‘eco-corridors’ between them, allowing the movement of species from one liveable pocket to another. This is required to expand the habitat for availability of food, to avoid inbreeding or to escape when threatened (Bromberek, 2009, p.19).

The need for such connections should be taken into account when planning any green-field development. Native vegetation should be allowed to weave through the built-up area, grouped and enlarged whenever possible. Such vegetation can be employed to create shelter belts used for redirecting wind and breezes, visual screens or acoustic barriers. Many tropical areas support the rather complex interdependent relationships which some plants and animals have with each other.

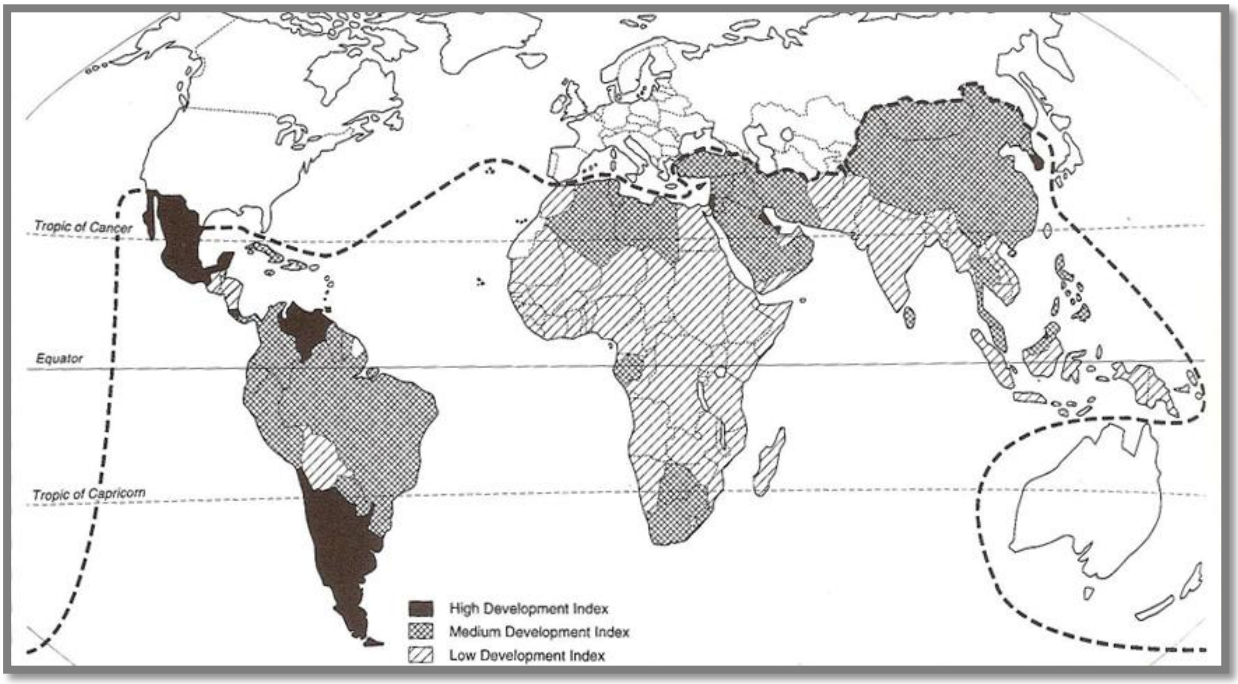
(Bromberek, 2009, p.19)

Tropical ecosystems also have weak soil composition and are prone to quick degradation and erosion once the original ground cover has been removed. Research has shown that once weathering and leaching processes have started, there is no practicable means of halting rapid soil erosion or replacing lost organic matter. A design implication is that any required circulation on the site should be planned with extreme caution and care. Other requirements can be presented as follows:

- Any unnecessary changes to the environment should be avoided;
- Landscaping should become an extension of the existing ecosystem, mimicking it and preventing further fragmentation;
- Plan resort development in border zones between, rather than deep within, ecosystem units;
- Avoid encroaching by resort developments, and their intensive use parts in particular, on unique land features, such as the only hill in the vicinity, the only lake or one of just a handful of freshwater streams as it is more likely than not that these areas host endemic flora and/or fauna species;
- Do not introduce imported live organisms, plants or animals, to the area; landscaping and population of decorative pools should be done with native species;
- Traffic should be planned using the shortest available routes; whenever possible, it should be taken above ground or led in a way which will not contribute to erosion, for instance avoiding steep gradients;
- Avoid using pesticides and herbicides. Pest and weed control, when really necessary, can be carried out using permaculture methods and manual removal; however, adaptation and passive methods such as screen and barriers are much more environment-friendly. (Bromberek, 2009,p.19)

Apart from the climatic characteristics of the tropics, there is other unique socio-economic aspect with which the region has been tagged for ages. This region as per figure 12 has been predominantly classified by the United Nations as the 'SOUTH' and 'THIRD WORLD'. This region as per the classification also has low human development index and thus most researchers and experts have mistakenly called the tropical region as under developed or third world. However, Dickenson, et al. (1996, p. 30) explains that the third world is mostly but not exclusively tropical. This region is described by Dickenson et al, the mass of their populations are mostly but not exclusively poor, poorly provided with education, health and other basic needs. It is also argued that many of the issues that has stratified these countries into third world category are being internally generated rather than being imposed from outside but these 3rd World countries remain constrained by structures of unequal exchange within the international economy. Nevertheless, by comparing the map of the tropics and that of the human development index, it becomes clear that predominantly most countries in the third world also lie within the tropics. It's however obvious that all communities

Figure 3-1: THE 'SOUTH' AS CLASSIFIED BY THE UNITED NATION HUMAN DEVELOPMENT INDEX



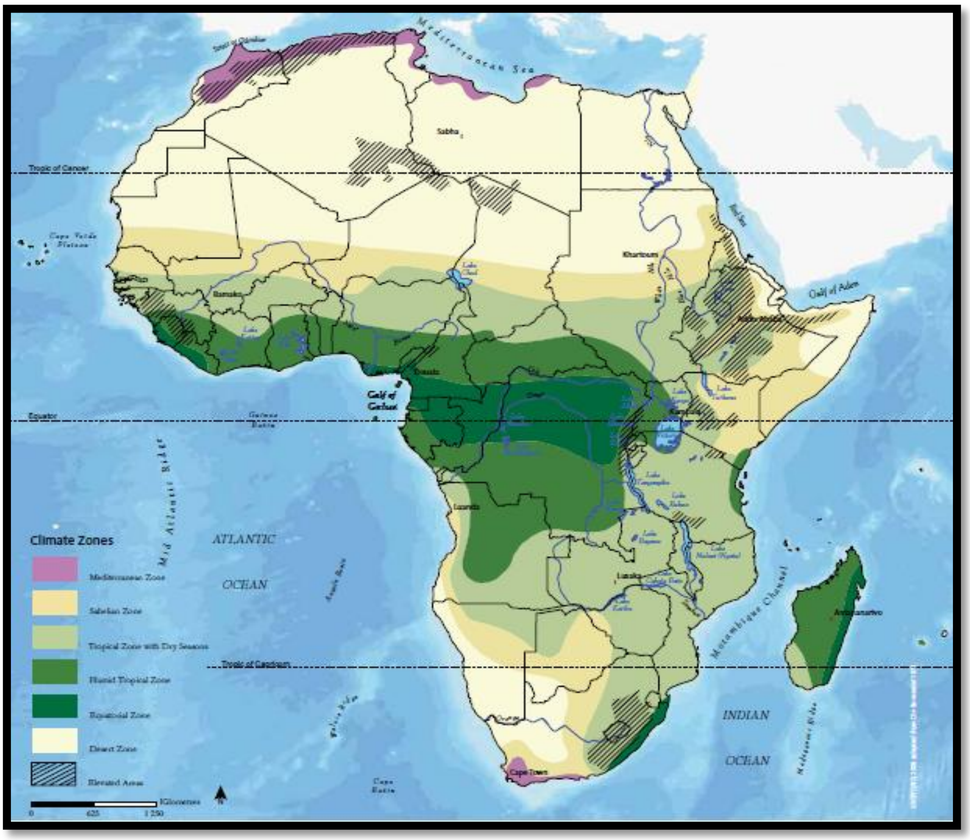
Source: United Nations Development Programme (UNDP) 1992; (Dickenson, et al. 1996, p.28)

Consequently, in defining Tropical sub-Saharan Africa (TSSA) one would have to combine the geographical, climatic, natural vegetation and political definition of sub-Saharan Africa. Socio-Politically, sub-Saharan Africa is Africa without the northern African States and South Africa. However, as per the Climatic zones indicated by United Nations Environment Programme (2008, p.8) in figure 3-2 below, Africa can be divided into seven major climatic zones. They are;

i. Mediterranean Zone
ii. Sahelian Zone
iii. Tropical Zone with Dry Seasons
iv. Humid Tropical Zone
v. Equatorial Zone
vi. Desert Zone
vii. Elevated (Mountainous) Areas

Three out of these seven climatic zones; the Tropical Zone with Dry Season, Humid Tropical Zone and the Equatorial Zone within the delineated socio-political sub-Saharan Africa can be termed as the Tropical sub-Saharan Africa.

Figure 3-2: Climatic Zones Of Africa

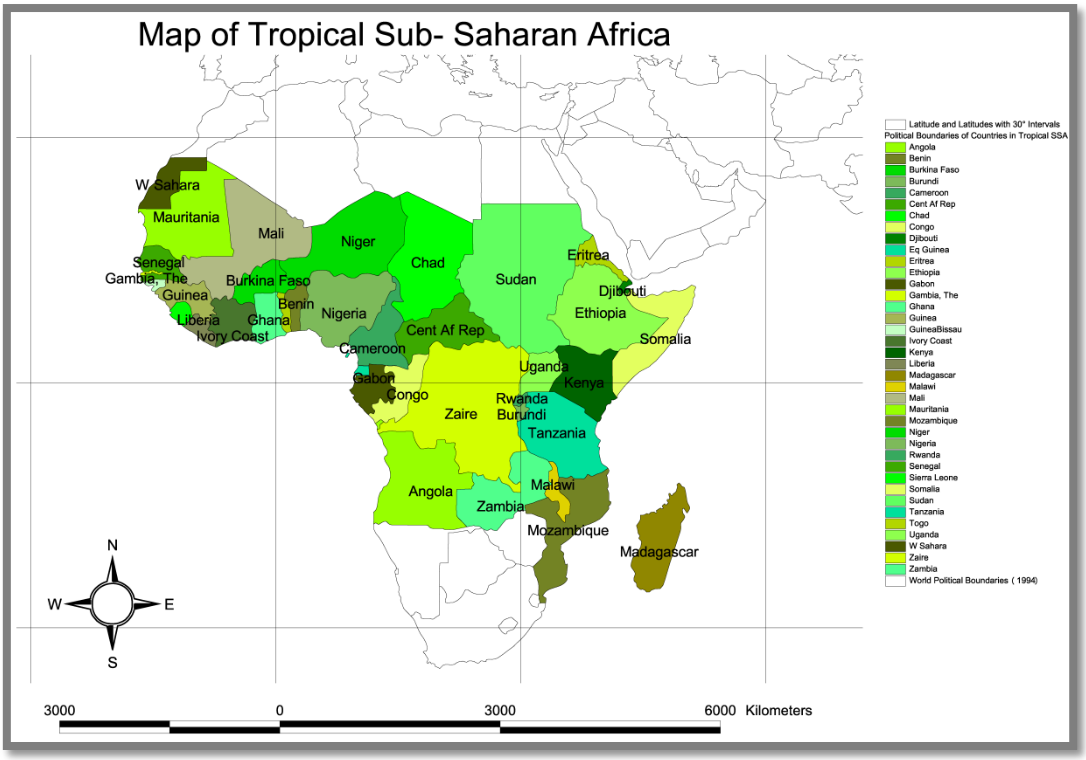


Source: United Nations Environment Programme 2008, p.8

More so, as per the climatic zones of Africa (shown in figure 3-2, above), Mauritania,Mali,Niger,Chad,Sudan, Eriterea, an Somalia which lies within the boundaries of the Tropics of Cancer and Capricorn are predominantly Sahel and Desert. Hence countries within the the Tropical Zone with Dry Season, Humid Tropical Zone and the Equatorial Zone would be termed as Tropical sub-Saharan Africa (though Chad, Sudan and Niger have half of their land mass within the selected climatic Zones it is considered predominantly Sahel)as indicated in figure 3-3 below.

Hence for the purpose of this research the area delineated as TSSA is as shown in figure 14 and is mostly Western, Central and Eastern African Countries.

Figure 3-3: Map Of Tropical Sub-Saharan Africa



Source: Author

3.2 SOCIO-ECONOMIC CHARACTERISTICS OF TROPICAL SUB-SAHARAN AFRICA

"Approximately 180 million of sub-Saharan Africa's 500 million people can be classified as poor,of whom 66.7 percent, or 120million, are desperately poor.By every international measure, be it per capita income($330), life expectancy (51 years), or the United Nation's Index of Human development (0.225 compared to 0.317 for South Asia, the next poorest region), Africa is the poorest region in the world"(USAID,1993, p.20;Kieh 2008,p.37). According to Yaker (1993, p.132), "Africa, potentially the richest continent,with the poorest people, having ben exploited for a long time,can and must become a dynamic developing region if there is to be a common future for mankind" (Yaker, 1993, p.132;Ihonvhere, 2008,p.35). In agreement to what Dickenson, et al. (1996, p. 30) indicated about the Tropical regions, Kieh (2008. p.41)also add that decades of mismanagement, unbridled corruption, coups, environmnetal degradation, the exploitation and marginalisation of women, misplace priorities, neglect of basic human needs have precipitated distortions and discalculation in the political economy.

Apart from not setting the prices for what it imports and not controlling the prices of what it exports, TSSA,as the saying goes, is the region that consumes what it does not produce, and produces what it does not consume (Kieh, 2008. p.41).Comparing figure 14 to that of 12, its obvious that almost all the countries in TSSA have low human development index and that also translates into the standard of urban fabric that would be existing in the towns and cities. TSSA has many large cities of international status, which are largely isolated from each other. These large cities play dominant role in their national internal urban systems, as well as centres of internation interraction. The cities include Daar, Senegal; Abidjan, Cote d'Ivoire; Accra , Ghana; Lagos, Nigeria; Kinshasa, DR Congo; Addis Abba, Ethiopia; Nairobi, Kenya; Dares Salam, Tanzania; Lusaka, Zambia; Harare, Zimbabwe; and Maputo, Mozambique (Kieh, p. 165).

Morphologically, a typical primate or largest city in Africa depicts urban internal dualism, depending on the site. Dualism is the justaposition of formal or modern sector to an informal or traditional sector, or a situation where a modern sector to an informal or traditonal sector, or situation where the modern sector is superimposed on the traditional sector (Mabogunje,1968; Kieh, 2008, p.169). Policies of spatial decentralisation of many African countries which favour smaller cities in investment and planning decisions have contributed immensely to the growth of the medium-sized cities, and they have been growing faster than the largest cities(Kieh, p. 168).

3.3 TRENDS OF COMMUNITY PLANNING AND DEVELOPMENT IN THE TROPICAL SSA

3.3.1 Urban and Community Typologies in SSA

The lack of urban concepts based on a response to tropical climate and to most basic human needs, such as protection of privacy, and sense of security and comfort....(Lauber, Cheret, & Ribbeck, 2005, pg 37), turns large African cities into a nightmare (Roberts 1996). Apart from the Apartheid City which was unique for South africa, TSSA city have always been a combination of one or more of the typologies described in Box 3-2 below. The United Nations (1973) proposed a general model of the African city based on the existence of an indigenous core, and the distribution of different ethnic groups according to density gradients which assigned low-density land use to the administrative and residential requirements of the colonial elites and high density to indigenous populations (United Nations, 1973; Pacione, 2009, p. 468)

Box 3-1: THE SEVEN TYPES OF AFRICAN CITIES

In a more comprehensive analysis O'Connor (1983) identified seven types of African city:

1. *The indigenous city*. Indigenous cities were constructed in the period prior to European colonization in accordance with local values and traditions. In south-west Nigeria the Yoruba city of Ife dates back to the tenth century, while at least ten others with populations exceeding 50,000 (such as Ibadan) existed before colonial rule. Elsewhere in tropical Africa, Addis Ababa is the largest extant example of an indigenous city.

2. *The Islamic city*. Though influenced by an urban tradition brought across the Sahara, most **Islamic cities** were built by Africans, with local initiatives dominant in their early growth. Found across much of the Sahara, this type includes Tombouctou, Katsina and Sokoto.

3. *The colonial city*. Established by Europeans, mainly in the late nineteenth and early twentieth century's, colonial cities comprise the majority of urban centres in tropical Africa and include most of today's capital cities. From the earliest years, immigration has ensured an African majority in the population. Although many decisions affecting city structure are made locally, they are still constrained by the inherited colonial framework and by continuing ties with the international economic system. Income is replacing ethnicity as a basis of residential segregation, with 'Westernised' Africans dominating the formerly European residential zones.

4. *The European city*. Founded primarily in southern and eastern Africa, for example Nairobi, Lusaka and Johannesburg, these settlements were established by and principally for Europeans. African in-migration and permanent residence were constrained, subject to the labour requirements of the Europeans. Normally the African population lived in segregated areas on the urban fringe (see the following discussion of the apartheid city).

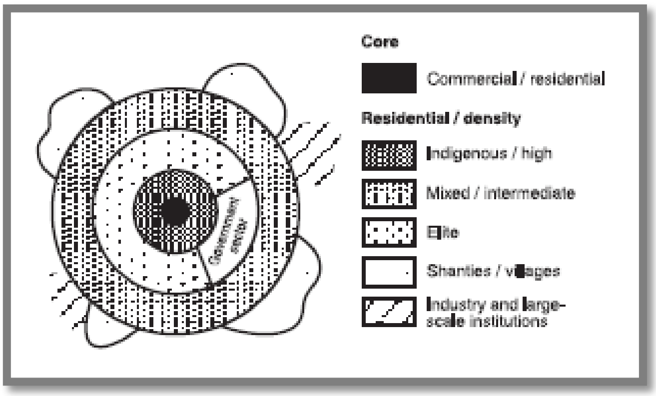
5. *The dual city. In a dual city, two or more of the above types are combined, as in Kano, where a walled I*slamic city is surrounded by a modern colonial-type city, or Khartoum–Omdurman, where the Islamic and colonial city elements are separated by the river Nile.

6. *The hybrid city*. A hybrid city is one that comprises indigenous and alien elements in roughly equal proportions (as in the dual city) but in which the parts are integrated. This urban type has increased since decolonisation as cities expand and become more integrated. Examples include Accra, Kumasi and Lagos.

7. *The apartheid city*. South Africa's apartheid city represented a unique form of urban social segregation that dominated the national urban system for most of the second half of the twentieth century. The roots of the apartheid city lay in the concept of 'separate development' and in early British colonial policy, which favoured 'native' reserves

Source: (O'Connor, 1983; Pacione, 2009,p. 468-470)

Figure 3-4: A General Model of the African City



Source: (United Nations, 1973;Pacione, 2009,p. 471)

Though this generalisation maybe true for some communities, there are .. "..disasters inherent in the generalisation about Afica. The people, culture, the climate, the vegetation, soils, temperature, precipitation of rain are not comparable in any two regions" (Oliver, 1976,p.17). Oliver, further emphsised and criticise this model and said, "it is perhaps futile to consider Africa as a unity in any sense applicable to architecture and town planning (Oliver, 1976,p.17). However,the forgoing outline of the multiplicity of factors which affect individual cultures, regions, tribes, even single villages and communities serve the importance of case studies rather than generalised ones (Oliver, 1976, p.18). Since discussions of the building forms of African peoples and their relation to community life tended to be sketchy in these writings (Oliver, 1976, p. 11), the very few materials and books written by the colonial masters with their prejudice interpretation become the basis for many community planning and development initiatives.

To this effect, Oliver (1976, p.23) in his book, Shelter for Africa mention that the history of colonial period in Africa is irreversible and the impact of industry on the third world is also inevitable.

Just like how the United Nations fix a multicutural and diverse continent in a box, European planners slap diagrammatic cultural poultices on decaying central areas while peri-urban squalor goes unheaded;they plan 'Garden Cities' in countries which have never known an industrial revolution , and force workers to make even longer journey to work (Oliver, 1976, p.236).The most predominant and common factor in the TSSA community is the effect of colonisation on the urban fabric. Many of the countries which were colonies were planned for the colonial masters without considering the effect of the urban form on the anthropology of the colonies. For instance, Zambia and Ghana were created as mining colonies, Malawi and Burkina Faso as Labour reservoirs, and Zimbabwe and Kenya as settler colonies(Kieh, p. 208).

Pacione in attempt to explain the effect of colonisation on the urban form came up with some determinants that can be identified with the various colonies in TSSA by the European masters. Although the concept of the colonial city embraces a variety of urban types and forms, it may be generalized as a distinct settlement form resulting from the domination of an indigenous civilisation by colonial settlers. Ten major factors have been identified as determinants of colonial/postcolonial urban form:

1. The motives for colonisation, e.g. trade (mercantilism), agricultural settlement or strategic acquisition;
2. The nature of pre-colonial settlement, e.g. rural villages or permanent urban areas;
3. The nature of imperial or colonial settlement, e.g. imperial control requiring military security with little if any permanent settlement, or explicit colonialism involving significant levels of permanent settlement;
4. An intermediate form of accommodation (as in much of Africa);
5. The structure of any indigenous settlements that were destroyed, ignored, added to by accretion or incorporated within a new planned city. Where no centres already existed, new colonial cities were established, sometimes for colonists alone, sometimes for colonists and indigenes in separate quarters, and sometimes for all groups without formal segregation;
6. The nature of the anti-colonial struggle and the degree to which the new leadership identified with existing politico administrative centres, especially the capital city;
7. The role of the ex-colonial elite and the degree to which it retains economic dominance;
8. The policies pursued by the independent state with respect to national integration, ethnic and class conflict, and the nature of the country's insertion into the world economy;
9. The nature of the modes and forms of production, including state policies towards the private, state and informal sectors, and the nature of access to and control over the means of social reproduction;
10. The extent of urban planning and legislative change under either capitalist expansion policies or some variant of socialist centralisation and transformation.

(Simon, 1992;Pacione, 2009, p. 454)

3.3.2 Morphological Analysis of the Community Spaces in Tropical SSA

In looking at the Morphology of the TSSA Communities, one needs to study it (city, town or village) as human habitat. Analyses of how the community had evolved from its formative years to its subsequent transformations identify and dissect it into various components. The typical TSSA community like any other is the accumulation and the integration of many individual and small group actions governed by cultural traditions and shaped by social and economic forces over time.

As the American Planning Association expatiates on the meaning of morphological analysis, it is based on three fundamental components: form, resolution, and time.

1. Form: Urban form is defined by three fundamental physical elements: buildings and their related open spaces, plots or lots, and streets.
2. Resolution: Urban form can be understood at four levels of resolution, corresponding to the building/lot, the street/block, the city, and the region.
3. Time: Urban form can only be understood historically because the elements of which it is comprised undergo continuous transformation and replacement.
   (American Planning Association 2006, p.401)

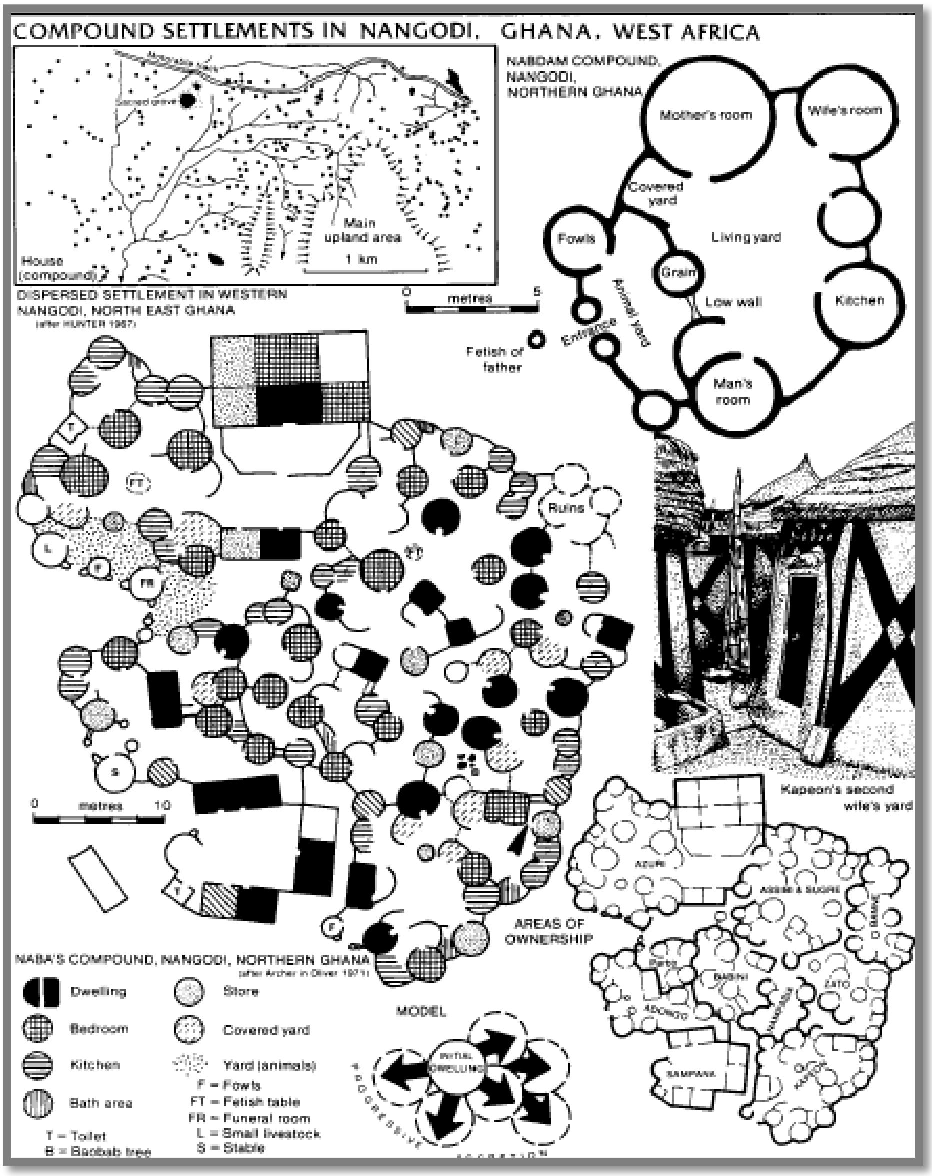
The morphology of the communal spaces in Tropical SSA is a direct reflection of some aspects of the morphological details inherent within its traditional housing units. Roberts (1996, p.87), makes it clear that the basic settlement unit is a house and thus it is also evident from the most superficial observations that settlement forms have close and complex relationships with human culture, reflecting lifestyles and aspirations. In outward appearance the traditional houses resembles a miniature fortress, but internally it may be likened to a honeycomb. Certain architectural conventions are rigidly observed (Roberts, 1996, p.1).

As indicated in the figure 3-5 below, though there are diverse shapes and forms used for traditional settlement buildings, most of the forms were chosen in the direct response to the climatic conditions pertaining to that locality. This arrangement for a given community according to Roberts (1996, p.1) never varies, but around the key features, the house develops gradually. Most importantly, Roberts(1996, p.1) emphasised that the key features, around which the house develops are not done haphazardly but in strict accordance with the observed conventions for the community in question the house develops, not haphazardly, but in accordance with strictly observed conventions). Oliver in his book, Shelter for Africa, report that,the Kikuyu hut (nyum-ba) for example, is a strong, comfortable, well-built structure, admirably suited to its users. African traditional settlement lend itself to the employment of any form of vegetable growth available' wrote W. Scoresby Routledge and Katherine Routledge in 1910. Its merits are manifold but its chief faults are lack of light, and any means of ventilation beyond the door (Routledge & Routledge, 1910,vp.184; Oliver, 1976, p.11). However, a limited number of factors appear to be important, in particular the circumstances of the physical environment, technological and economic factors, social and demographic conditions and more general historical circumstances (Roberts 1996, p.18).

At the first glance it appears chaotic and more of a labyrinth than a functional plan of a unit within small settlement. As in the village so is the compund (Griaule, ibid p. 97; Oliver, 1976, p.13). The major question that bothers the minds of many planners and developers is how village organisation or family relationships might be expressed in the physical disposition of the community?Or how could the use of spaces within and without the buildings be controlled by social hierachies or symbolic values were scarcely appreciated, much less examined (Oliver, 1976,p. 8)? Settlement forms are valuable as historical evidence, but as we now see them they are filtered through centuries of change and adaptation (Roberts, 1996, p.119). Relatively few studies to date have attempted to relate the internal principle, the hidden and abstract systems, with those of the physical form of house and village. In this, Marcel Griaule, the eminent French anthropologist and his team were exceptional. Griaule showed that a complex symbolism governed the layout of the village and the individual dwelling, the cultivation of the fields and by interaction, all other facets of Dogon life. 'The village may be square like the first plot of land cultivated by man, or oval with an opening at one end to represent the world egg broken up by swelling germinating cells(Oliver, 1976,p. 13).

Usually a town is a relatively large cluster of dwelling places, with buildings and people concentrated into a relatively small area. Because it is never wholly dependent upon farming this morphological distinctiveness extends into many other aspects, particularly the relationships between the people in the town and the local ruler or state, between the settlement and the surrounding area and between the individuals within the community (Roberts 1996, p.18). Several key points emerge, notably that nucleation is dominant in West and Central Africa, while in the eastern and the western parts of Africa more mixed settlement is the norm, with an emphasis upon hamlets and dispersion (Roberts, 1996, p.168).

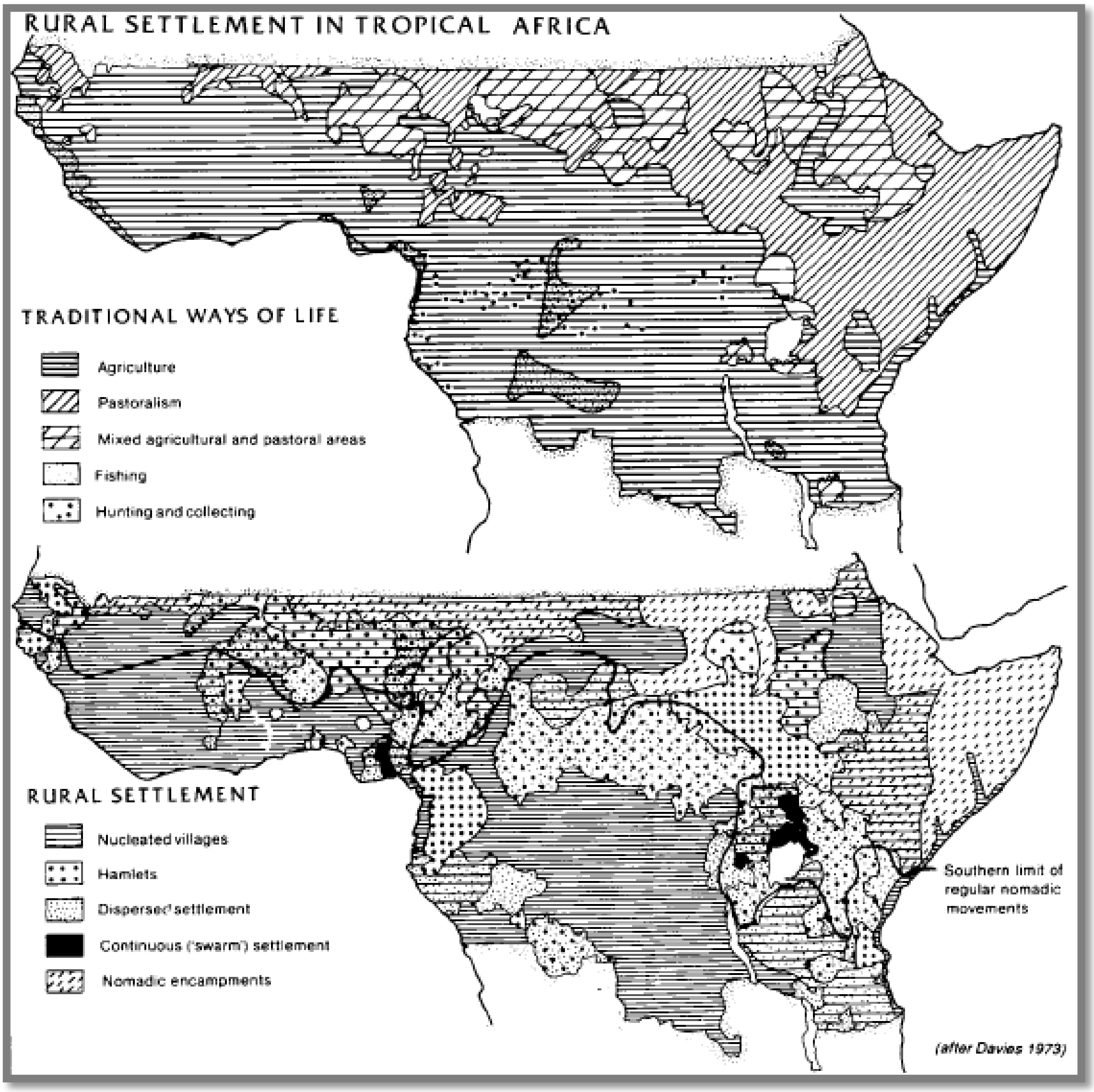
Figure 3-5: INTERNAL MORPHOLOGY OF A UNIT FOR A TYPICAL TRADITIONAL SETTLEMENT



Source: (Roberts 1996, p.2)

The map of rural settlement in tropical Africa in figure 3-6 was created using the broad assumption that all nucleated clusters containing over ten compounds were villages while smaller nucleation are hamlets (Davies 1973, p.28; Roberts, 1996, p.167). Those areas without a significant tendency towards clustering into true nucleation were classified as ‘dispersed’, no matter how intense the actual pattern of dispersion. This includes those regions of such sustained dispersion, for example in Uganda and eastern Nigeria,as they are described (Roberts, 1996, p.168).These does not, of course, appear within a vacuum; they function within distinctive contexts, patterns, of which the forms are the constituent parts. Roberts (1996, p.37) goes further to explain that the broader frameworks that ought to be discussed include the physio-geographic and anthropo-geographic frameworks within which settlements develop (Roberts, 1996, p.37).

Figure 3-6: MAP OF PREVIOUS SETTLEMENT PATTERN IN TROPICAL SUB-SAHARAN AFRICA



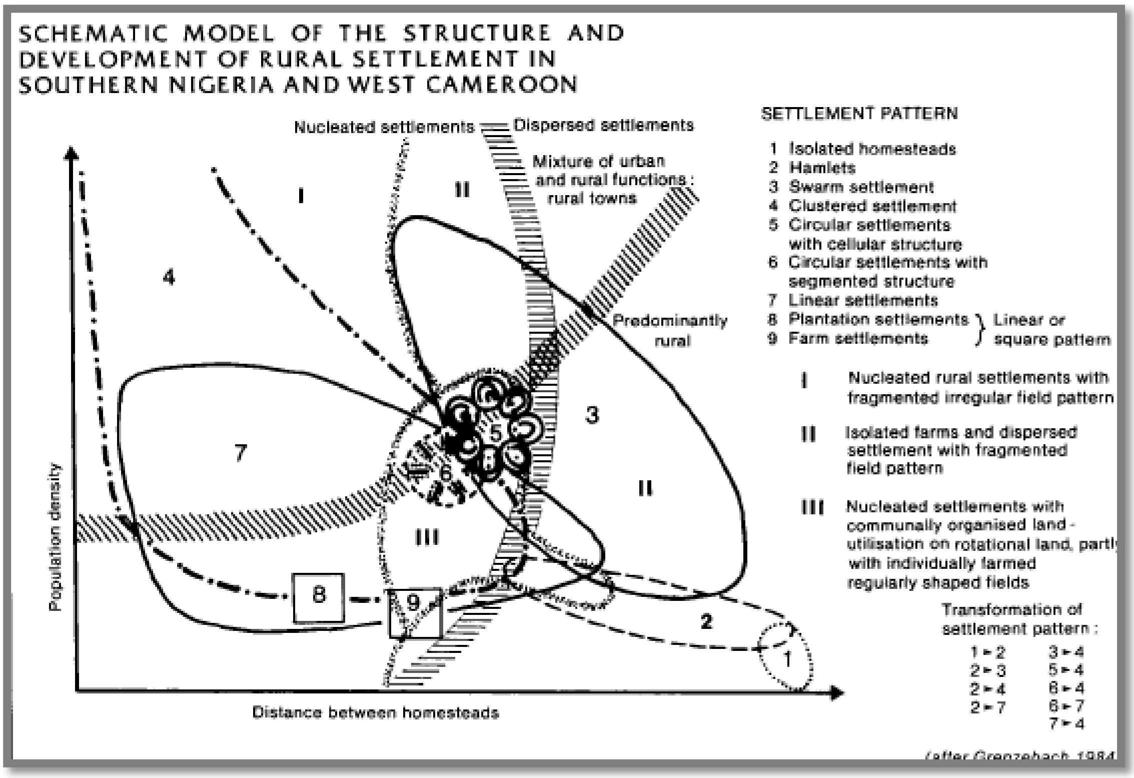
Source: (Roberts 1996, p. 167)

Thus settlement traditional settlement pattern was mainly anthropo-geographic dependant which was also consequentially physio-geographic. Mainly of the settlement were based on their way of life which also depended upon the natural environment as well. For example, the traditional Ashanti settlement was based on: A main street pattern whose axis east-west or north-south had religious significance and leads to the location of the chief's palace and the main clan groups plus the suburbs for strangers. Functional requirements arising from the retailing of food and the processions that accompanied formal visits, religious festivals or the return of an army from battle when the chief is carried head high in their palanquins (Oliver, 1976, p.162). The Ashantis also happen to be within the tropical forest belt (warm humid) and hence the shape of building styles they chose, which was rectangular as compared to the circular settlemnts of Nagodi in the North Eastern part of Ghana (warm and dry). The sequence of spaces within the Ashanti setllements is very important to the daily life even though its significance has tended to be disguised by the regularity of modern layouts. The main street is in a small village, whether used as a thorough road or not, is valued as a place of public display. It is here that surplus food is exposed for sale,and communal activities, film shows and the political rallies take place. Temporary shelters of bamboo or palm nut fronds are frequently built at a focal point in the street to give shade to these activities, but the valuable shade trees which were a feature of motor traffic (Oliver, 1976, p.163).

Most of these spaces are now missing after the colonial rule. The spaces which had meaning was replaced with foreign concepts which became meaningless for the traditional African. However, African Society should not be the mirror of Europe and should not be! (Oliver, 1976, p.23). These examples show the role of colonial forces in moulding settlement in Africa. In some areas distinctive new patterns were thus imposed, wholly modifying the direction and character of traditional arrangements; but in others the effects were more subtle. Nevertheless, the example from Nigeria carries the argument further, for it is a powerful reminder that neither Africa nor any other part of the world, other than a very few isolated areas such as pre-contact interior New Guinea, has ever been free of an interaction between endogenous and exogenous forces, whose interaction and balance, coming together, generate new forms and new patterns (Roberts, 1996, p.139).

According to Oliver, European planners slap diagrammatic cultural poultices on decaying central areas while peri-urban squalor goes unheaded;they plan ‘Garden Cities’ in countries which have never known an industrial revolution , and force workers to make even longer journey to work(Oliver, 1976,p. 236).Cities like Tema was created in Ghana which eventually yielded Ashiaman, one of the biggest slums in West Africa. More so, the African designers trained in European styled schools and sharing a westernized environment seldom question the appropriateness of these planning concepts (Oliver, 1976,p. 14). It is precisely in the housing, urbanisation and planning that most dramatic changes are now taking place.From the eighteenth century grid-iron plan of cape town to the star plan of dakar plateau, from the colonial city of ougadougou to the proposed development plans for the Nigerian cities, it is the European planning thought which have determined the map of Africa’s urban centres(Oliver, 1976, p. 14).

Figure 3-7: SCHEMATIC MODEL OF THE SRUCTURE AND DEVELOPMENT OF TYPICAL TROPICAL SSA SETTLEMENT



Source: (Roberts 1996, p. 168)

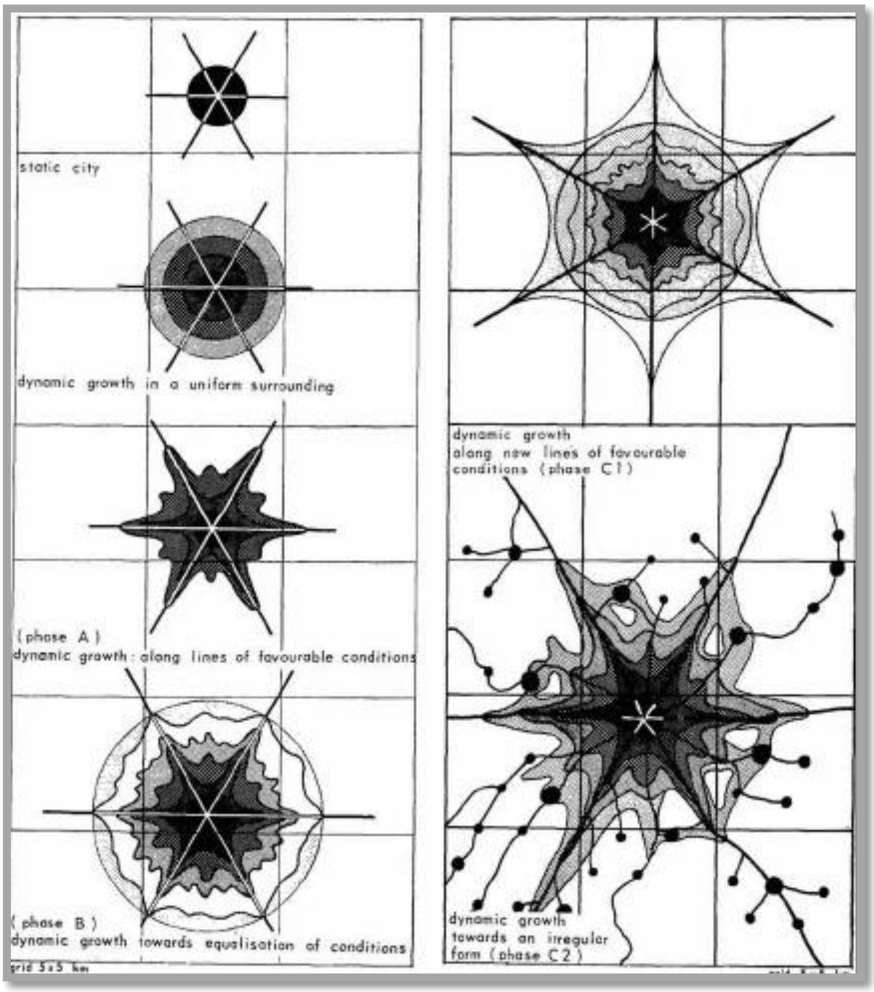
In a fascinating graph reproduced as Figure 13-7 above, Grenzebach (1984) summarises the morphological characteristics of all the forms of rural settlement present within a large area of West Africa comprising some 200,000 square kilometres. The two axes of the grid are respectively the distance between homesteads along the *y* axis, and the population density on the *x* axis: neither scale is exactly quantified. The classification defines a series of settlement patterns on the basis of the forms which make them up. The varied types overlap, but are further divided into categories on the basis of the nucleated/ dispersed division, shown as a horizontally shaded near vertical line. There is also a further division between those which are predominantly rural and those which incorporate a mixture of urban and rural elements. The former are landscapes which are socially and economically underdeveloped, dominated by agrarian, predominantly subsistence economies, while the latter are economically more advanced, market orientated, with more complex social structures and infrastructures, leading to hierarchical differentiation. Superimposed upon this already complex diagram are three further categories which define the relationships between the settlement types and the field systems, although this threefold grouping expresses only in general outline what is in reality a wide range of variation. This graph is in effect a complex set diagram, categorising settlements and the patterns of which they are a part, and then placing these categories in a logical and overlapping relationship with each other, using the nucleated/dispersed and predominantly rural/rural-with-some-urban, as broad framing structures. Thus far, the diagram is an interesting form of classification embracing a very large sample, but it is more than this, allowing deep insights into processes of change. It reveals the untold complexity present, yet reduces it to structured, manageable proportions. For the whole of the area studied, Grenzebach was able to estimate both the surface area covered by each category of settlement and the proportion of the total population contained within each category (Grenzebach (1984); Roberts, 1996, p.168).

3.3.3 Fractals in African Settlement Patterns

Recent revelation in the morphological details of African traditional settlement shows consistent demonstration of Fractal Geometry as indicated by Ron Eglash. However, Fractals which according to Batty and Longley (1987, p.123) are irregular shapes whose geometry is scale-dependent. At every scale, the degree of irregularity which characterises the geometry appears the same, this being referred to as self-similarity. At no scale can the form of a fractal or any part thereof be described by a smooth function; thus any such function is said to be non-rectifiable (Batty and Longley 1987, p.123). Winter however argues that,at times this dependence and demonstration of fractals in architecture is diffuse, and modes of theoretical transference are subtle, symbolic or semiological. At other times wholesale appropriations of geometry takes place and large fragments of theory are pirated away from their originating discipline and used opportunistically after fractal geometry was formalized by Benoit Mandelbrot in the late 1970s (Ostwald Winter 2001,p.73)[28].

[28] http://www.springerlink.com/content/b266408w9071t548/fulltext.pdf_accessed on 25th January,2010

Figure 3-8: SHAPE OF ORGANICALLY GROWING CITY



Source: (Doxiadis 1968; Batty und Longley 1994, p.34)

Prior to the formalisation of Fractal Geometry by Benoit Mandelbrot in the late 1970s, Doxiadis' Ekistics (Doxiadis 1968; Batty und Longley 1994, p.33) which represent one of the most complete statement of organic approach to city planning was used to identify most of the cities in Africa. From figure 3-8 above, most African cities were best described as phase C2-dynamic growth towards an irregular form. An example is Ibadan and Tema where Doxiadis himself master planned. Nevertheless, Bryn Nelson of San Francisco Chronicle reports that Eglash (1999) had documented the use of fractal geometry -- the geometry of similar shapes repeated on ever-shrinking scales -- in everything from hairstyles and architecture to artwork and religious practices in African culture. The complicated designs and surprisingly complex mathematical processes involved in their creation may force researchers and historians to rethink their assumptions about traditional African mathematics (Bryn Nelson 2000) and settlement planning. When Eglash looked elsewhere in the world, she goes on to report; he saw different geometric design themes being used by native cultures. But he found widespread use of fractal geometry only in Africa and southern India, leading him to conclude that fractals were not a universal design theme (Bryn Nelson 2000).

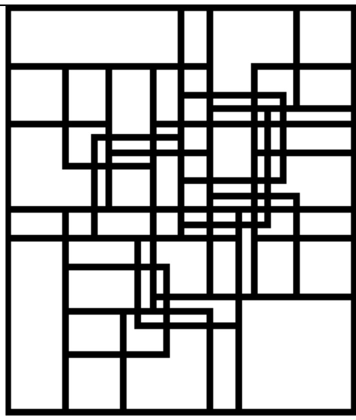
Eglash is quoted as saying in an interview that “from a European point of view, that may look like chaos, but from a mathematical view it's the chaos of chaos theory -- it's fractal geometry'' (Eglash ,1999; Bryn Nelson 2000). In some cases, Eglash found that fractal designs were based purely on aesthetics -- they simply looked good to the people who used them. In many cases, however, Eglash found that step-by-step mathematical procedures were producing these designs, many of them surprisingly sophisticated. “When Europeans first came to Africa, they considered the architecture much disorganized and thus primitive. It never occurred to them that the Africans might have been using a form of mathematics that they had not even discovered yet'' (Eglash ,1999; Bryn Nelson 2000).

Figure 3-9 shows an aerial photo of a building in the city of Logone-Birni in Cameroon, inhabited by the Kotoko ethnic group. Their structures show a clear scaling pattern, rectangles within rectangles within rectangles. . There are many similar buildings in the city, this is one of the largest, the palace of the chief. Since this architecture can be described in terms of self-similarity -- it makes use of the same pattern at several different scales -- it is easy to simulate using a computer-generated fractal (figure 20). Here we use both “active” lines that undergo self-replacement in each iteration, and “passive” lines that do not (Eglash 1999)[29].

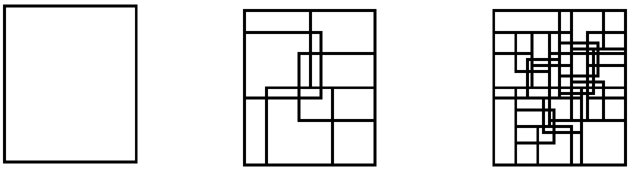
Figure 3-10 shows an aerial of a Ba-ila settlement in southern Zambia. It is an enormous ring shape, about 400 meters in diameter, composed of ring-shaped livestock enclosures, which are themselves composed of ring-shaped granaries and houses (what Americans would call a “hut”). There are two different types of scaling here: one which is a recursive nesting of rings, and another which is a scaling gradient (smaller to larger). The geometric scaling gradient maps onto a social status gradient, both within each livestock enclosure, as well as for the different sizes of livestock enclosures in the village as a whole. Similarly, the recursive nesting of ring of rings works at every level: for the village as a whole, the chief’s extended family is a ring of rings at the rear centre, just as each house keeps a sacred alter in the rear centre of the house. The two geometric elements of this structure -- a ring shape overall, and a status gradient increasing with size from front to back -- echoes throughout every scale of the Ba-ila settlement, as we see in its fractal simulation (figure 3-10).

[29] http://www.rpi.edu/~eglash/eglash%20presentation.doc_accesed_20th_January_2010

Figure 3-11: PALACE OF THE CHIEF IN LOGONE-BIRNI



Third iteration: a fractal model for the palace



First three iterations for the palace model

Figure 3-12: FRACTAL MODEL FOR THE PALACE

Source:http://www.rpi.edu/~eglash/eglash%20presentation.doc_accesed_20th_January_2010

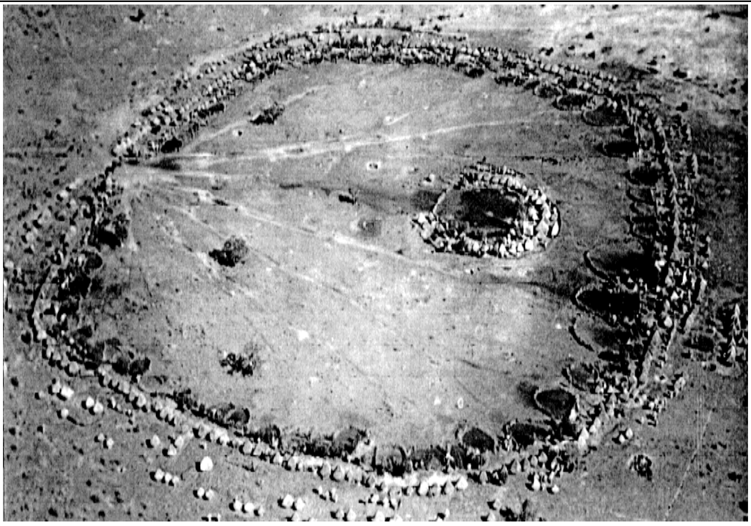


Figure 3-13: VERTICALLY SCALLED IMAGE TO COMPENSATE THE ANGLE DIFFERENCE DURING FOTO SHOOTING.

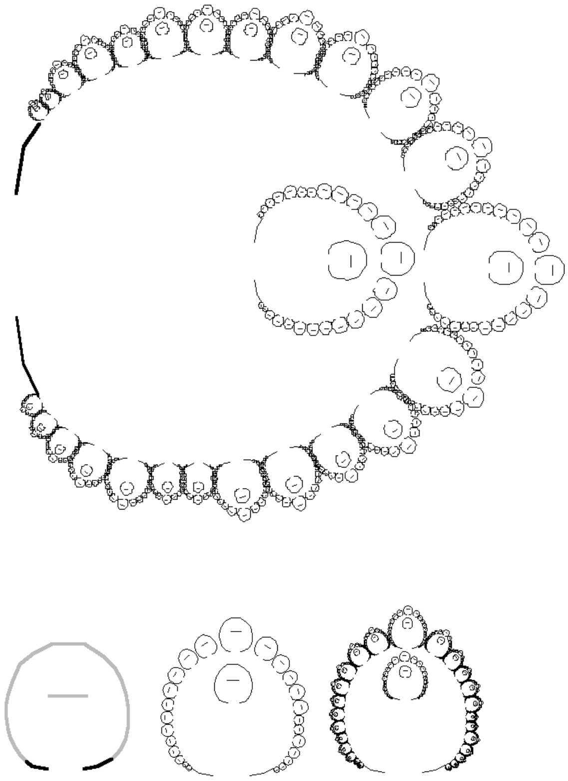


Figure 3-14: FIRST THREE ITERATIONS OF A FRACTAL MODEL FOR THE BA-ILA VILLAGE. 3[RD] ITERATION AT TOP.

There are a wide variety of ways in which scaling properties are used in Africa; Figure 3-15 shows a straw wind screen that is common throughout the Sahel and the fishing communities of West Africa. Each row of millet straw is shorter than the one that came before it. Why this recursive scaling pattern? The artisans who created this explained to me that the long rows use less straw and less time, but let in wind and dust. The shortest rows are the ones that keep out dust the best, because they are the tightest weave, but they also take more materials and time. Figure 3-14 show a typical example of how the windscreen produced by the local folks was interpreted scientifically by the engineers on critical analysis and proved to be correct according to Eglash.

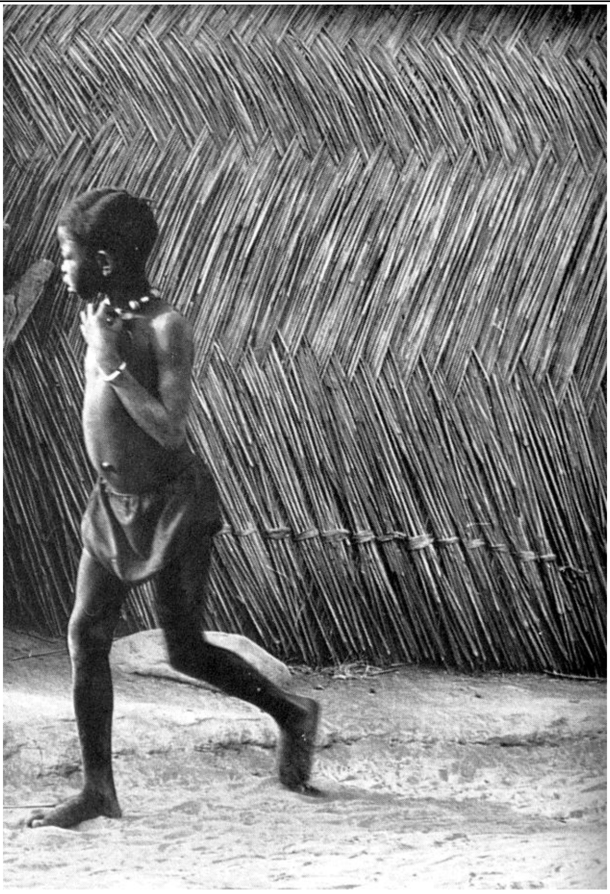


Figure 3-16: SCALING PATTERN IN A STRAW WINDSCREEN.

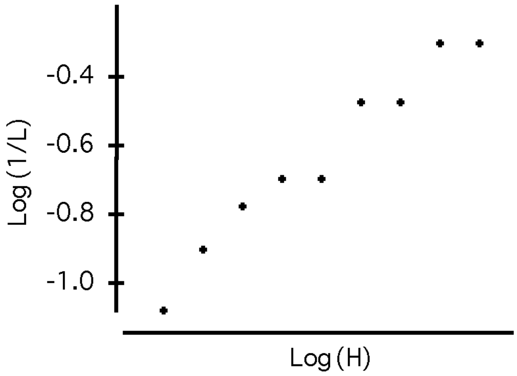


Figure 13b: scaling of straw length (L) to height (H)

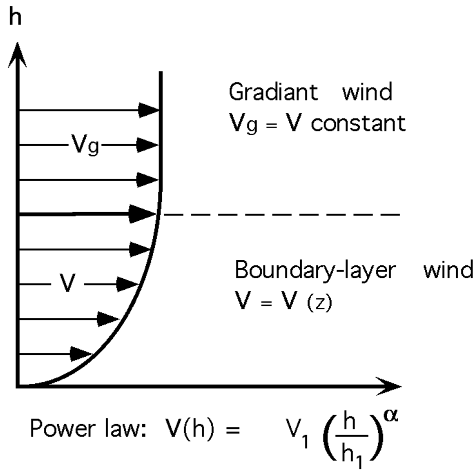


Figure 3-17: SCALING OF WINDSPEED TO HEIGHT FROM THE WIND ENGINEERING HANDBOOK

Source: http://www.rpi.edu/~eglash/eglash%20presentation.doc_accesed_20th_January_2010

4 ENERGY EFFICIENCY FROM COMMUNITY PLANNING

4.1 THE ENERGY SITUATION IN SSA

Africa has a landmass of just over 30.3 million km^2, an area equivalent to the United States of America, Europe, Australia, Brazil, and Japan combined. As of 2004, Africa housed 885 million people (World Bank, 2005, International Council for Science (ICSU), 2007, p. 3) in 53 countries of varied and diverse sizes, socio-cultural entities, and resource endowments, including fossil and renewable energy resources. Most of these energy resources are yet to be exploited, which is a contributing factor in making the continent the lowest consumer of energy, as illustrated in Figure 4-1. Despite the continent having about 14% of the world's population and producing 7% of the world's commercial energy, it consumes only 3% and exports more than half of its production (Davidson & Sokona, 2002; International Council for Science (ICSU), 2007, p.4). While the population of Africa has grown by more than 3% annually for some years now, its global share of total primary energy supply has only increased from 3.5% to 5.2% between 1973 and 2003 (IEA, 2005; International Council for Science (ICSU), 2007, p.4), indicating a reduction in energy access on a per capita basis.

Box 4-1: Effect of Energy Access and Efficiency on some MDGs

Lack of access to reliable, safe and mostly environmentally friendly energy is a strong constraint on human development. Energy services can play a variety of direct and indirect roles to help achieve the goals:

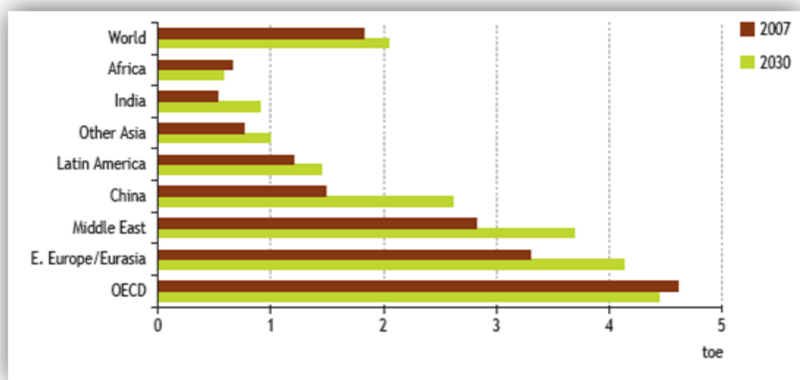
1. **Access to energy facilitates economic development** and means that value-adding income generating activities are enhanced. Micro-enterprise and livelihood activities can be extended beyond daylight hours, creating additional employment opportunities. Access to energy helps bridge the digital divide.
2. **Access to energy reduces hunger and improves access to safe drinking water** through pumping facilities.
3. **Access to energy reduces disease and child mortality** and is crucial to a functioning health system, through refrigeration for homes and clinics, sterilizing equipment and transport to clinics.
4. **To achieve universal primary education and the empowerment of women** energy reduces time spent fetching water, firewood, and other daily drudgery. Light at home enables children to study after dark.
5. **More efficient use of energy promotes environmental sustainability**, sustainable use of natural resources and reduces harmful emissions, particularly indoor air pollution

Source: (UN-HABITAT, March 2006, p. 4)

Most African countries have a challenge in meeting their energy needs especially Sub-Saharan countries and the attainment of the MDGs seems a mirage without anything is done about the energy poverty in the region. The impact of the energy situation on the development is so critical that as indicated by box 4-1, 5 out of the eight MDGs are virtually dependent on the efficiency of the energy sector. In Sub-Saharan Africa only 29% of the population has access to electricity today. Despite slightly increasing electrification rates, the total number of people in the Region without access to electricity has grown by 78 million since 2001 — mainly due to rapid population growth, which has outpaced electrification. Most of the people without access to electricity in 2030 are in Sub-Saharan Africa (698 million) and South Asia (489 million). Four out of five of them live in rural areas (Table 4-3). In Sub-Saharan Africa, despite a projected increase in the electrification rate from 29% in 2008 to 47% in 2030, the number of people without access to electricity increases by 111 million by 2030.

Achieving many of the MDGs have direct dependency the availability of an affordable modern energy services and infrastructure.

Figure 4-1: Projected per-capita energy demand by region



Source: (OECD/IEA, 2009, p.78)

In sub-Saharan Africa the region depends heavily on inefficient traditional biomass (used in particular for cooking in households), which accounts for over 80% of primary energy demand (as shown in Figure 8) (International Council for Science (ICSU), 2007 p. 4). Today 2.5 billion people or 37% of the world's population rely on biomass as their primary fuel for cooking. Over half of those people live either in India or Sub-Saharan Africa. Reliance on biomass often results in regular exposure to harmful emissions of carbon monoxide, hydrocarbons and particulate matter. The World Health Organization (WHO) estimates that 1.5 million premature deaths occur each year due to indoor air pollution from the use of solid fuels: it is estimated that indoor air pollution causes about 36% of lower respiratory infections and 22% of chronic respiratory disease (WHO, 2006; OECD/IEA, 2009, p.134). Women and children suffer most from indoor air pollution, because traditionally they are responsible for household chores. Also in regions reliant on biomass, women and children are typically responsible for fuel collection, an exhausting task that can result in long-term physical damage (OECD/IEA, 2009, p.134)

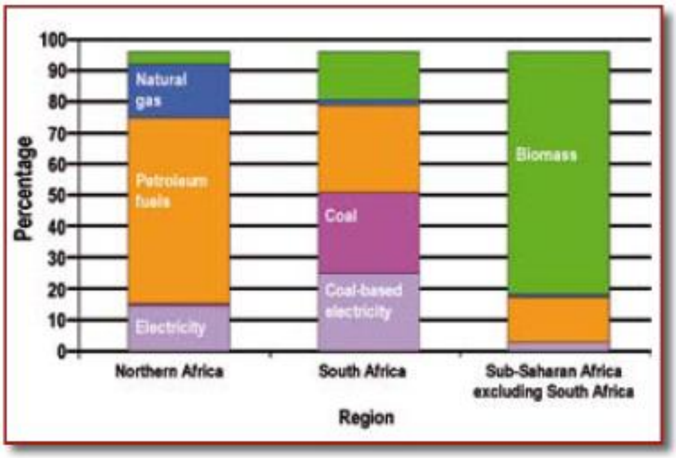


Figure 4-2: Percentage Energy Demand in Africa by Region

Source: IEA 2004; (International Council for Science (ICSU), 2007 p. 4)

According to Max Ahman[30] as cities in developing countries (especially SSA) grow fast, they demand more energy but, unplanned urban growth using traditional solutions like charcoal burning are ill-fitted to a modern urban environment. Fast growing cities in the developing world (for that matter SSA) therefore find themselves with inefficient energy systems that have environmental ramifications at the local, regional and global level due to inadequate energy planning (UN-HABITAT, March 2006, pg 6).This situation needs to change if SSA is to be economically competitive with other developing regions and realize its sustainable development goals. Improved access to modern energy services, therefore, is crucial for the overall socio-economic development of the region, but certain key challenges need to be overcome. Sources of power supply in Africa broadly reflect each sub-region's energy resource endowment. Oil and gas reserves are concentrated in North and West Africa (power sector dominated by fossil-fuel fired electricity). Hydroelectric power with some limited use of geothermal-based and biomass-based power stations in Eastern Africa.

Although SSA is endowed with fossil and renewable energy resources vast enough to cover all its energy needs, yet it is estimated that no more than 20 per cent, and in some countries as little as 5 per cent of the population has direct access to electricity. The proportion of people in Africa still without electricity is higher than in any other continent. The rate of urban electrification is lower than in any other continent.

[30] An independent Nairobi-based consultant from Lund University in Sweden who works on energy and transport

Figure 4-3: Electricity Access and Projections

	2008				Projections			
	Population without access (millions)	Electrification rate (%)			Population without access (millions)		Electrification rate (%)	
		Overall	Urban	Rural	2015	2030	2015	2030
Africa	589	40	67	23	627	700	45	54
North Africa	*2*	*99*	*100*	*98*	*2*	*2*	*99*	*99*
Sub-Saharan Africa	*587*	*29*	*57*	*12*	*625*	*698*	*36*	*47*
Non-OECD Asia	809	77	94	67	765	561	80	87
China	*8*	*99*	*100*	*99*	*5*	*0*	*100*	*100*
India	*405*	*65*	*93*	*53*	*385*	*294*	*69*	*79*
Other	*396*	*63*	*85*	*48*	*374*	*267*	*68*	*81*
Latin America	34	93	99	70	18	13	96	98
Middle East	21	89	98	71	11	5	95	98
Sub-total	**1 453**	**72**	**90**	**58**	**1 420**	**1 279**	**75**	**81**
E. Europe/Eurasia and OECD	3	100	100	100	2	2	100	100
Sub-total	*3*	*100*	*100*	*100*	*2*	*2*	*100*	*100*
World	**1 456**	**78**	**93**	**63**	**1 422**	**1 281**	**80**	**84**

Source: (OECD/IEA, 2009, p. 132)

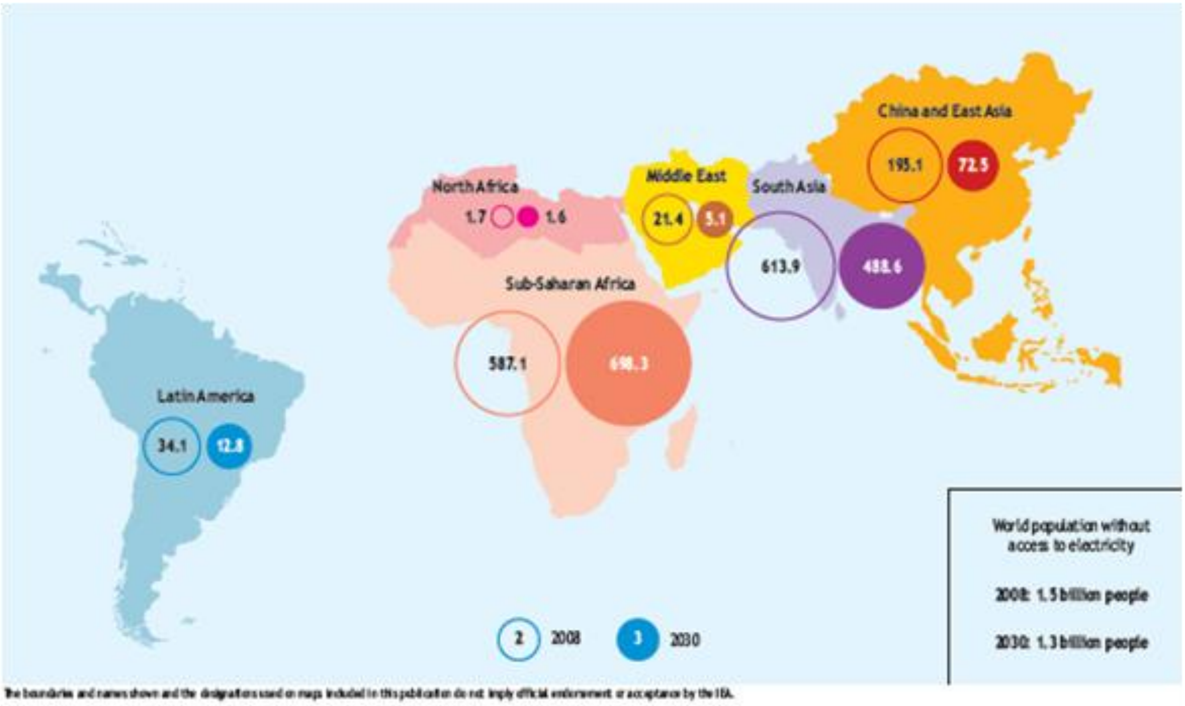
This situation is worse in rural areas where 9 out of 10 people in Africa, are without electricity. The rate of rural electrification is lower than in any other continent. The proportion of people in Africa still depending on inefficient traditional energy sources is higher than in any other continent. The dominant source of fuel in low-income African homes is wood which women and children spend many hours in search of. Electricity could extend study hours for these school children, and free up time for other activities for women. Deforestation with associated land erosion and desertification continue to worsen as trees are cut down for desperately needed fire wood. In general, the rate of electrification in Africa is lower than in any other continent!

Power blackout is a regular scene in cities, towns and villages across Africa with attendant negative impact on the quality of living and business productivity. Power plants and transmission lines across Africa, most of which were erected in the 1950s and 1960s operate today at just a fraction of installed capacity due to insufficient maintenance and lack of modernization.

Countries with either gas, diesel or coal fired power plants often find themselves with no electricity whenever there is disruption in supply of these fossil fuels due to either high cost or production disruption. Nigeria for example, has a number of newly built gas fired power plants which are not producing electricity yet because Nigeria, an exporter of gas and crude, is yet to supply gas or diesel to these plants. When drought strikes countries which depend on hydro-power, resort to rationing of power supply. These scenarios underscore the need for a new approach to electricity generation in which a mix of several energy sources including renewable sources.

Across the continent, wars and militancy have left power generation and distribution infrastructure disrupted, damaged or destroyed. For example, Sierra Leone's Bumbuna hydroelectric project was nearly complete when civil war disrupted construction. Most of Liberia's energy power plants and transmission lines were so damaged or destroyed during its long civil war that the national electricity company estimates it will cost more than $107 million and take several years to achieve restoration to the level they were before the war. The situation is similar in Angola and Mozambique.

Figure 4-4: Number of people without access to electricity (millions)



Source: (OECD/IEA, 2009, p. 131)

Box 4-2 : RENEWABLE ENERGY RESOURCE POTENTIAL OF AFRICA

Africa is endowed with **A Huge Renewable Energy Resources** and is as diverse as they are evenly distributed and enormous in quantity:

- **Geothermal resources** in the Red Sea Valley, the Rift Valley and between Nigeria's Atlantic southeast coast and Cameroon's Atlantic southwest coast remain largely untapped.
- Although **Hydroelectricity** is the biggest source of electricity in a number of countries in Africa, its potential remains largely underutilized. Again, donors' preference for large dams prevents the adoption of a new approach to hydroelectricity generation that involves the use of cost effective, easy to erect and ecological friendly micro hydro power plants. Some of the largest water courses in the world are found in Africa's regions, therefore several **decentralized mini** and **micro hydro power plants** on the Nile, Niger, Senegal, Congo, Orange, Limpopo, Volta and Zambezi rivers can generate enough electricity to meet all of Africa's energy needs.
- **Energy from Wind and Ocean current:** Africa is surrounded by Indian Ocean on the east coast and Atlantic Ocean on the west coast with huge ocean wind and current which, if harnessed for electricity, are sufficient to cover all the electricity needs of Africa. For example, ocean-current-turbines inside the ocean along the 2000 kilometers long coastline from Morocco to Senegal could potentially generate all of Africa's energy needs. While wind turbine spacing of only 2.4 MW/km^2 on parts of the 2000 kilometers long coastline from Morocco to Senegal could potentially generate a production of more than 1000 TWh per year. This would be sufficient to cover the entire electricity needs of Africa or close to half of the entire electricity needs of the European Union estimated at (2300 TWh). Ocean current power plant generates electricity from horizontally flowing Ocean current. The fast the current the more electricity can be generated. While hydro power plant generate electricity using vertically falling water
- **Solar resource** is by far the single most abundant energy resource Africa has and if harnessed could meet all the electricity needs of Africa. Solar energy, falling freely from Africa's skies to reach everywhere on the continent without transmission lines can be utilized to provide off-grid electricity to remote communities far from national grids, as well as utility scale electricity for industries.

Source: **http://www.desertecafrica.org/index.php?option=com_content&view=category&id=2&layout=blog&Itemid=2 accessed 18/01/10**

From the above figure 4-4, one can see that the energy poverty in Africa is acute with almost half of the populace with no access to electricity, hence the people ought to be more efficient in the use of the little that is available. However, the reverse is true in that Energy efficiency in Africa is generally low, both at the industrial, transport and domestic level. In Kenya, for, example, it is estimated that between 10 and 30% of the primary energy input is wasted. 'It is estimated that 20 – 30 percent of energy resources in Ghana goes waste in industries, commercial enterprises, transport sector, agricultural sector and the household sector. Currently, it is estimated that that the level of energy waste in the use of electrical energy by consumers is over 20 percent, implying that consumers waste more than the entire generation of the Kpong Hydropower Plant, implying that consumers waste more than the entire generation of the Kpong Hydropower Plant'[31]. As per their 15 year strategic plan, energy losses in Ghana totalled about 26 percent of the total primary supply in 2000 but increased to about 30 percent in 2004 (Ghana Energy Commission, 2006, p. 5). Unlike the developed countries, the developing countries like Ghana have a high percentage of their national energy demand being biomass. For example, the Ghana Energy Commission reports that, the residential or household sector of the Ghanaian economy accounts for almost 50 percent of the country's energy consumption. The significant residential sector share of the nation's energy demand is due to the high usage of wood fuels comprising mainly firewood (almost 76 percent) and charcoal (Ghana Energy Commission, 2006, p.5).

Provision of electricity is largely confined to urban middle and upper income groups and to the formal commercial and industrial sectors. In spite of substantial investment, the power sector in sub-Saharan Africa is characterized by;

- Unreliability of supply
- Low capacity utilization and availability factor
- Deficient maintenance
- Poor procurement of spare parts
- High transmission and distribution losses
- The financial performance of many power sector utilities in Africa is largely unsatisfactory
- Power utilities have failed to provide adequate electricity services to the majority of the region's population, especially the rural communities and the urban poor

[31] http://www.wikieducator.org/Lesson_5:_Energy_Efficiency_and_Conservation- accessed 18th February, 2009.

- The core sources of electricity in most sub-Saharan African countries are hydropower and oil products
- Hydropower contributes about 18% of the total power generation in Africa

In Ghana for instance, 'whilst industry grew at 2 – 4% per annum between 1989 and 1997, energy consumption over the same period grew at 10 – 14 percent. This is mainly due to lack of energy management practices that results in energy waste'[32].

4.2 CONCEPTS AND STRATEGIES

4.2.1 The Concept of Energy Efficiency

Energy Efficiency (EE) encompasses all changes that result in a reduction in the energy used for a given energy service (heating, lighting...) or level of activity. This reduction in the energy consumption is not necessarily associated to technical changes, since it can also result from a better organization and management or improved economic efficiency in the sector (e.g. overall gains of productivity)[33]. One cannot really achieve efficiency without conservation since latter helps reduce wastage. Conservation involves curbing wastage and increasing efficiency of a given amount of energy to provide more comfort or services with the same input of energy. Energy efficiency and conservation means elimination of practices and processes that waste energy while at the same time attaining maximum comfort and convenience in the most efficient way[34]. This does not however mean doing without energy but rather producing the same comfort, productivity and services with less energy. The concept of energy efficiency demonstrates how substantial energy savings from conservation practices appear possible without significantly affecting the way people live. Simple actions to enhance energy efficiency includes saving heat, using natural ventilation instead of air conditioners(where possible), using less energy per person while maintaining maximum comfort improving the efficiencies of converter technologies, and operating technology at its best efficiency. In simple terms it is the process of doing more with less energy and optimisation of the total life cycle impact of any given project. Change in energy use over time is driven by a combination of efficiency, weather, behavioural, and structural effects that may be only partially separable and may differ among energy services (Battles, 2000).[35]

[32] http://www.wikieducator.org/Lesson_5:_Energy_Efficiency_and_Conservation- 18th February,2009.

[33] This definition of energy efficiency is provided by the World Energy Council (WEC) http://www.worldenergy.org/wec-geis

[34] http://wikieducator.org/Lesson_5:_Energy_Efficiency_and_Conservation

[35] http://www.eia.doe.gov/emeu/efficiency/ee_ch2.htm

However World Energy Council put it that Energy efficiency is a matter of individual behaviour and reflects the rationale of energy consumers. Avoiding unnecessary consumption of energy or choosing the most appropriate equipment to reduce the cost of the energy helps to decrease individual energy consumption without decreasing individual welfare. Avoidance of unnecessary consumption is not only a matter of individual behaviour, but it is also, often, a matter of appropriate equipment: thermal regulation of room temperature, or automatic de-activation of lights in unoccupied hotel rooms are good examples of how equipment can reduce the influence of individual behaviour[36] and the disposition of the various land uses in the community.

4.2.2 The Energy Efficient Strategies

There is also ample of evidence that a dense city can offer greater energy efficiency compared to a sprawling city. Though opined by many urban economist that increasing urbanisation leads to increasing energy use as people start climbing the income ladder, urban poverty is so high in SSA to the extent that increasing demand that not necessary reflect in revenue accrued from the energy usage. More so, high population densities enable cities in SSA offer many opportunities for more efficient energy use, sharing of resources and investment costs (UN-HABITAT, March 2006,pg 6). High densities enable the cost-effective use of waste (predominantly biomass in SSA) as an energy resource. Urbanisation causes energy growth but at the same time offers the possibilities to use and supply energy efficiently. Both these aspects can increase energy efficiency if appropriately included in planning. Strategies that can be adopted to create energy efficient communities have been suggested by many experts and one of such pioneers are Craig B. Smith who is an energy expert had more than two decades of experience in the energy field. In his book on '*Energy Management Principles*', he makes some useful suggestions on how energy can be managed in existing cities. Cities ought to be master planned and allowed to grow smartly and this according to Smith (1981) would help demonstrate how to create the environment for efficient use of energy. Strategies as Smith (1981) opined, include;

- Planning to minimize city energy use in public buildings, street lights, and other municipal facilities;
- Minimising industrial/ commercial energy use through incentive measures(tax relief) and through regulation(building codes and legislation);
- Providing plans and incentives for energy-efficient housing;

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36 www.worldenergy.org/publications/energy_efficiency_policies_around_the_world_review_and_evaluation/1_introduction/1175.asp Accessed on 17th December,2009

- Minimising transportation energy use by integrating services, shops, industrial parks and community facilities (as opposed to dormitory communities);
- Municipal service should be fully integrated to provide most efficient utilities and services, and permit recovery of wastes and by products; e.g., municipal waste recovery and incineration for power generation, cogeneration, district heating or cooling, etc.;
- Effective land use planning: e.g., street, public buildings, industrial parks, recreational facilities, and agriculture should be made in a comprehensive long-term way (Smith, 1981, p. 401).

The US Department of Energy suggests new land use planning strategies that will improve energy efficiency and will protect natural corridors and open space. These include transit oriented design, mixed-use strategies, urban growth boundaries, infill development, greenways, brown fields redevelopment, transfer of development rights, open space protection, urban forestry, land trusts, agricultural land protection, and solar access protection Energy efficiency in building design can be improved by maximizing solar access, by minimizing infiltration but taking full advantage of natural ventilation, by creating non-window spaces as buffers on north walls, and by utilizing natural convection and passive solar designs, for example. High-performance lighting and maximization of natural light by solar access can also improve energy efficiency, reducing energy costs (Park & Andrews, 2004, pg 323).Nevertheless, optimizing the use of energy resources will require different strategies in different places to reflect specific local conditions. For instance, a higher population density will make CHP more practical, but it may militate against other devices, such as passive solar design, due to the increased overshadowing (Park & Andrews, 2004, p.328).

In particular, combined heat and power (CHP; also known as cogeneration), which reuses waste heat after producing electricity, can increase the overall process energy efficiency to more than 70%. Steam or hot water can be transformed to chilled water for refrigeration by means of absorption chillers technology. City planning decisions strongly influence the economic feasibility of district heating and cooling systems. Such systems are most viable in compact downtown areas with high load density and a diversity of uses that support 24-hour operations. They are not viable in dispersed suburban settings. (Park & Andrews, 2004, p. 325)

According to Desertec-Africa[37] because electricity supply to *homes* and *industries* across the continent to a large extent *comes from the grid or generators,* extension of the grid to remote or sparsely populated communities is not a feasible option either due to low economic development and electricity demand or even for political reasons. Insufficient electricity production means supply to the Industries from the grid is often rationalized, resulting to low industrial productivity, low employment opportunities and increased emigration of Africa's workforce to Europe and other places. Therefore new approach to electrification of Africa is required and should include firstly decentralized solutions. Renewable energy sources are often best option to provide electricity to remote communities that are not connected to the grid.

The following decentralized solutions could be ideal for rural electrification:

a) Electricity for rural households can be based on decentralized, off-grid electrification involving installation of standalone systems such as Photovoltaic (PV), wind turbine, micro-hydro power, and biomass.

b) Mini and micro grids fed by renewable energy sources or renewable-fossil-mixed plants for higher electricity demand for lighting, refrigeration, education, communication and health services.

[37] DESERTEC-Africa is an independent organization that has set itself a mission to get the African continent take advantage of what it has in abundance: - sun energy falling as sunlight on the African deserts to produce what it is in dire need of: - electricity, by means of Concentrated Solar Power (CSP), as well as harness wind energy along its coastal regions. (Source: http://www.desertec-africa.org/index.php?option=com_content&view=category&layout=blog&id=2&Itemid=2)

Box 4-3: STRATEGIES FOR INCREASING ENERGY EFFICIENCY FROM DEMAND AND SUPPLY

DEMAND-SIDE AND SUPPLY-SIDE OPTIONS	
OPTIONS	**EXAMPLE**
DEMAND SIDE	
Consumer energy efficiency	Home weatherization, energy-effcient appliances for lighting, heating, air conditioning, water heating, duct repair, motor, refrigeration, energy-efficient construction programs, appliance timers and control, thermal storage, and geothermal heat pumps
Utility energy conservation	Load management, high-efficiency motors, and reduced transmission and distribution losses
Rates	Time-of-use, interruptible, and revenue decoupling
Renewable	Solar heating and cooling, photovoltaics, passive solar design, and day lighting
SUPPLY SIDE	
Conventional power plants	Fossil fuel, nuclear, life extensions of existing plants, hydro/pumped storage, repowering, and utility battery storage
Non-utility-owned generation	Cogeneration, independent power producers, and distributed generation,
Purchase	Requirement transactions coordination transmissions, and competitive bidding
Renewable	Biomass, geothermal, solar thermal, photovoltaic, and wind

Source. (U.S. Department of Energy (2001); Park & Andrews, 2004, P.327)

In general, a balance mix of renewable energy sources such as CSP with fossil fuel backup can provide affordable power capacity on demand for homes and industries across the continent[38].

Secondly, Desertec-Africa, at their blog site reiterates that there is a need to explore other sources of investment capital than public fund for the development of electricity-infrastructure.

[38] http://www.desertecafrica.org/index.php?option=com_content&view=category&id=2&layout=blog&Itemid=2 accessed 18/01/10

It goes on to state that, According to an estimate by World Bank's clean energy and Development, developing countries, of which SSA is included, would need between 2003 and 2030 a total investment of $ 8.1 trillion, equivalent to an average of $300 billion per year, to meet their energy needs, of which electricity need constitutes about 73%. As indicated in Box 4 above, there are quite a number of issues that can be addressed strategically on both the demand and supply side which can eventually increase energy efficiency in the community or city. Utilising renewable energies requires different approaches on both the supply and demand side of the energy chain.

Going by the current level of investment, as submitted by Desertec-Africa, in the electricity sector, just 50 % of the needs are financially covered, that is about $80 billion per year out of $160 billion per year. How can this investment gap be closed? It is obvious that this huge capital need cannot be covered by only public fund (which includes funds from government, bilateral and multilateral donor sources). Thus a key strategy to make SSA energy efficient would be to create an enabling environment for private source of investment capital to close the huge investment gap in the electricity-infrastructure development in Africa.

However, as emphasised by Desertec Africa, Private investment capital, both foreign and domestic can be attracted to electricity infrastructure development in SSA if and when "market for electricity infrastructure" exists and policy framework in place: Policy makers/government/politician must act first to ensure that their investment is secure.

4.3 ENERGY EFFICIENCY AND COMMUNITY PLANNING

Although planners rarely focus explicitly on energy issues, planning decisions influence energy use and production in profound, long-lasting ways (Park & Andrews, 2004, p. 317). In the 20th century, city planning broadened its scope and developed its tools, including land use planning, zoning, transportation planning, and growth management. Energy planning has not been the major agenda in city planning (Park & Andrews, 2004, p.329). Previous research findings 1975 by Council for Environmental Quality indicated that urban form can reduce Transportation Energy by 54% and Total Energy by 47% as shown in Table 2 below. Carrol (1977), also reports in a later research finding that urban form can reduce transport energy by 52% whilst Naess (1995) also indicate 60% as shown in figure 4-5 below.

According to the Centre of Excellence for Sustainable Development, American cities and towns account for over 80 percent of national energy use. Land use planning and urban design affect about 70 percent of that, or 56 percent of the nation's total energy use (Anderson, 1993; U.S. Department of Energy, 1996, p.1). In their report to the U.S. council for Environmental quality, the Real Estate Research Corporation indicated that Energy consumption is determined primarily by residential heating, air conditioning requirements and automobile use. Heating and air conditioning requirements are related primarily to the type of dwelling unit—denser developments have lower demands than single family units. Transportation demands are affected both by the degree of clustering and community planning and by density. "Planning" alone can save nearly 14 percent of total energy consumed, but "planning" combined with increased density can save up to 44 percent (Real Estate Research Corporation, 1974,p.5). As indicated by the American Planning Association, the form of community development pursued in part determines the amount of increase in energy demand. The group also explains that studies conducted over more than 30 years indicate that low density, single-use communities result in substantially higher rates of energy and material consumption than communities designed to accommodate higher densities and mixed uses (American Planning Association 2006, p.484)

Figure 4-5: PREVIOUS RESEARCH FINDINGS ON REGIONAL PLANNING AND ENERGY EFFICIENCY

IMPACTS OF REGIONAL PLANNING ON ENERGY CONSUMPTION

Author	Regional Study Area	Time Horizon	Regional Scenarios	% Reduction	
				Transportation Energy	Total Energy
Council of Environmental Quality (1975)	Hypothetical region	Static comparison	Low density sprawl High density planned Combination	0 53.9 29.4	0 46.3 26.8
Roberts (1977)	Washington D.C.	1973-1992	Sprawl Sectoral Beltway oriented Transit oriented Dense center	0 5.4 9.0 18.4 17.4	0 2.8 3.4 7.6 7.9
Carrol (1977)	Nassau and Suffolk counties, Long Island	1972-2000	Sprawl Clustered	0 51.9*	0 19.0* *reduction in incremental energy use
Edwards (1977)	Sioux Falls, S.D.	Static comparison	Least efficient Most efficient	0.0 80.+	N/A N/A
Næss, (1995)	Norwegian and Sweedish towns	Static comparison	Low density, decentralized High density, centralized	0 60	N/A N/A

(Source: Anderson, 1993; Naess, 1995; U.S. Department of Energy, 1996,p. 42)

Creating energy efficient community plans requires measuring energy demands and supplies for housing, employment, transportation, and infrastructure. These measurements are similar to other calculations that tabulate dwellings, residents, workers, traffic, and other variables in city planning (U.S. Department of Energy, 1996 p.10).

The spatial arrangement of fixed items in an urban system- can be analysed through various lenses. Measures of compactness, land use diversity, street and road connectivity and accessibility help provide quantitative descriptions of the basic elements that constitute the outward shape and internal structure of the built environment at the town and regional levels(Horner 2002,pg 534-566;Song 2003; Lantsberg, 2005,p.50). Location, density, proximity, connectivity, diversity of land uses, and other development concepts familiar to planners are integral to addressing energy and climate issues, but they require heightened scrutiny regarding their effect on energy use, GHG emissions, and climate change adaptation strategies. Compact development also reduces the costs of other infrastructure, such as for energy, sewer, and water. The savings in energy use, maintenance, operations, and embedded energy in the materials is measurable and significant. There is also a loss of efficiency when electricity is transmitted and distributed over long distances. Sometimes the issue of development patterns is oversimplified, focusing on providing housing near employment centres (Mueller & Rynne, 2004).

According to Lantsberg in his report to California Energy Commission he opined that while it is known that compact and connected urban form reduces the demand for transportation energy, the overall extent of non-transportation energy impacts of urban form and increased densities is uncertain (Lantsberg, 2005, p.51). Concentrated areas of civic uses and employment can be organized with housing to form a land use framework for efficient regional transportation. Housing must include a diversity of types and a choice of locations to provide easy access to employment and daily needs. Housing choice mitigates the forces of sprawl (Mueller & Rynne, 2004).

Figure 4-6: INFLUENCE OF URBAN PLANNING ON ENERGY DEMAND

Planning Variables	Energy Link	Effect of Energy Demand
Shape of Urban Boundaries	Travel requirements	Energy use variation of up to 20%
Shapes and sizes of Land use designations	Travel requirements (especially trip length and frequency)	Variation of up to 150%
Mix of Activities	Travel requirements (especially trip length)	Variation of up to 130%
Density/Clustering of Trip ends	Transit Feasibility	Energy savings of up to 20%
Density and Mix	Space conditioning needs and district cooling/heating/cogeneration feasibility	Savings of up to 15%. Efficiency of primary energy use improved up to 30% with district heating and cooling
Site Layout/Orientation/Design	Solar use feasibility	Energy savings of up to 20%
Siting/Landscaping/exterior materials	Microclimate improvement	Energy savings of at least 5%; more in exposed areas

(Source: Adapted from Owens, 1986; U.S. Department of Energy, 1996, p. 4)

The demand side of the energy consumption according to ICLEI – Local Governments for Sustainability,UNEP, and UN-Habitat) 2009, p. 12) is more important to conserve energy than the supply side. The basis for an energy efficient community planning should be the demand for energy services, rather than what energy can be supplied. The committee also report that energy conservation, energy efficiency and demand-side management are considered prior to supply-side solutions. Thus this is re-emphasised in the ENERGY YARDSTICK report by the U.S. Department of Energy, 199, pg 4),the shape and boundaries of an urban form have direct effect on travel requirements which in turn affect energy use to vary up to 20%. Density and Clustering of trip ends which affect Transit feasiblity , as indicated by table 3 above,have the same energy saving effect as site layout or orienntation of the structures on the site.This savings, the report indicated can be up to 20% of the normal energy demand.

BOX 4-4: MENU OF ISSUES WITHIN THE URBAN FABRIC FOR PLANNING ENERGY EFFICIENT COMMUNITIES

A DOZEN DESIGN IDEAS FOR EFFICIENT NEIGHBORHOODS

1. Reduce and/or relocate yards to allow for increased densities.
2. Mix housing types—single family, town homes, apartments, co-housing.
3. Hide the garage in an alley or side yard and emphasize front porches.
4. Make the streets narrow and the sidewalks wide to slow traffic and encourage walking and interaction with neighbors.
5. Reduce the number of cul-de-sacs, and connect streets so that pedestrians, bikes, and autos can travel in short, convenient routes.
6. Improve connections to transit to encourage its use.
7. Bring back the corner store and other neighborhood shops so that people can shop without driving.
8. Shrink parking lots to save land and pavement and discourage dependence on the automobile.
9. Work at home to reduce the number and length of work trips.
10. Use the sun for heating and lighting to reduce energy costs and air pollution.
11. Use trees and community gardens for cooling to reduce energy costs and improve the pedestrian environment.
12. Use shared energy production systems at the neighborhood center for economies of scale and better efficiencies.

(Source: Felsenthal, 1995; U.S. Department of Energy, 1996 p. 61)

In attempt to create an energy efficient community, the U.S. Department of Energy and its partners suggested certain intervention that can be utilised to minimize the energy demands and also optimize the enrgy supplies as well. In the Box 4-4 above a list of useful menu which Community planners can use as initial input for design criteria and creation of policy and guidelines. To minimise energy at the demand side, they suggested that;

- Use large-scale land forms and microclimate to identify the most weather-protected development sites, which will reduce building heating and cooling demands.
- Consider small-scale land forms, landscape, existing buildings and pavement, solar orientation, and other issues that affect microclimate when subdividing parcels and siting buildings to further reduce building energy demands.
- Increase land-use mixes and densities to reduce travel requirements, to further reduce building heating and cooling demands, and to increase infrastructure operating efficiencies.

- Orient circulation and parking to pedestrians, bicycles, and transit to reduce auto dependence; and, provide infrastructure for alternative transportation fuels.
- Minimize infrastructure and optimize its operation to reduce embodied and life-cycle energy needs (U.S. Department of Energy, 1996, p. 63).

However on the supply side, they suggested that one need to;

- Maximize the use of on-site renewable energy resources and high-efficiency technologies to rely less upon imported energy and reduce demands for grid-delivered electricity and natural gas, thereby prolonging the existing energy infrastructure's ability to deliver adequate supplies.
- Interconnect with electric and natural gas grids at locations with sufficient capacity to avoid or minimize the need for new transmission or distribution lines and equipment.

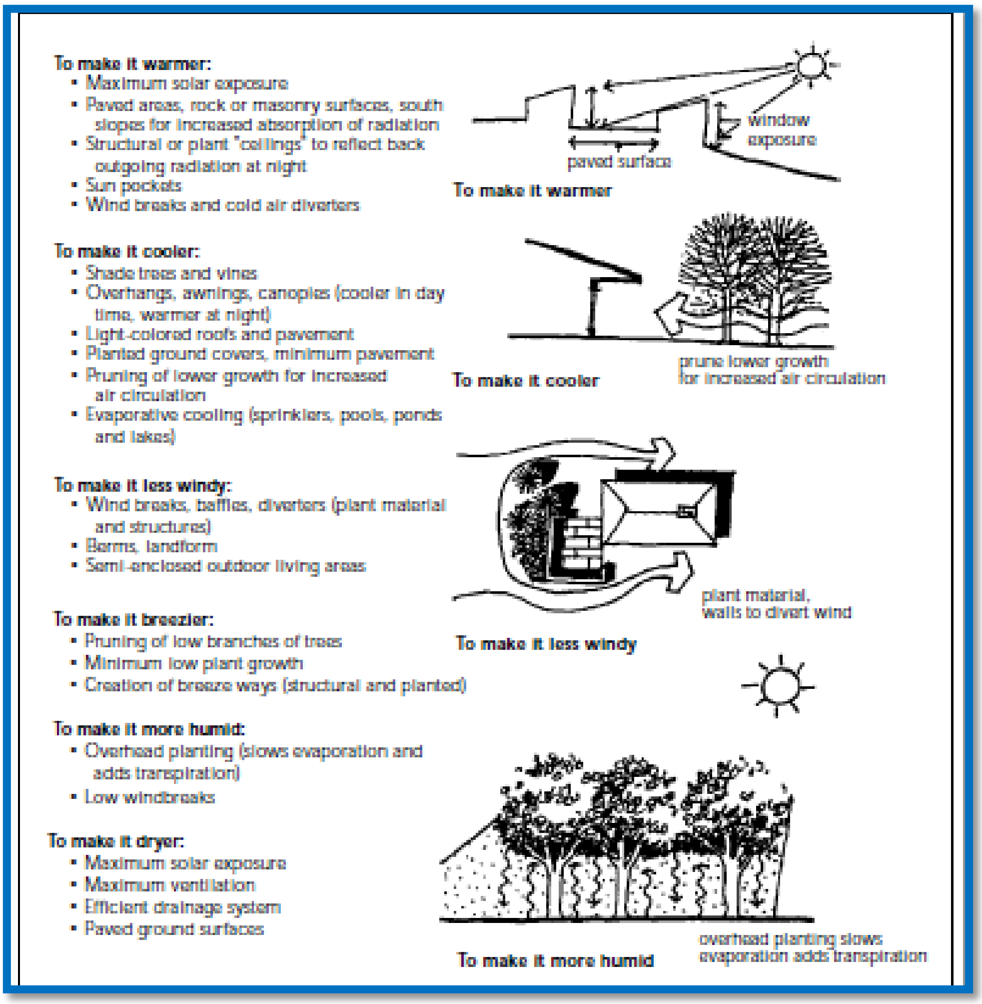
Table 2: ENERGY EFFICIENT SITING STRATEGIES BY CLIMATIC ZONE

Objectives	Hot, Humid	Hot, Arid
Adaptations	Maximize Shade. Maximize wind	Maximize shade late morning and all afternoon. Maximize humidity. Maximize air movement in summer.
Position on Slope	High wind	Low for cool air flow
Orientation on Slope	South	East-south east for P.M. shade
Relation to Water	Near any water	On lee side of water
Wind Buffering/Channelling	Sheltered from North	Exposed to prevailing winds
Clustering	Open to wind	Along E-W axis, for shade and wind
Building Orientation	Face south toward prevailing	Face South
Trees	High canopy trees. Use deciduous trees near building	Trees overhanging roof if possible
Road Orientation	Broad Channel, E-W axis	Narrow, E-W axis
Material Coloration	Light, especially for roof	Light on exposed surfaces, dark to avoid reflection

(Source: American Institute of Architects, 1991; U.S. Department of Energy, 1996 p. 71)

From the above table it can be deduced that siting strategies which is a basic Urban Design and Planning tool remains quite vital and important for the development of energy efficient communities especially in TSSA which has both Hot Humid and Hot Arid Climates.

Box 4-5: ENERGY EFFICIENT SITING TECHNIQUES BY COMFORT OBJECTIVE



(Source: American Institute of Architects, 1991; U.S. Department of Energy, 1996 p. 71)

4.4 NEXT GENERATION ENERGY EEFICIENT URBAN STRATEGIES

In Australia and Europe, there are many futuristic urban strategies which have been implemented in the urban fabric to increase energy efficiency. One of these interventions is the usage of noise barriers as PV energy generators which when fed into the grid pays about 43 to 33 euro cent per kilowatt. According to Neidlein (2009, p. 51) his article in the PV Magazine, as per the vision of Markus Auerbach of the German Federal Highway Research Institute(BASt) in Bergisch-Gladbach, introduction of as many noise barriers as possible should not only block out street noise but also produce solar power. In 1999, according to Neidlein, the European Union study conducted by an internationally renowned expert estimated that the PV potential of noise barriers in England, France, Italy, Switzerland and Netherlands amounted to about 800 megawatts (515 megawatts for existing structures and 286 megawatts for new barriers). More so, the potential for making about 80% of the 3000km noise barriers and walls in Germany, according to the Swiss consulting firm is about 388 megawatts. This capacity according to the Ghana energy report is about twice the capacity of the Kpong Hydro power plant and about 170 percent of the power imported by Volta River Authourity in 2006 (Ghana Energy Commission, 2006, p.122). In 2008 along the Autobahn 94 near southern Bavarian town called Töging, a 1 megawatt solar array was commissioned and installed as shown in figure 4-8 below. There were however as usual for every breaking of new grounds in development, hurrdles which were overcame for the project to be completed. Among the hurdles were;

a. A one year period of drafting of the 25 year lease agreement with the highway department for the 1 kilometre road shoulder along A94.
b. Having to perform numerous demonstrations to proof the stability, its resistance to high winds, heavy rains and snow as well as any traffic hazard of the noise barriers with the PV system.
c. Have to pay 60,000 Euros for relocation of the habitat of 3 special lizards(as per European Union ecological Standards (Source: Neidlein, 2009, p. 4).

Figure 4-7: INSTALLATION OF PV NOISE BARRIER PILOT SYSTEM IN TÖGING

One of the lanes on Autobahn A 94 near Töging had to be temporarily closed during construction of the PV system on a noise barrier. Mounting the some 4,000 panels on a specially built concrete, wood, and aluminum base took a good bit of manual labor.

(Source: Neidlein, 2009, p. 48)

In other to ensure the functionality of this PV Noise barriers technical requirements as indicated in box 4-6 below was instated to guide future developer and planners.

Box 4-6: TECHNICAL REQUIREMENTS FOR PV NOISE BARRIERS

TECHNICAL REQUIREMENTS FOR PV NOISE BARRIERS

Replacement/service: The elements of the system have to be easily replaceable in case of damage. Efficient replacement methods are very important, since elaborate traffic safety measures often have to be taken when replacing elements on a highway.

Efficient installation: Installation times vary considerably. A high degree of factory pre-installation has proven to be very efficient and improves quality. On a weather-dependent construction site, work stages should be kept to a minimum (attachment and final wiring). Unwieldy system elements that do not fit onto a standard truck can limit the degree of pre-installation.

Safety: Safety considerations have to be taken into account in each phase of the project. On the highway, clearance, elasticity of construction, and blinding effects are especially important issues. In railway applications, the important issues are disruption of rail operations during construction and operation, as well as the system's grounding.

Current leakage: On bridges, it is especially important to isolate the system from concrete, as current leakage can damage the material.

Soiling: Dirt is clearly visible on the panels at certain times. However, no permanent influence on yields has been detected.

Theft prevention: Good panel integration includes fittings that make unauthorized removal difficult. Of course, such fittings also make it more difficult to replace defective panels. Presently, there are a number of options for preventing theft, such as video monitoring and special wiring.

Panel breakage: On the autobahn, rocks and other objects may damage panels that face the roadway. In general, it is best to elevate the lower edge of panels as much as possible. However, minimum height has to be determined for each project based on the distance of the panels from the roadway. Still, systems can continue to function without loss of yield.

Graffiti: Graffiti is a problem on accessible noise barriers, especially for photovoltaics that face the roadway. Observations have shown that graffiti is present at heights up to 2.5 meters. PV panels at these heights can be protected using Teflon coatings. Spray paint can be removed relatively easily from the Teflon-like material on thin-film panels.

(Source: Neidlein, 2009, p. 51)

4.5 BARRIERS AND BENEFITS OF ENERGY EFFICIENCY IN COMMUNITIES

4.5.1 Barriers[39] to Energy Efficiency Systems and Strategies in SSA

According to Hirst and Brown (1990), the barriers that pose limitations to the realisations are divided into two types: structural and behavioural. Structural barriers , they explain result from the actions of many public- and private sector organizations (Box 4-7) and are primarily beyond the control of the individual end-user. Behavioural barriers, on the other hand, are problems that characterize the end-user's decision-making, although they may also reflect structural constraint. From a much simplistic perspective as per Ghana Energy Commission (2006), limitations to Energy efficiency in are mainly due to the following three aspects of energy production and usage;

a. Generation of Energy
b. Distribution of Energy
c. Consumption of Energy

These stand points eliminate the responsibility of the government and policy makers and leaves the blame at the door steps of suppliers and users. Barriers to achieving a good level of energy efficiency improvement include the lack of policy or regulatory measures, the lack of information and awareness of potential benefits, a failure to emphasize good energy management, and a lack of technical capacity to identify, evaluate and implement energy efficiency measures. Technology and financing barriers are also seen in some situations. Of these barriers, the failure to practice good energy management is typically one of the most important factors for enterprises. Improving energy management is almost always a low-cost action that achieves valuable benefits in the short term. (Renewable Energy and Energy Efficiency Partnership (REEEP) 2008 p.13). Hirst and Brown (1990), expatiate on these barriers by combining combining the suply and demand sideof the barriers as indicated in Box 4-6.

[39] A barrier is an obstacle which prevents a given policy instrument from being implemented, or limits the way in which it can be implemented. In the extreme situation, barriers may lead to policy instruments being overlooked, resulting in strategies being much les effective. (KonSULT, 2005)

Box 4-7: Barriers to improving energy efficiency in a Community

1. *Structural barriers: conditions that are beyond the control of the individual end-user*
    - Distortion in fuel prices
    - Limited access to capital
    - Government fiscal and regulatory policies
    - Codes and standards
    - Supply infrastructure limitations
2. *Behavioural barriers: problems that characterize the end-user's decision making*
    - Attitudes toward energy efficiency
    - Perceived risk of energy-efficiency investments
    - Information gaps

Source: (Hirst and Brown 1990)

a. Distortions in fuel prices:

The prices that consumers pay for fuels do not reflect fully all the environmental and social costs associated with fuels production, conversion, transportation, and use. For example, the costs of acid rain and of global warming (CO_2 emissions) are not now reflected in the prices of fossil fuels and electricity. Consumers in all sectors of the economy will likely invest less in energy efficient systems than would be socially optimal because of the substantial environmental costs of energy production that are not included in consumer prices, other non-internalized social costs (such as reliance on foreign oil and growing aversion to nearby construction of large energy facilities). However, Hirst and Brown (1990) concludes that price signals can strongly motivate or inhibit energy efficiency actions.In SSA there are a lot of government subsidies for fossil fuels and users do not pay the real cost of the fuel being used hence don't see the essence of implementing energy efficient systems.

b. Limited access to capital:

Total Cost of energy-efficient systems are often more expensive than their inefficient counterparts. Obtaining the additional money to pay the incremental capital costs of efficiency improvements is often a problem. Lack of financial incentives and tax credits for energy efficient systems, investments and activities in SSA also creates huge obstacle for the implementation of energy efficient strategies.

c. **Government fiscal and regulatory policies:**

Usually, most Governments in SSA provide greater support for energy production than for energy efficiency as well as invest in Research and Development towards energy efficiency. Government budget are virtually non-supportive of any such initiatives but variety of government policies, practices, and programs implicitly affect private decisions on the purchase and operation of energy-using systems. Unfortunately, these government actions tend to favour increased energy use rather than greater energy efficiency.

d. **Codes and standards:**

Codes and standards are usually viewed as instruments of change and not as barriers. Codes and standards covering materials and equipment can be used to encourage the implementation of energy-efficiency options. However, standards are mostly concerned with health, safety and reliability rather than with energy efficiency. The absence of codes and standards in the respect of urban planning and design as well as building and construction also creates a serious impediment for the efficient use of energy in the community.

e. **Supply infrastructure limitations:**

The availability of new energy-conserving technologies is often limited to particular geographic regions of the country. Alternative fuels for transportation suffer from lack of an infrastructure. For example, the corrosive properties of methanol require substantial investment in its transportation, distribution, and storage. More so, there are few people skilled in engineering, operations, and maintenance to adequately nurture the development and deployment of new energy technologies. Energy issues are not strong components of the college curricula that train automotive, industrial, and HVAC engineers.

f. **Attitudes toward energy efficiency:**

Most people in the SSA region lack basic means of survival hence the real issues on the mind of the ordinary person is how to make ends meet and to survive. They depend on the government to subsidize all petroleum products being used and those that have access to it also use it without any caution since they are not paying the overall cost themselves. Most of the public officials and offices that need to set the example of conserving energy rather set the negative examples. Lights and electric appliances are left on during the day without anybody controlling them and government official also move around with a long entourage of motorcade to public functions. More so it is perceived that the public places have a high premium on comfort, ease, and convenience, goals that are usually in conflict with energy efficiency policies and strategies.

g. **Information gaps:**

Credible information on the performance of energy-efficient technologies is often lacking. Such information is critical to those who decide on the commercial deployment and market penetration of new technologies, including investors, regulators, and consumers. Information regarding the technical and economic viability of such technologies under full-scale, real-world conditions is often scarce. The absence of such data leads to greater perceived risks and a reluctance to adopt such systems.

4.5.2 Benefits of Energy Efficiency Systems and Strategies

Benefitting from energy efficient strategies may not be the same for SSA as in the western economies. Whereas there is absent or minimal infrastructure in Africa to even supply energy, let alone use it efficiently, its paramount that the little available is used judiciously to create the necessary benefits that would help improve the quality of life of the people. However, according to California Centre for Sustainable Energy, Energy efficiency increasing amount of studies have shown that “high performance/green buildings" can provide all of the following, depending on the measures incorporated and the type of occupancy:

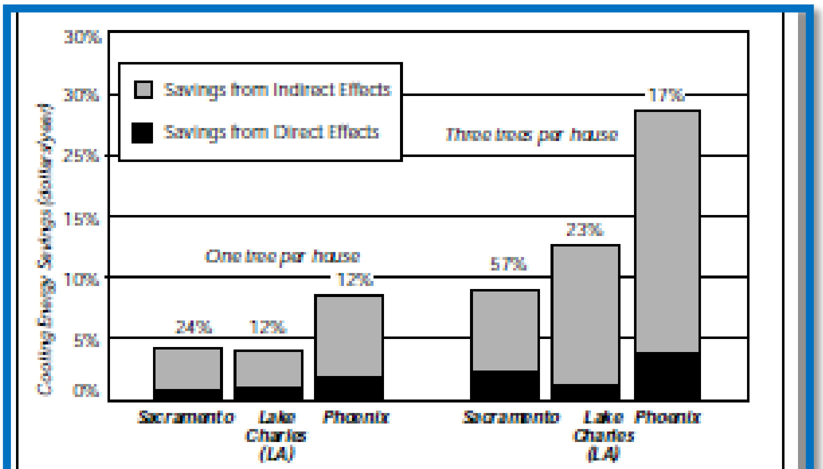
- Reduced Operating Costs
- Lower Maintenance Costs & Extended Equipment Lives
- Increased Productivity & Reduced Employee Absenteeism
- Reduced Incidents of Building Related Sicknesses
- Higher Test Scores from Students
- Increased Product Sales
- Reduced Impact on Municipal Infrastructure
- Higher Resale and/or Leasing Values & Marketability
- Decreased Building Product Waste Streams
- Increased Market For Recycled Content Materials
- Equivalent (but preferable) to Supply-Side Resources (e.g. Power Plants)
- Enhanced Environmental Quality & Decreased Pollution

Thus if such benefits are also accrued in most part of Africa, the deficit of most Government budgets in SSA would be supplemented by the financial savings that would be gained from the energy conservation and efficiency strategies introduced. More so, the expert report[40] from the United Nations Foundation indicates that doubling the rate of energy efficiency improvement would:

- Allow the world to hold CO^2 concentrations below 550 ppmv
- Avoid $3.0 trillion worth of new generation
- Save consumers $500 billion per year by 2030
- Eliminate the same amount of energy supplied by 2,000 coal power plants
- Return the globe to 2004 energy consumption levels
- Drive business productivity improvements and new employment opportunities

Apparently like the people of Sacramento, Lake Charles and Phoenix of the US, countries in TSSA can also benefit from incorporating passive measure like landscaping in their communities to help conserve the non-existent energy in the region. When one tree was introduced per house the cooling effect as indicated in box 4-8 was impressive but became dramatic when the number of trees was increased to three. That means in order to reduce the dependency on air conditioners and other mechanical ventilation systems which are the main sources of residential energy consumption systems.

Box 4-8: ENERGY SAVINGS OF LANDSCAPING-Sacramanto,Lake Charles and Phoenix



Percentages refer to savings of total cooling energy. Direct savings include the direct shading effect of a tree on a house; indirect effects include the evapo-transpirative properties of trees. As the number of trees increase, the relative contribution of the indirect effect grows in comparison to the direct effects.

(Source:EPA,1992; U.S. Department of Energy, 1996 pg. 74)

[40] Expert Group on Energy Efficiency, 2007: Realizing the Potential of Energy Efficiency: Targets, Policies, and Measures for G8 Countries. United Nations Foundation, Washington, DC, 72 pp

In the report (THE ENERGY YARDSTICK USING PLACE[3]S TO CREATE MORE SUSTAINABLE COMMUNITIES) to California Energy Commission, the Oregon Department of Energy and the Washington State Energy Office, the committee emphasized the multiplier effect of planning communities to be energy efficient. They stated that because of energy's pervasive influence in a community, creating a plan for its efficient use is a good strategy for simultaneously accomplishing other community goals, including:

- **Affordable Housing:** Lower energy bills for housing and commuting can mean better eligibility for home financing or renting.
- **Greater mobility options and reduced traffic congestion:** Energy efficient travel options such as walking, biking, and transit can reduce auto dependence. Improved land-use patterns can reduce the number and length of auto trips. Strategies to increase auto occupancy can further reduce congestion.
- **Improved air quality and reduced greenhouse gas emissions:** Fewer automobile trips and more efficient houses and businesses result in significantly lower air pollutant and greenhouse gas emissions, especially carbon dioxide (CO_2). Energy management initiatives are among the most cost-effective actions that local authorities can take to reduce the air pollution that causes serious environmental and health problems within their cities.
- **Reduced cost to provide public services:** Compact development with a mix of uses reduces the length of water, sewer, natural gas, and electric lines needed to serve a community. There is a potential of significant savings in the construction, operation and maintenance of the lines, booster pumps and labour. While many local authorities are faced with budget deficits, the appeal of saving money is often the starting point for municipal energy management initiatives. Improved efficiencies in municipal energy consumption offer plentiful opportunities for reducing operating costs.
- **Open space and agricultural land preservation:** Efficient development of compact regions and cities reduces overall urban land consumption.
- **Increased personal and business income:** Energy savings translate into more disposable income for individuals and more working capital for businesses. These dollars tend to re-circulate in the local economy, creating more economic benefits than dollars used to purchase energy.
- J**ob retention and creation:** Reduced commercial and industrial energy costs and reinvestment of savings can mean better protection of existing jobs and greater potential

for new jobs. Inefficient energy systems represent important investment opportunities in the community, and such investments are among the most effective ways to create new employment. When energy management reduces expenditures on fuel and electricity, the savings can then be re-spent within the community. (U.S. Department of Energy, 1996, p.1)

- **Local economic development** – The energy management industry itself is a growth industry and its promotion can be an effective component of local economic development strategies in the community. In addition, big business is increasingly considering the liveability of a city an important factor in deciding where to locate – access to urban goods and transport efficiencies (and so spatial development and public transport provision) are critical to creating liveable cities. (ICLEI – Local Governments for Sustainability,UNEP, and UN-Habitat, 2009, p.8)

5 ECOLOGICALLY RESPONSIVE COMMUNITY PLANNING

5.1 ECOLOGICAL SITUATION IN SSA

5.1.1 Air and Atmosphere

Given Africa's relatively low level of industrial development, air pollution is not as severe or as widespread as in some other parts of the world. However, in Africa's most populous cities, long-term exposure to congested traffic and poor air quality is a health hazard. In rural areas, biomass burning releases unhealthy particulates into the air, contributing to air pollution and health problems such as respiratory illnesses and allergies (UNEP 2006c, p. 16).

5.1.2 Land Cover and Land Use

Land cover refers to the physical attributes of the earth's surface that can be seen readily, such as water, trees, grass, crops, and bare soil. Land use refers to the social and economic purposes for which land (or water) is managed, such as grazing, timber extraction, conservation, irrigation, and farming. Traditional African societies are agrarian or pastoral, depending directly on the environment to meet peoples' daily needs from what they can grow, raise, catch, or gather. Three-fifths of African farmers subsist by directly utilising land resources (Dlamini 2005; UNEP 2006c, p.16).

5.1.3 Land Conversion

Land conversion is the process of changing land use or land cover. Land conversions may be natural or human-induced. Human induced conversion may be deliberate or unintentional. Table 1.1 shows changes in land cover and land use brought about in Africa due to increasing human population.

Deforestation is a form of land conversion that is most evident in Africa. Forests and woodlands provide multiple goods and services that contribute to social and economic development.

At the local level, forests provide construction materials, food, energy, medicine, catchment protection, soil protection, shelter and shade, habitat for wildlife, and grazing, as well as sites of cultural significance such as sacred groves. Forests and woodlands also help ensure water quality, regulate river flows (and thus hydropower potential), and prevent soil erosion; they represent sources of energy, timber products, and non-timber products such as fruits, resins, and gums as well as genetic resources that can be used in developing pharmaceuticals. At the global level, Africa's forests and woodlands are valued for their role in climate regulation and as repositories for biodiversity (UNEP 2006c, p.16.).

5.1.4 Changes in Land Productivity

Changes in land productivity may be positive (such as irrigating or fertilizing the soil) or negative (such as pollution or erosion).As with land conversion, land productivity changes may be natural or human-induced, and if human-induced, may be accidental or deliberate. Environmental concern in Africa surrounds negative changes in land productivity due to land degradation and desertification.

5.1.5 Land Degradation

Land degradation is the process of reducing the capacity of land to produce food or materials. An estimated 65 per cent of Africa's agricultural land is degraded due to erosion and/or chemical and physical damage. Thirty-one per cent of the continent's pasture lands and 19 per cent of its forests and woodlands also are classified as degraded (FAO 2005). As of 2000, over 19 per cent of African grasslands had been converted to agricultural land, and 0.4 per cent to urban areas. Other grassland areas were lost to land degradation, often due to overgrazing by livestock (White and others 2000). Grasslands support some of the continent's highest concentrations of cattle.

More than one-quarter of Africa's arid and semi-arid lands are degraded (White and others 2000) due to soil erosion, loss of soil nutrients, pollution, or Stalinisation. Poor farmers often have little choice but to cultivate crops or graze cattle on marginal lands, which can lead to a cycle of increasing soil erosion and land degradation. Land degradation in arid and semi-arid regions can eventually lead to desertification

5.1.6 Desertification

Desertification is one of the most severe forms of land degradation. Dry lands that form desert margins, such as those found in Sudan, the Sahel, and southern Africa are most prone to desertification. Such vulnerable lands—which occupy about five per cent of Africa's land mass—are home to 22 million people (Reich et al. 2001).

Erosion and desertification are fundamentally linked. It is estimated that some areas in Africa are losing over 50 metric tonnes of soil per hectare per year. This is roughly equivalent to a loss of 20 000 million metric tonnes of nitrogen, 2 000 million metric tonnes of phosphorus, and 41 000 million metric tonnes of potassium per year. Areas of serious erosion can be found in Sierra Leone, Liberia, Guinea, Ghana, Nigeria, Democratic Republic of the Congo, Central African Republic, Ethiopia, Senegal, Mauritania, Niger, Sudan, and Somalia (FAO 1995). Land degradation and desertification processes result from both human activities and climatic variability. People use controlled fire to manage grasslands and savannahs for livestock production and wildlife, control pests, clear dying vegetation, and convert wild lands to cropland (Trollope and Trollope 2004). Fires are necessary to maintain the health and extent of grassland and savannah ecosystems, but if the interval between fires is too short, the land can be degraded beyond its ability to sustain farming and grazing. Land degradation and desertification can occur quickly when fire is used too much or too often in fragile arid and semi-arid areas.

5.1.7 Biodiversity

Biological diversity, or biodiversity, is the term used to describe the full array of life in a region, including species richness, ecosystem complexity, and genetic variation. Biodiversity may be the greatest natural resource, as it is a source of food, medicines, clothes, energy, building materials, clean air, clean water, psychological well-being, and countless other benefits (Norse and others 1986).

The effective use of biodiversity at all levels—genetic material, species, communities, and ecosystems—is a precondition for sustainable development. However, human activities are the root cause of declining biodiversity worldwide; losses of plants, animals, and other species are taking place at a rate far higher than the natural background rate of extinction (UNEP 2008). It may be too late to stem the loss of biodiversity in certain parts of the world; however, in most of Africa the opportunity still exists for proactive intervention (Biodiversity Support Program1993). Africa's competitive advantage is enhanced not only by the fact that its environment is among the world's richest biologically but also by the fact that it has not yet sacrificed its endowment of these resources (Biodiversity Support Program 1993). Africa's living things account for almost one-third of global biodiversity, with the greatest concentrations occurring in the African equatorial ecosystems and those that border them. Of the world's 4 700 mammal species, one-quarter occur in Africa. Huge populations of mammals are found in the eastern and southern savannahs, including at least 79 species of antelope (UNEP and McGinley 2007). Africa also has more than 2 000 species of birds one-fifth of the world's total—and at least 2 000species of fish, more than any other continent.

In addition, Africa has about 950 amphibian species. New species of amphibians and reptiles are still being discovered. For example, during the 1990s, discoveries of new amphibian and reptile species in Madagascar alone increased the number of known species of these organisms by 25 per cent and 18 per cent, respectively (Anon 2007).The African mainland has between 40 000 and 60 000 plant species. Southern Africa alone has at least 580 families and about 100 000 known species of insects, spiders, and other arachnids (Anon 2007).

Eight of the world's 34 biodiversity hotspots are in Africa (CI 2007c). To qualify as a hotspot, a region must contain at least 1 500 species of vascular plants (> 0.5 per cent of the world's total) as endemics, and it must have lost at least 70 per cent of its original habitat (CI 2007b). Scientists have designated the African biodiversity hotspots on the basis of both existing biodiversity and the threats to that biodiversity with the intention of focusing protection efforts on these valuable areas. Over the last 30 years, the efforts to protect and sustain biodiversity have strengthened. More recently, there has been a shift toward focusing on the sustainable use of biodiversity resources and the sharing of their benefits. Nevertheless, biological diversity in Africa continues to decline (UNEP 2002). Over 120 plant species are extinct, with another1 771 threatened (Bird and Medina 2002). Threats to species are both direct (such as bush meat hunting) and indirect (such as habitat loss). Some species, such as the Bonobo or pygmy chimpanzee (Pan paniscus), exist in very limited areas. Loss of habitat in these relatively small areas can lead to the rapid extinction of species (Brooks et al. 2002). Much effort has gone into designating protected areas in Africa with the hope of saving these areas of crucial habitat (UNEP 2006c, p.25)

5.1.8 Water

Changes in water quality and quantity —in freshwater environments (lakes and rivers) and in coastal and marine environments—rank among the most challenging environmental and social issues that Africa currently faces an increasing population and a decreasing water supply lead to water scarcity and stress. Water scarcity is defined as less than 1 000 m3 of potable water available per person per year, while water stress means less than 1 700 m3 of potable water is available per person per year (UNEP 2002).

The availability of fresh water is essential to development in Africa. Nevertheless, the per capita water consumption in Africa, 31 m3 per year, is still comparatively lower than other regions—for example, North America— 221 m^3 per year (UNESCAP 2007). Agriculture, by far, accounts for most of the water consumption and withdrawal in Africa, followed by reservoirs, municipal use, and industrial use. In terms of agriculture, water consumption can be defined as the amount of surface and groundwater absorbed by crops and transpired, or used directly in the building of plant tissue, together with water that evaporates from the area where crops are located. Water consumption also includes all activities where the use of water results in a loss of the original water supplied, such as industrial or community consumption (UNESCO 2007). Withdrawal is the extraction of water from surface or subsurface reservoirs (UNESCO 2007).

Engineered water transfers and dams, as well as the exploitation of non-renewable groundwater supplies, account for the overuse of freshwater supplies throughout the world. In Africa, irrigation of agricultural lands occurs in the arid and semiarid regions in northern and southern regions of the continent and along the Sahel. In these areas, much of the surface and groundwater resources are highly exploited. While water consumption and withdrawal in Africa has been increasing over time, the continent's water resources have been decreasing, mainly as a result of persistent droughts and changing land use patterns.

5.1.9 Bio-capacity

The total available bio-capacity or eco-system supply of an area is determined by the amount of biologically productive area available and the productivity or yield of that area (Global Footprint Network, 2006, p.15). Bio-capacity as explained by the Global Footprint Network (2006, p.15), can be maintained by protecting soil from erosion and degradation as well as preserving cropland for agriculture This also , the Network continues to suggest that, involves protecting river basins, wetlands and watersheds to secure freshwater supplies, and maintaining healthy forest and fisheries. However, according to Global Footprint Network (2009, p.6), though Africa has 14 per cent of the world's population, it has about 12 per cent of the total global bio-capacity which are concentrated primarily in the Sub-Saharan Africa. In 1961, Africa had an available bio-capacity of 3.5 global hectares per person compared to an Ecological Footprint of 1.2 global hectares (Global Footprint Network, 2006, p.20). By 2002 as indicated by Global Footprint Network, (2006, p.20), this ecological reserve had shrunk from 2.3 to 0.2 global hectares per person. By 2006 the report showed that an average African has a Foot Print of 1.1 global hectares compared with an available bio capacity of 1.3 global hectares per person. More so, as the continent's population grew from 287.3 million to 902.0 million between 1961 to 2005, the bio-capacity available per person in Africa decreased by 67 per cent.

5.2 CONCEPT AND STRATEGIES IN ECO-RESPONSIVE PLANNING

5.2.1 Concept

An "Eco-city" is a city that decreases environmental burden or stress, improves living conditions and helps in achieving sustainable development through a comprehensive urban improvement system involving planning and management of land and its resources and implementation of environmental improvement measures[41]. Eco-City concept focuses on overall urban planning and urban ecosystems, civil society and greening of the city (GEC, 2005, p.2). However, according to one of the pioneers of the concept, Register (1987, p.3), says an Eco-City is an ecologically healthy city of which none of such city exists. There are bits and pieces of the eco-city scattered about in present day cities and sprinkled through history, but the concept- and hopefully, the reality- is just beginning to germinate. This may mean Eco-Cities are Utopian except that attributes of them can be achieved in existing or

[41] http://www.urbanecology.org.au/topics/ecologicalcities.html_accessed_20-08-2010

planned cities. The vision of an Eco-City involves compact mixed-use urban form, well defined higher-density, human-oriented centres that are focal points for population and employment growth and are linked by public transport, priority to the development of superior public transport systems and conditions for non-motorised modes of travel, with minimal road capacity increases to curtail automobile dependence, and protection of the city's natural areas and food-producing capacity. The eco-city aims to employ innovative 'closed loop' environmental technologies for water, energy and waste management, economic growth based on creativity and innovation and sensitive to local environmental and cultural contexts, sustainable urban design principles, and a high quality public realm both physically in terms of public space and socially in terms of social (Pacione, 2009, p. 617)

> **"From an ecological planning perspective, the amount of growth is less important than the pattern of growth in determining the level of environmental impact and the efficiency of resource use."**
>
> **Mark Roseland,**
> Ecological Planning for Sustainable Communities
>
> Source: (U.S. Department of Energy, 1996)

The environmental improvement projects undertaken in the Eco-city Projects are expected to be[42]:

- Innovative, non-conventional, practical and sustainable.
- Cost effective.
- Easily maintainable.
- Simple in design.
- Creating visible impact.
- Replicable.
- Providing multiplier effect.
- Using locally available materials and artwork.
- Adopting design concepts that appeal/suit the local people.
- Custom made state-of-art designs to suit local conditions.
- Play a catalyzing/demonstrating effect.

Active participation of public in the improvement of the city should be encouraged right from the stage of planning to implementation (Wackernagel and Rees 1996; Roseland 2000, p. 119). Due to the broad definition of Sustainable Cities or Green Cities, the Eco-City Concept has also unsurprisingly been termed synonymous to it. Eco-City Concept is a subset of the Sustainable City Concept. Thus for the purpose of this study, an attempt is being made to add energy efficiency to the eco-responsiveness in urban planning (Eco-City concept) to achieve a level of Green or Sustainable City or

[42] http://www.urbanecology.org.au/library/cities/ecocities/makecitiessustainregister.html

community. The Eco-City Concept can apply to a broad spectrum of sustainable cities ranging from planned or existing cities which have attained some level of sustainability due to adaptation.

5.2.2 Strategies

There are various strategies applied by various planners in planning and developing existing and planned eco-cities. Notable amongst these are the Green Infrastructure Network and the Smart Growth Strategy. Nonetheless a lot of planners also adopt either strategy exclusively or a mixture of these two strategies or apply the emphasis by elimination method. The strategy of framing an Eco-City Project favourably by purposefully excluding factors such as international flights during the design and monitoring stages or carefully drawing city limits to exclude harmful factors (Palca, 2008; Ekblaw, et al., 2009, p.7) is what can be termed as the 'emphasis by elimination' method in Planning. Favourable aspects which align with the Eco-City Concept is emphasised and those that contradict are eliminated. This method is usually used when an exclusive strategy is adopted and has been applied in various newly planned Eco-Cities and existing Cities being turned around to obtained the Eco-City status.

a. Green Infrastructure Network

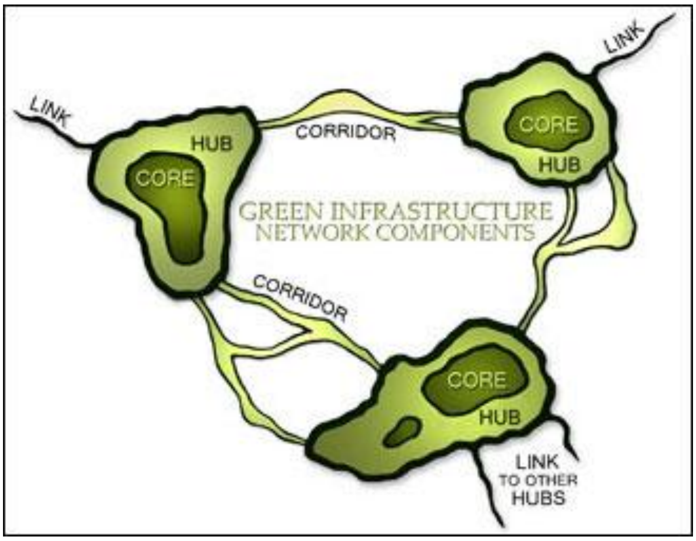
Green infrastructure Net work planning is a strategy that differs from the conventional approaches to open space planning because it looks at conservation values and actions in concert with land development, growth management and built infrastructure planning(Benedict, et al., 2001,p.5). The American Planning Association, (2006, p.486) defines Green Infrastructure as the interconnected network of protected land and water that supports native species, maintains natural ecological processes, sustains air and water resources and contribute to the health and quality of life for the communities and people. The Association also suggests that it also encompasses a wide variety of natural and restored ecosystem and landscape features or components which are links (linear components and hubs). Davies, et al., (2006,p.2)[43] also adds another dimension to Green infrastructure by defining it as the physical environment within and between our cities, towns and villages. More so they explained that it is a network of multi-functional open spaces, including formal parks, gardens, woodlands, green corridors, waterways, street trees and open countryside. It comprises all environmental resources, and thus a green infrastructure approach also contributes towards sustainable resource management.

[43] Culled from www.greeninfrastructure.eu

Green infrastructure as opined by Benedict, et al (2001, p.7) unlike green space is a must have instead of nice to have, a necessity and not an amenity. More somewhere as green space is seen as self-sustaining, GI reflects something that needs to be actively maintained and at times restored.

They are influenced by 4 factors including; linking natural areas to counter fragmentation and biodiversity; identifying and protecting interconnected open space systems to benefit wildlife and ensure a sustainable future; and building upon the excitement and appeal of modern-day greenways movement (Benedict, et al., 2001, p.9)

Figure 5-1: GI Network Components



Source: http://www.conservationfund.org/_accessed_20-07-2011

HUBS according to Benedict, et al. (2001, p.7) anchor green infrastructure networks and provide an origin or destination for wildlife and ecological processes moving to or through it.

- RESERVES: Large protected areas, such a national wildlife refugees or state parks, that serves as primary sites for conserving biological diversity and natural resources such as fisheries and fresh water. Reserves also can protect important historical and cultural sites and provide some nature-based recreation opportunities(American Planning Association, 2006,p.486)
- REGIONAL PARKS AND PRESERVES: Less extensives hubs of regional significance, such as the forest preserve system of cook county,Illinois,that provide ecological benefits and conserve biological diversity, as well as offer important compatible resource-based recreational opportunities. (American Planning Association, 2006,p.486)
- ECOLOGICAL SITES: Smaller sites that conserve important or unique natural or geologic features(American Planning Association, 2006,p.486)

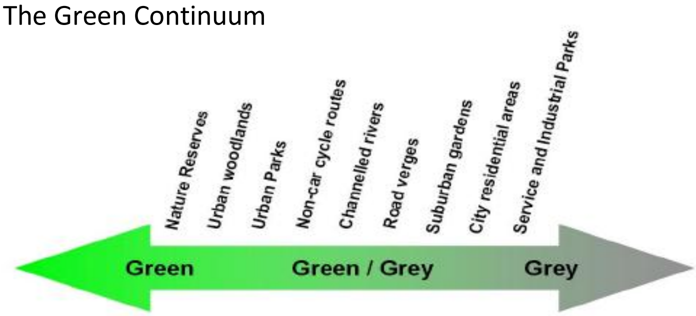
- CULTURAL/HISTORIC/RECREATIONAL SITES: Community parks or cultural historical sites that provide recreational oportunities, help protect and intepret and interpret a community's heritage, and, often, can serve as an origin or destination for a recreational trail and/or protect important cultural/historic features. (American Planning Association, 2006,p.486)
- TRAILHEADS: Selected ecological, recreational or cultural / historic sites with appropriate visitor services that serve as points of origin or destination linked by trail corridors. Trailheads can occur within rural natural areas and working landscapes or within urban areas ranging from large metropolitan areas to small communities. Trailheads serve as human hubs within greenways system. (American Planning Association, 2006,p.486)

LINKS according to Benedict, et al.(2001,p.8) are the connections that tie the systems together and enable green infrastructure to work. They range in size, function and ownership, including;

- LANDSCAPE LINKAGES: Large protected natural areas that connect existing parks,preserves,or natural areas and provide sufficient space for native plants and animals to fluorish while serving as corridors connecting ecosystems and landscapes. Landscape linkages may also provide space for the protection of historic sites and opportunities for recreational use;
- CONSERVATION CORRIDORS: Less extensive linear protected areas, such as river and stream corridors that serve as biological conduits for wildlife and may provide recreational opportunities;
- GREENWAYS: protected corridors of land managed for resource conservation and/or recreational use;
- GREENBELTS: Protected natural lands or working lands that serve as a framework for development while also preserving native ecosystems and/ or farms or ranchland
- ECOBELTS: Linear woody buffers that can ease the zone of tension between urban and rural land uses while providing ecological and social benefits for urban and rural residents

There is a grey-green continuum of thinking relating to concepts surrounding 'infrastructure', although 'green' can be used to denote the function or facility provided by an element, even if it is not strictly 'green' in land use terms. Elements that might be classed as 'grey', but which contribute to the wider functioning of green infrastructure should be treated as part of the green infrastructure network. Grey infrastructure, such as bus routes, should be made to integrate with green infrastructure networks rather than vice-versa (Davies, et al., 2006, p.5).

Figure 5-2: The Green Continuum



Source: Davies, et al., 2006, p.3).

It is not seen just as a way of providing an improved green structure for the landscape, but also as a mechanism for more informed decision-making and more 'joined-up' thinking in relation to urban and regional environmental planning (Davies, et al., 2006, p.10).

Integrated planning and design should connect both 'green' and 'gray' infrastructure in an effective, economical and sustainable network. (American Planning Association, 2006, p.486)

Strategically the context and functions of Green Infrastructure as identified by Davies, et al., (2006, p.2) as;

I. Sustainable resource management – particularly relating to the role of GI in the sustainable
II. Management of land and water resources, including production (e.g. energy and food crops), pollution control, climatic amelioration and increased porosity of land cover.
III. Biodiversity – particularly relating to the importance of connectivity of habitats at a variety of landscape scales;
IV. Recreation – particularly relating to greenways and the use of non-car routes to address public health and quality of life issues;
V. Landscape – examining resources such as green spaces and corridors from aesthetic, experiential and functional points of view;
VI. Regional development and promotion – particularly relating to sustainable communities issues relating to overall environmental quality and quality of life.(Davies, et al., 2006, p.2)

Green infrastructure planning represents the coming together of various interests as described above. It is not seen just as a way of providing an improved green structure for the landscape, but also as a mechanism for more informed decision-making and more 'joined-up' thinking in relation to urban and regional environmental planning. Green infrastructure is seen as a critical part of urban infrastructure and as a positive way to conceptualise green space planning. The aim is to increase the quality of natural capital rather than concentrate solely on the quantity of natural capital.

Embedded within green infrastructure planning is the idea that stakeholders should have the opportunity to be involved in the shaping of environmental and green space planning at a variety of scales. Recent enthusiasm for pushing forward green infrastructure planning indicates that GI has become a ‘musterpoint’ for academic, public bodies and practical agencies interested in green space issues and a way to help develop environmental thinking across disciplinary and political boundaries. The integration of GI into the comprehensive eco-responsive community planning provides some benefits of to the Community Planning Process. The processes involved in the GI Planning process as a strategy for the Eco-Responsive Community planning recognizes and addresses the needs of both people and nature apart from provision of a mechanism to balance environmental and economic factors.

The GI Network planning provides a framework for integrating diverse natural resource and growth management activities in a holistic, ecosystem-based approach. GI Network ensures that both green space and development are placed where most needed and most appropriate whereas it identifies vital ecological areas and linkages prior to development in suburban and rural landscapes. More so, GI according to Benedict, et al.(2001,p.16) identifies opportunities for the restoration and enhancement of naturally functioning systems in already developed areas and provides a broad, unifying vision for the future that diverse people and organizations can buy into. The group also explains that GI enables communities to create a system that is greater than the sum of its parts and also helps provide both communities and developers with predictability and certainty. Finally, Benedict, et al.(2001,p.16) goes on to expatiate that GI Network enables conservation and development to be planned in harmony, not in opposition to one another.

b. Smart Growth Strategy

Another strategy commonly used to plan Eco-Cities is the Smart Growth Strategy. The "Smart growth" is a collection of land use and development principles that aim to enhance our quality of life, preserve the natural environment, and save money over time. Smart growth principles ensure that growth is fiscally, environmentally and socially responsible and recognizes the connections between development and quality of life. Smart growth enhances and completes communities by placing priority on infill, redevelopment, and densification strategies (ICMA/ EPA,2006). Communities which use such strategy in planning its neighbourhood are sometimes called Sustainable communities. A common thread among different views is development that revitalizes central cities and older suburbs, supports and enhances public transit, promotes walking and bicycling, and preserves open spaces and agricultural lands. Smart growth seeks to revitalize the already-built environment and, to the extent necessary, to foster efficient development at the edges of the region, with the goal of creating more liveable communities with sufficient housing for the region's workforce (ICMA/ EPA,2006)When communities choose smart growth strategies, they can create new neighborhoods and maintain existing ones that are attractive, convenient, safe, and healthy.They can protect the environment while stimulating economic growth. Most of all, they can create more choices for residents, workers, visitors, children, families, single people, and older adults—choices in where to live, how to get around, and how to interact with the people around them. When communities do this kind of planning, they preserve the best of their past while creating a bright future for generations to come. (ICMA/ EPA,2006)

The principles[44] behind smart growth strategy include:

1. Well Planned mix land uses with compact mixed used village centre and neighbourhood. Each neighbourhood has a mixture of homes, retail, business, and recreational opportunities. Residents can choose to live, work, shop and play in close proximity. People can easily access daily activities, transit is viable, and local businesses are supported. The tools needed to implement such a principle are mixed use commercial zoning, density-based zoning incentives and retrofit suburban shopping centres.
2. Provision of a variety of transportation choices with intermodal pedestrian bicycle and Transit Network. Build a regional network of pedestrian and bicycle trails to provide opportunities for residents to bicycle or walk to work or shopping. Neighbourhoods are attractive and have safe infrastructure for walking, cycling as well transit facilities and services, in addition to driving. The tools needed to implement such a principle are;
    - Build regional trail system
    - Develop bicycle amenities
    - Create bicycle lanes
    - Park and ride lots
    - Re-establish commuter rail links
    - Traffic calming measures
    - Improve public transit with links to intermodal centres
    - Required bicycle and pedestrian amenities in new developments
    - Pedestrian-friendly street design standards

[44] http://www.smartgrowth.bc.ca/Default.aspx?tabid=133_accessed_on_10th _Jan_2011

3. Create diverse housing opportunities and neighbourhood quality. Provide a variety of housing choices in existing residential neighbourhoods and create more liveable, pedestrian-friendly neighbourhood environments. Ensure each community provides its fair share of the region's affordable housing while discouraging the recent trends of exclusive gated communities for the rich. People in different family types, life stages and income levels can afford a home in the neighbourhood of their choice. In this case the tools needed to implement such a principle are;
    - Accessory apartment bye-laws or ordinances
    - Inclusionary zoning bye-laws or ordinances
    - Elderly and handicapped zoning bylaws or ordinances
    - Zoning for limited commercial use in neighbourhoods
    - Incentives for home ownership and mixed income housing to stabilize neighbourhoods in core cities
    - Use of Community Preservation Act funds to construct or repair affordable housing, or to rescue expiring affordable units
    - Parks and recreation areas in neighbourhoods
4. Encourage growth in existing communities by revitalising urban core areas and downtowns. Investments in infrastructure (such as roads and schools) are used efficiently, and developments do not take up new land. Streamline or update antiquated zoning regulations to promote mixed use and infill development in downtown areas. Allow a greater density downtown than in surrounding areas. Prescribe a balanced mix of commercial, residential, cultural, and entertainment uses. Allow mixed uses in formerly single use buildings. In this case the tools needed to implement such a principle are;
    - Downtown zoning to promote mixed uses and infill development
    - Zoning for downtown residential uses
    - District Improvement Financing (DIF)
    - Business Improvement Districts
    - Economic Target Areas/Tax Increment Financing (TIF)
    - Main Street Programs
    - Standards for design, landscaping and streetscaping
    - Improve urban parks and green spaces
    - Recycle underutilized city land
    - Encourage government or private institutions to locate downtown

- Incentives to reduce costs for rehabilitation of older buildings for mixed use and housing

5. Preserve open spaces, natural beauty, and environmentally sensitive areas. Create programs to protect key open space features, including "blue-ways" to protect river corridors and "greenbelts" to protect wildlife corridors, mountains, and ridgelines. In this case the tools needed to implement such a principle are;
    - Adopt Community Preservation Act
    - Wetland protection overlay zoning
    - River protection overlay zoning
    - Scenic upland overlay zoning
    - Dedication of parkland in new developments
    - Public access areas on waterfronts
    - Regional open space coordinator
    - Create regional open space funding pool

6. Protect and enhance agricultural lands as well as support farm businesses. Create programs to protect prime farmlands and incentives to encourage the growth and development of farm-related businesses. Establish local agricultural commissions to coordinate farm preservation efforts. A secure and productive land base provides food security, employment, and habitat, and is maintained as an urban containment boundary. In this case the tools needed to implement such a principle are;
    - Transfer of development rights bye-laws or ordinances
    - Local land trusts for farmland preservation
    - Technical assistance to farm businesses
    - "Omnibus" state farm retention legislation
    - Regional year-round farmers market
    - Local agricultural commissions
    - Right-to-Farm districts
    - Tax benefits for farmers

7. Utilize smarter and cheaper infrastructure and green buildings. Green buildings and other systems can save both money and the environment in the long run. In urban areas, target public funds for improvements and upgrading of infrastructure, such as sewer and water

facilities, streets and roads, to promote private investment. In rural areas, limit infrastructure expansions to prevent urban sprawl. Develop in a way that uses available resources without threatening future generations' ability to meet their growth and development needs. The tools needed consequently to implement such a principle are;

- Policies to limit sewer and water extensions
- Targeted state and federal funding for infrastructure improvements
- Incentives for energy efficient buildings and those that are heated and powered by clean energy
- Promotion of clean, renewable energy on municipal, commercial, and residential buildings and land
- Green building construction and certification
- Development of eco-industrial parks
- Zoning bye-laws to encourage solar access, adhered to required energy efficiency standards, and use native plants in landscaping to reduce water use -.

5.3 BARRIERS AND BENEFITS OF ECO-RESPONSIVE PLANNING

5.3.1 Barriers to Eco-Responsive Planning and Strategies in SSA

The barriers bedevilling the various efforts to eco-responsively plan and develop communities in Tropical sub-Saharan Africa (TSSA) are diverse and quite difficult to mitigate in the region. These barriers range from subtle intangibles like attitudinal issues to a more visible one like non availability of resources. They may be classified as **Technical, Economical, Political, Informational** as well as **Social**. Though TSSA countries, with less existing infrastructure than developed countries, have a flexibility advantage and could potentially leapfrog to cleaner technologies and plan eco-responsively, the barriers and challenges imbedded in their socio-economic systems makes it difficult to make meaningful progress.

Technically, TSSA appears to be centuries behind the developed countries like Germany, Netherlands and Spain who have made significant progress in areas of Eco-Responsive Planning and Development. The ability to change emissions trajectories and plan eco-responsively depends on the availability of appropriate and affordable technology, which will not be in place at some future date without research and development (R&D) investment, dissemination, and immediately implementing learning-by-doing in TSSA. Developing countries (of which TSSA is part) are still lagging in innovation for adaptation; hence, it is usually more cost-effective to adopt technologies from developed countries than to re-invent them, in some cases technological solutions for local problems do not exist (IBRD[45]/ The World Bank, 2010, p. 293). The choice to switch to a more energy, eco-responsive and economically efficient system realistically cannot be made in the future if the required technologies are not yet on the shelf and at sufficient scale to be affordable and if people do not yet have the know-how to use them (Shalizi, et al., 2009; IBRD / The World Bank, 2010, p. 51).

The issue of economic impoverishment of the TSSA Communities have led to the almost total reject for the call for eco-responsive planning and development. As indicated by the chicagotribune.com[46] which quoted a member of the Nigeria conservation board as opining that though we breathe air and enjoy breeze, the kinsmen are hungry and clean air does not provide protein or carbohydrates. He suggested that it is prudent to provide an alternate means of livelihood and it would then be easier to convince the people from clearing the forest and poaching the endangered species (United Nations Environment Programme (UNEP), 2008, p.xv). More so, lack of adequate funds to support scientist and eesearch institutions to inform policy-makers in making the right decisions that affect the environment is also another barrier.There are few but meagrely supported institutions that have the human resources to train experts in the area of eco-responsive planning. To compound the problem is the absence of data of the natural capital within the TSSA for the planners to consider when planning which is mostly attributed to inadequate allocation of funds and resources to research and development as well as statiscal services.

Another subtle but influential barrier which has political inclination is the problem of inertia, which means that today's actions will determine tomorrow's options. According to the World Bank Group, Inertia is also present in the built environment, limiting flexibility in reducing greenhouse gases or designing adaptation responses. The group suggests that Infrastructure investments are lumpy, concentrated in time rather than evenly distributed. They are also long-lived: 15–40 years for factories and power plants, 40–75 years for road, rail, and power distribution networks. Decisions on land use and urban form—the structure and density of cities—have impacts lasting more than a century (IBRD / The World Bank, 2010, p.10). Hence inertia reinforces the reason for lack of political will on the parts of government to decisively act on policies that promotes eco-responsive planning since the outcome is usually realized after a political regimes mandate to rule. Political inaction on environmental issues and policies such the situation in Ghana where Diamond mining companies (both Corporate and artisanal) have depleted the environment of the communities but politicians

[45] The International Bank for Reconstruction and Development

[46] Quoted from chicagotribune.com-Rainforest at Alarming Rate- by Edward Harris, Associated Press Writer, February 3, 2008)

virtually do nothing to stop such practices due to votes. (KonSULT, 2005). Politicisation of most policies and laws in parliament has also contributed in a subtle way to deny most TSSA countries of sound legal framework that would guide the Green Infrasructure network.

Miscommunication by the media is a barrier which hinders the process and promotion of eco-efficient planning. The issue of sending messages and information to the public which undermines the credibility of the crusade for eco-efficient planning has been persistent. The public is usually bombarded with words or images of quasi biblical effects of climatic change which set into motion pernicious reactions. Many people also think it is beyond human intervention to effect any positive change in an imminent scary weather catastrophe. More so, as opined by IBRD, typical global warming news outlining the scientific proof, stressing the severe consequences of inaction and urging immediate steps can lead people into thinking that preventive action is meaningless (IBRD / The World Bank, 2010, p. 323).This miscommunication culminates to be an informational barrier. Over the past decade, awareness of climate change has grown without translating into widespread individual action (Bannon, et al., 2007; The World Bank, 2010, p. 323). Conversely after all the available research findings and information released to the public, flying, driving, holidaying abroad, and using household appliances have increased globally (IPPR, 2008; The World Bank, 2010, p. 323).

There is an apparent disconnect between perception and action which reiterate the IBRD suggestion that concerns about climate change do not necessarily mean understanding its drivers and dynamics or the responses needed. Polls show that the public admits to remaining confused over climate change's causes and solutions (Wimberley, 2008; The World Bank, 2010, p. 323). This "green gap" in public attitudes stems partly from how climate science is communicated and how our minds (mis)-understand climate dynamics (Norgaard, 2006; The World Bank, 2010, p. 323). Bulkeley also opines that though people today are exposed to lots of information on the causes, dynamics, and effects of climate change and this information has clearly increased concern, but it has not led to action (Bulkeley, 2000; The World Bank, 2010, p. 323). However Kellstedt, et al., (2008), explains that because information can produce misleading feelings of "empowerment," which then turns into ambivalent powerlessness when paired with more "realistic" messages, conveying urgency by stressing the unprecedented nature and scale of the problems can result in paralysis (Kellstedt, et al., 2008; The World Bank, 2010, p. 323). Similarly, Immerwahr, (1999) suggests that playing up the multi-stakeholder nature of mitigation and adaptation is a reminder that the solution rests with no single actor, resulting in a general feeling of helplessness and disempowerment. This is what the

World Bank, (2010, p. 323) says might explain why, in developed countries and some countries within TSSA where information on climate change is more readily available, people are less optimistic about a possible solution.

Socially, there are quite a subtle but destructive attitude and behaviour of most people in the TSSA region especially Ghana. The opulent, resource dependent life styles of Hollywood stars and western culture of living is gradually being accepted as the status quo for success. Hence new communities and real estate developers tend to respond to this demand by implementing projects that tends to consume so much land and energy but green wash with solar panels and call them as eco-friendly. This distortion makes it difficult for the public in the absence ready information to distinguish between what indicators and characteristics of community development can be called eco-responsive. Sadly, the local cultural practices and beliefs which were used to help protect the environment are now being considered as outmoded and the Non-farming days and Fishing days which helped most fauna to breed are almost non-existent. The so called modern forestry policies also lack the necessary enforcement support to see them through. The days when some rivers, forest and mountains were considered as deities and protected from exploitation are over and hence the TSSA pristine biodiversity is left to the mercy of ignorant, greedy and hungry local folks and foreigners.

5.3.2 Benefits of Eco-Responsive Planning and Strategies in SSA

An Eco-Responsive Planning (ECP) encompasses all natural, semi-natural and artificial networks of multifunctional ecological systems within, around and between urban areas, at all spatial scales. It emphasises the quality as well as quantity of urban and peri-urban green spaces (Turner, 1996; Rudlin and Falk, 1999; Tzoulas, et al., 2007,p.169), their multifunctional role (Sandström, 2002; Tzoulas, et al., 2007,p.169), and the importance of interconnections between habitats (van der Ryn and Cowan, 1996; Tzoulas, et al., 2007,p.169). The benefits accrued from ECP transcends diverse range of environmental, social, recreational, psychological, public health, and economic benefits. Since the GI network strategy in community planning and development is an anchor to the ECP, all benefits derived from inclusion of GI in a community development plan is same for an Eco-Responsive Community.

GI within the framework of an ECP maintains the integrity of habitat systems and may provide the physical basis for ecological networks. The development of ecological networks has been advocated as a means of alleviating the ecological impacts of habitat fragmentation. This makes biodiversity conservation an integral part of sustainable landscapes (Opdam et al., 2006 Tzoulas, et al., 2007,p.170).Nevertheless, only a few empirical studies have shown the successful role of ecological corridors as conduits for wildlife (e.g. Haddad and Tewsbury, 2005). So, the functionality of corridors in ecological networks remains contested (Noss, 1993; Hobbs, 1992; Beier and Noss, 1998; Simberloff et al., 1995; Tzoulas, et al., 2007,p.170). However, in the absence of alternative strategies for addressing the ecological impact of fragmentation, ecological networks have become a popular element of urban planning (Jongman and Pungetti, 2004; Tzoulas, et al., 2007,p.170).

The elements of a GI can be seen as preserving and enhancing diversity within ecosystems in terms of habitats, species and genes. Diversity is one of the most important indicators of ecosystem health (Rapport, 1995 Tzoulas, et al., 2007,p.170). A GI Network, composed of cores, hubs, and corridors, is identified and designed to maximize the many benefits and existing assets inherent in a community or region. ECP through the concept of well planned and developed GI mitigates climate change on the regional and macro-level by:

- Absorbing and storing carbon(carbon sequestration);
- Reducing travel through provision of local recreation opportunities;
- Providing walking and cycling routes to reduce carbon emissions from vehicles;
- Supplying biomass or biofuels to directly replace fossil fuels;
- Supplying timber to replace less sustainable construction materials;
- Increasing local food production to reduce food miles.

More so, in the event where the effects of climatic change and global warming is in force, ECP through the incorporation of well planned GI assist the ccommunities by adaptation to the effects of climate change is enhanced by:

- Creating cooler microclimates and reducing the need to cool buildings;
- Creating cooler microclimates and making towns and cities more pleasant in hot weather;
- Storing and intercepting rainwater and encouraging natural drainage, to prevent flooding;
- Storing river flood water to reduce the risk of fluvial flooding e.g. through the restoration of floodplains;
- Providing shelter and protection in extreme weather;

An interconnected system within the ECP framework allows for greater vitality, value and function of the natural areas & ecological networks including their ecosystem services or natural benefits. The link between ecosystem health and public health is the set of ecosystem services provided by the GI in the ECP framework. Ecosystem functions include biotic, bio-chemical and abiotic processes, within and between ecosystems (Turner et al., 2005; Brussard et al., 1998; Tzoulas, et al., 2007, p.170).

Poorer areas often contain the most neglected and under-used areas of public space. The rehabilitation of a park in a deprived area can act as a catalyst for regeneration in the entire neighborhood. CABE's report, Community Green, shows how providing good quality local green space is an effective way to tackle inequality and improve health.

The term "ecosystem service" refers to the delivery, provision, protection or maintenance of goods and benefits that humans obtain from ecosystem functions (Millennium Assessment, 2003; de Groot et al., 2002; Bolund and Hunhammar, 1999). Cultural, psychological and other non-material benefits that humans obtain from contact with ecosystems contribute in particular to human health in urban settings (Butler and Oluoch-Kosura, 2006)[47]. An easy analogy is to compare green infrastructure aspect of the ECP to grey infrastructure - in the same way that our roads, sewers, and utilities convey and assist our social systems (grey infrastructure), green infrastructure is the support and conveyance network for our natural systems. The natural systems that make up green infrastructure include open space and natural areas such as its greenways, wetlands, parks, forests, farms & ranches, vacant lands, creeks & streams, mountains & foothills, shorelines, trails, watersheds, and recreational or scenic areas[48]. A possible mechanism explaining the relationship between the amount of green space, well-being and health has been hypothesized (cf. de Vries et al., 2003; Takano et al., 2002; Tzoulas, et al., 2007,p.170). By introducing GI into the communities through the ECP, the interconnected system of these lands, conserve ecosystem values and functions, sustains clear air and water, promotes a sustainable economic regional framework, and contributes to the health and quality of life for its residents. By reducing of the urban heat island effect through evaporative cooling, shading and providing corridors for cooler air to flow into urban areas the health of inhabitants wth an eco-responsive community is enhanced and improved. Additionally, improvement of the air quality by filtering out pollutants and easy opportunities for recreation is also ensured. The GI within the ECP framework help to reduce stress and improve mental health through enjoyment of open space and nature. It also provides safe, easily accessible green routes for walking and cycling which keeps the community active and healthy. Through the GI network, space is made available for urban agriculture which encorages the cultivation and growing fresh food in the urban environment.

The CABE reports that well-designed green infrastructure improves our quality of life by encouraging community cohesion through bringing people together and using green spaces for social events. Apart from making places more attractive and giving them a better image, an eco-responsive community with a well planned GI network helps to reduce crime (and the perception of crime) through natural surveillance in well-used public spaces. Green areas in one's living environment may

[47] http://dspace-sub.anu.edu.au:8080/jspui/bitstream/10440/525/1/Butler_Linking2006.pdf_accessed_20th_January_2011

[48] http://www.greeninfrastructuredesign.org/green-infrastructure

ameliorate air pollution, and the urban heat island effect (Whitford et al., 2001; Tzoulas, et al., 2007,p.170), and may also lead to people spending a greater amount of time outdoors and being more physically active. On the other hand, green spaces that are perceived to be overgrown or unmanaged may have a negative effect on peoples' well-being by increasing anxiety caused by fear of crime (Kuo et al., 1998; Bixler and Floyd, 1997).

GI offers the community a working landscape and a sustainable alternative to traditional engineering by providing[49];

- protection against flooding by using:-
    - living roofs, large trees and soft landscape areas absorb heavy rainfall;
    - a network of street swales and unculverted rivers which can safely manage large volumes of water;
- Storage and recycling of water for summer irrigation;
- Energy efficiency for building by using green roofs which insulate buildings where as large trees shade offices which reduces the need for air conditioning;
- Cleansing and cooling services for the air, water and soil;
- Green spaces to encourage exercise and socializing;
- provides a place with character and a strong identity;
- allows us to access nature, and feel part of it;
- Improves the image of a place, boosts property prices and attracts investment.

Economically, the ECP framework through GI network improves the strength of local economies because increasing green space can lead to an increase in average house prices in an area. Whereas good green spaces and landscaping improve an area's image and encourage inward investment, an attractive landscaping encourages businesses to relocate to and stay in a place. According the CABE's report, a high quality environment encourages tourism and also supports a more productive workforce by improving health, alleviating stress and increasing motivation. Apart from providing food timber and industrial crops (e.g. bio fuels) the green infrastructure 'sector' is a major employer especially in the TSSA where Agriculture contributes more than 50 percent to the economy.

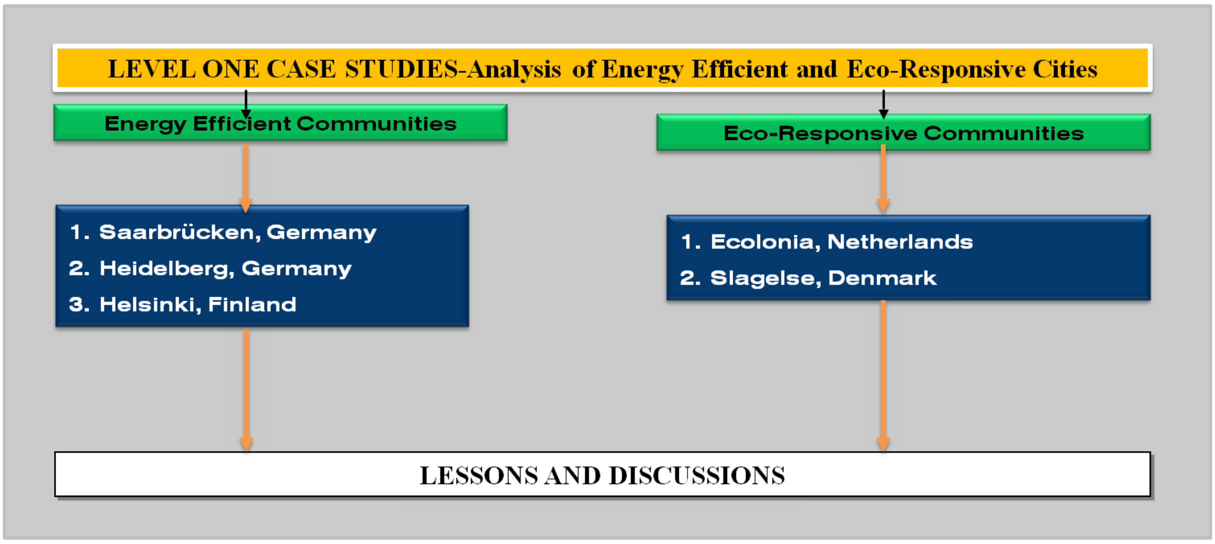
[49] http://www.cabe.org.uk/sustainable-places/green-infrastructure

6 LEVEL ONE CASE STUDIES - GENERAL OVERVIEW

6.1 INTRODUCTION

The level one case study is the analysis of a group of cases that identify the importance and significance of the core issues of this research, which is Energy Efficiency and Eco-Responsiveness. This level takes a look at some existing cities who have successfully attempted to incorporate the concepts of energy efficiency and eco-responsiveness into the planning and administration of the urban fabric. As indicated in the figure below, Saarbrücken and Heidelberg in Germany as well as Helsinki in Finland shall be studied under the Energy efficient cites, whereas, Ecolonia in Netherlands and Slagelse of Denmark is considered under the eco-responsive communities.

Figure 6-1: General Overview of Level One Case Study



Source: Author

6.2 ENERGY EFFICIENT COMMUNITIES

Energy is intrinsic to urban settlements, embedded in the built environment, directly used to power socioeconomic activity, transport, and communications, as well as to enable the provision of municipal services (Nandi, et al., 2010, p.2). Achieving this daunting goal calls for committed approaches from collaborative efforts and strong and focused urban governance, with proactive support from the all stakeholders in the community. According to Nandi, et al., 2010, although cities house approximately half the world's population it however account for two-thirds of global energy requirements, with high levels of associated greenhouse gas (GHG) emissions.Hence it, prudent to take a critical look at the strategies that was and have been adopted by some cities that have achieve some level of success in energy efficiency in the urban milieu. In an attempt to meet the Mayor Michael Nutter's goal of becoming the greenest city in America, the Philadelphia Business Journal reports on the January 20th, 2010[50], that an energy bill passed by the city council was passed into law. Thus from January 2010, New city government building are required to meet a higher energy efficiency standard. By meeting this standards of making every government building of about 10,000 square feet to obtain LEED Silver certification based on the guidelines established by US Green Building Council, the city aim at reducing city government energy consumption. Though this is a recent attempt of a city to enhance its energy efficiency, there had been previous attempts through regional planning measures that have been recorded and adapted by the U.S. Department of Energy (1996, p.42). Since the early 70's, various regional scenarios were created to assess its impact on the energy efficiency gains with emphasis on transportation energy. Thus though this looks like single person initiative, there are quite a number of examples where communities have undetaken pragmatic and innovative steps towrds the development of energy efficient communities.

6.2.1 Saarbrücken, Germany

The position by Craig B. Smith on Energy Management Principles (Smith, 1981) has been supported by many cities of which Saarbrücken[51] is popular. As indicated in the extract from the database 'SURBAN - Good practice in urban development', at the beginning of the 1990s, the local energy policy was upgraded with the elaboration of the Energy Study 2005, which aims to reduce the environmental burden of energy supply and use by reducing the CO_2 emissions at least 25% by the year 2005 (European Academy of the Urban Environment, 2001). The general policy initiative that was pursued by Saarbrücken include;

1. the setting up of large energy-related financial support programmes;
2. the introduction of a direct installation programme for households;
3. the introduction of least-cost planning for trade and industry customers;
4. the introduction of variable linear electricity tariffs;
5. the vigorous information campaigns;
6. the commitment to the promotion of renewable energies;
7. transforming the energy utility from an energy supply company into an energy service agency;
8. The dissemination of activities inside a number of organisational energy networks (European Academy of the Urban Environment, 2001).

[50] http://philadelphia.bizjournals.com/philadelphia/blogs/real_estate/2010/01/phila_requiring_higher_energy_efficiency.html
[51] The City of Saarbrücken is the capital of the Land Saarland, the smallest German Federal State. It has a population of nearly 200,000, and covers an area of 168 square kilometres. It is situated in the Saar Valley along the French border which had been a traditional coal producing region.

The Saarbrücken Stadtwerke (the city's municipal energy company) have been phenomenal by the various initiative, policies and actions that it has introduce to ensure Saarbrücken become a flagship of an energy efficient community. These policies of the Saarbrücken utilities coincided with the national political objective demanded by the German Enquete Commission in the Measure for the Protection of the Earth's Atmosphere, as well as with the aims of the national conservative-liberal government as of that decade. In consequence, the City of Saarbrücken and the Saarbrücken utilities took on the responsibility to act as a pilot project for the whole of the Federal Republic in order to establish a practical test case for the active implementation of energy-efficiency measures and the promotion of renewable energies (European Academy of the Urban Environment, 2001).

In giving examples of cities that have achieved great strides in energy efficiency and its worth learning from, Beatley (2000,p. 264), mentions that a reduction of 53% in heating consumption from the period of 1981-1996 was achieved by Saarbrücken. The city authorities, he said,saw that in other to reduce energy consuption, it had to take the first step of enhancing the efficiency of its own buildings and reduce its energy consumption.This according to them had immediate control and can set positive example for the citizens. Among some of the actions that Saarbrücken undertook to conserve and create and energy efficient city include;

I. Directing housekeepers and building Managers about appropriate levels of heating (for example, offices and school room etc. heating was set at 20°C and 12°C for stair wells) during the day;
II. Monitoring of electricity consumption by building managers for record keeping and analysis (Beatley, 2000, p. 264);
III. Improvement of the insulation capabilities of the buildings and intallation of energy efficient doors and windows by investing about 540,000 USD (Beatley, 2000, p. 264);
IV. Granting incentives in the form of low interest loans to home owners for improvement and rebates for purchase of energy efficient appliances and for conversion of water heating from electric to gas (Beatley, 2000, p. 268);
V. Creation of an impressive information Centre with resources to help residents with energy issues. The help to distribute free electric consumption meters and help citizens calculate the energy consumptions of their home was also initiated. As an icing on the cake, the presence of a physical model of an energy efficient town helped the residents to visualise the vision of the municipality with energy efficient strategies incorprated in the communities (Beatley, 2000, p. 267);

VI. The solar cycle management includes 260,000 square metres of solar-suitable roof surface;

VII. Saarbrücken has succeeded in implementing two of the largest solar photovoltaic projects in the European Union. The Solar House project (8 kW) started in 1988 as a demonstration model for the solar power from Saarbrücken rooftops. The intention was to encourage people to invest in their own energy supply system;

VIII. The total energy unit is a tandem photovoltaic and block heat power station at the Saarbrücken Innovation and Technology Centre SITZ' (European Academy of the Urban Environment, 2001);

Box 6-1: Results and Impacts of Saarbrücken Energy Concept

After being awarded the UN Environmental Prize at the UN Climate Conference in Rio in 1992, the Saarbrücken Energy Concept have chalked many successes among which are;

- A CO_2 emission reduction of 15% was realised between 1990-1996 for the energy and traffic sectors;
- In 1994, Saarbrücken generated over 95% of its own electricity - mainly with environmentally compatible coal-fired CHP stations (in 1980 the share was only 30%);
- The share of piped energies, gas, and district heating is more than 80%;
- Between 1980 and 1989, SO_2 emissions were reduced by 76%, NO_x emissions fell by 34%, and CO_2 decreased by 15% despite the use of coal as the mainstay of energy supply;
- If you compare the CO_2 emissions between 1980 and 1997 for the municipal buildings, the results have been striking. The heating energy consumption and CO_2 emissions fell from 176 GWh (45,100 tonnes $CO_{2)}$ in 1980 to 72 GWh (12,900 tonnes $CO_{2)}$ in 1997. The electricity consumption fell from 20 GWh (23,600 tonnes $CO_{2)}$ in 1980 to 17.4 GWh (20,100 tonnes CO_2) in 1997. Over one-third of the city's space heating needs are met on a voluntary basis now;
- In 1997, about 50 mostly privately-owned photovoltaic systems were delivering some 250 kWh and 200 kWh of solar energy per annum to the municipal electricity system. The municipal utilities pay their solar power suppliers a fee of 55 pfennigs per kWh;
- The public transport sector contributes to the reduction of emissions as well. For example, the municipal vehicle fleet has converted 40 buses and 200 other municipal cars to natural gas. In the coming years, the rest of the buses will also be converted to natural gas;
- Since 1980, the number of gas heat customers more than doubled from 12,000 to over 24,000, and the number of district heat customers increased from 7,000 to 21,000;
- The new tram system has been running since October 1997, and is used by more than 25,000 people each day. The ambitious goal is to reduce individual car traffic by 20%;
- All of these things sustain the rapidly expanding market in non-polluting energy and energy saving devices.

Source: (European Academy of the Urban Environment, 2001)

As if the above impacts was not enough to shout out the success of the energy efficiency strategy of Saarbrücken, the solar and wind energy aspect of the energy efficiency startegy became also a flagship. It became a basis for supporting basic research projects, made available funds for private power suppliers of solar energy and also introduced linear tarriffs for the use of solar and photovoltaic energy. More so, the training being offered on Solar Architecture apart from the advice is also worth mentioning.

6.2.2 Heidelberg, Germany

Heidelberg is at the forefront of environmental protection in Europe and has cut CO2 emissions by over 15,000 tons per year in municipal buildings since 1993. The city has developed a comprehensive energy management system for local authority properties and has been involved in a wide range of projects for sustainable development.

From 1993-2004, CO2 emissions from municipal buildings and university facilities (1999-2002) were reduced by 35% and 13% respectively. The city uses civic forums to ensure community participation and aims to cut CO2 emissions by 20% before 2015.

Figure 6-2: Aerial View of Bahnstadt in the City of Heidelberg

(Source: Presentation by Dipl. –Ing. Alexander Kröhn)[52]

The city has developed a comprehensive energy management system for local authority properties and has been involved in a wide range of projects for sustainable development. From 1993-2004, CO2 emissions from municipal buildings and university facilities (1999-2002) were reduced by 35% and 13% respectively.

[52] http://www.dfhk.fi/fileadmin/user_upload/Projekte/Veranstaltungen/Heidelberg_20091105_-_Helsinki_v4_eng.pdf_accesed 28-01-2010

The city uses civic forums to ensure community participation and aims to cut CO2 emissions by 20% before 2015. The Heidelberg Energy Saving Regulation aims to promote energy efficiency and renewable energy in new and retrofitted buildings. One initiative with new solar thermal modules on rooftops has saved 320,000 kWh of heat since 1993; other solar thermal installations totalling nearly 5000sq metres are used for public swimming pools.

Developers must ensure that non-municipal buildings have high levels of energy efficiency, in order to receive planning permits. Some developments are completed with heating requirements far in advance of the city's official requirement for new housing. Heidelberg has a history of using civic forums to make decisions.

The city sets up a forum and prepares the agenda and minutes for all stakeholders to have the right to put an item on the agenda. Working groups and roundtables for individual projects or actions meet regularly to make decisions. Participation is voluntary but there are high levels of response, as many stakeholders see the need to cooperate and the potential of energy-saving activities for their own work. In 1997, the first forum on the topic of energy was created, paving the way for the establishment of the local energy agency in 2000.

This forum developed and became the Heidelberg Climate Protection and Energy Circle, comprising all stakeholders from the energy and climate sectors together with key civic partners. Participants discuss and develop strategies and projects and make recommendations for city policy. Results Best practices of buildings and building pools in 2004, Heidelberg commissioned the Institute for Energy and Environmental Research to evaluate the city's activities since its 1992 Climate Protection Strategy and to undertake a CO_2 audit.

The Institute developed a list of 43 recommendations and measures for the energy sector, based on the findings and the outcomes of stakeholder consultations. The focus of these measures comprised 8 categories – cross-cutting; municipal organizations; private households/housing associations; services, businesses and industry; public bodies (other than city); US army; energy-related services and products; and energy supply.

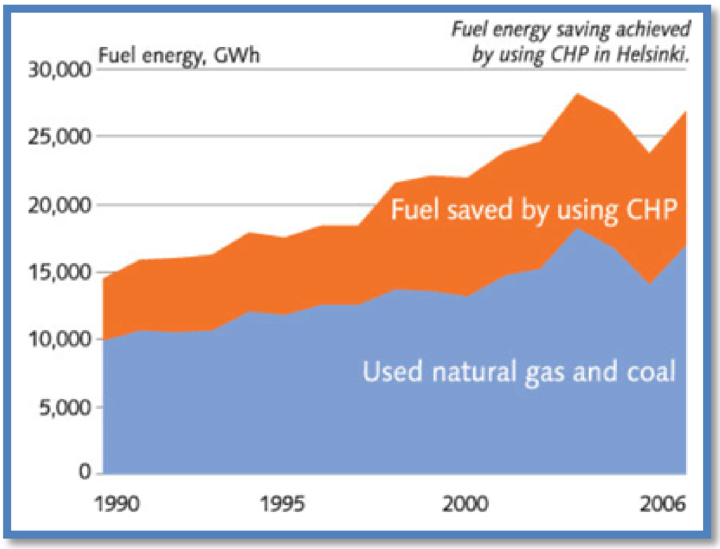
The Heidelberg Climate Protection and Energy Circle are responsible for implementation of the programme through projects, with political legitimacy provided by council approval. In 2006-7, projects have included energy-saving in church parishes, schools and sports clubs; optimization of urban energy planning in city districts; sustainable business activities for SMEs; optimization of ventilation in university buildings; and an energy and CO_2 audit for the whole city (excluding transport). Around €470,000 is provided for the support programme for rational energy use, which provides grants for energy upgrades such as roof insulation or window replacements. The annual financial savings for the city are €1.7 million compared to 1994, although the Office for Environmental Protection, Trade Supervision and Energy say that it is difficult to break this down and identify specific investments or savings from individual projects.

6.2.3 Helsinki, Finland[53]

Another best practise example is Helsinki, in Finland with a population of about 561,000. Helsinki has an environmentally and economically viable system of district heating and cooling that reduces emissions in the city by 40% a year - an average 2.7 Mt CO2 annually. Primary energy saved amounts to 9700 GWh in the Helsinki Energy system with annual financial savings of about 346 million Euros. A world-leading heat pump plant is playing an important role by recycling sewage to generate heating for the city - it's one of a number of innovative strategies that are cutting fossil fuel use in Helsinki and helping to meet the City's targets to reduce greenhouse gas emissions by more than a third of the current levels by 2030. Energy remains the leading source of GHG emissions in Helsinki and consumption of energy is projected to rise. Thus, extending DH in new suburbs, DC in the city centre, maintaining the efficiency of the system and improving the efficiency on the consumer side, are key issues now and further on. The substitution of fossil fuels with biomass and other carbon-neutral sources will take place in the future. Other measures will focus on low-energy city planning and buildings, efficiency and energy saving training for proprietors and consumers, improved procurement, etc. The city-owned Helsinki Energy company is responsible for infrastructure investments and operations. Investments have focused on improving the eco-efficiency of DH and DC plants (from 2005-2007, total investment USD 77 million) and were mainly self-financed, with some additional state subsidies in the heat pump plant project.

Figure 6-3: FUEL ENERGY SAVING ACHIEVED BY USING CHP IN HELSINKI

[53] Source: http://www.c40cities.org/bestpractices/energy/helsinki_heating.jsp accessed 28-01-2010



Source: http://www.c40cities.org/bestpractices/energy/helsinki_heating.jsp accessed 28-01-2010

The Helsinki Metropolitan Area, comprising four cities and 1 million people, has high per capita energy consumption compared to other large Nordic cities - over 6 t CO_2eq per person. This, however, is relatively low in Finland, as there is little heavy industry in the region. The Helsinki Metro- Area has reduced its GHG emissions from 1990-2000 by 5.7%, a cut largely due to a 12.8% fall in Helsinki city. This fall is largely attributed to improved energy efficiency in energy production and reduced use of coal for generation.

Local air quality has improved through DH, as it has practically replaced house-specific heating equipment and chimneys. Moreover, CHP and DH lead to decreased energy bills and much lower emissions. DC has the same effect, using natural resources and technical measures for services that could be inefficiently produced using building-specific equipment. DC frees up space in buildings by reducing the need for compressors, fans and condensers. It also reduces urban noise and vibrations from cooling equipment. This means property owners can increase their space, reduce installation and maintenance costs of equipment, plus improve the indoor environment, as well as reduce emissions. The overall lifetime of DH or DC systems is much longer than that of a building-specific unit.

Helsinki Energy produces over 90% of the heat demand of the city in CHP plants with over 93% of buildings connected to the District Heating (DH) network. Power is generated in the same process, exceeding the consumption in Helsinki. Hence, excess electricity is sold to the Nordic market, generating revenues for the City. DH and DC are local products available to households - they compete with other heating and cooling methods and customers choose what to buy on a free market. While the main sources of CHP production in Helsinki are gas and coal. A growing part of DH and DC energy is based on resources that otherwise would be wasted. This means the efficiency of the CHP system exceeds 90%, generating an annual saving of 40% CO_2 emissions. Future plans will shift generation further away from fossil fuels to renewable sources. District Cooling (DC) is outsourced production and distribution of cooling energy for air-conditioning and cooling of offices and residential buildings. DC is delivered to customers via chilled water in a separate distribution network. During winter, cooling energy is obtained from cold seawater through heat exchangers. In summer, condensing heat from power generation is diverted to absorption chillers for DC, which increases the efficiency of thermal power plants.

Additionally, a heat pump plant utilizes waste heat energy from purified sewage. This facility opened in 2006 and is the world's largest production plant, combining DH, DC and heat capture from sewage water and sea water. This plant has a 90MW capacity for DH and 60MW capacity for DC, and is projected to cut CO_2 emissions by 80% compared to alternative forms of production.

6.3 ECO-RESPONSIVE COMMUNITIES

From an ecological perspective, urban development affects the layout configuration of the urban and the natural landscape by altering the size, shape, interconnectivity, and composition of natural patches. According to Alberti, 2005, it also produces a variety of unprecedented and intense disturbances through physical changes in the landscape. He further stipulates that various configurations of the urban structure imply alternative outcomes in the mosaic of patches and, thus, differential effects on ecosystem function. Since urban development alters ecological conditions through physical changes, alternative urban patterns are expected to generate differential ecological effects (Forman and Godron 1981; Alberti, 2005, P. 172). It is therefore important to understand through the studies of some communities which have through urban management, planning and governance principles, succeeded in creating communities that are responsive to the ecological environment.

Changes in land cover affect biotic diversity, primary productivity, soil quality, runoff, and sedimentation rates. By altering the availability of nutrients and water, urban activities also affect population, communities, and ecosystem dynamics. Urbanized areas also modify the microclimate and air quality by altering the nature of the surface and generating large amount of heat. (Alberti, 2005, p.174)

6.3.1 Ecolonia- Alphen aan den Rijn, Netherlands

Initiated in 1991, Ecolonia was a joint venture between Novem and Bouwfonds, with support of the Netherlands Ministry of Housing and Spatial Planning and Environment, and the Ministry of Economic Affairs. Ecolonia demonstration project is a part of the town Alphen aan den Rijn, which is located in the Dutch ”green heart” between Amsterdam, The Hague, Rotterdam and Utrecht. This central location was an outstanding argument for accepting Alphen aan den Rijn as the small town which is best suited for a demonstration project in the field of ecological urban development. The sustainable town planning project at Alphen aan den Rijn was commissioned by the Dutch national Environmental Agency in order to gain experience in the field of ecological town planning, as well as in the area of ecological architecture. The site belonged to the city council and was originally marshland that lay below sea-level. Ten years before the projected started, the land had been artificially drained by pouring on a three-metre deep layer of sand. The only natural characteristic of the reclaimed land is the watercourse (Rovers, 2000).

The policy goal that steered the success of this project was to show that the sustainable building is possible in a city of population, 68000 inhabitants using current knowledge and techniques; identify the gaps in this knowledge and augment it with acquired information; and to build and sell 101 single-family dwellings for the housing market.

Figure 6-4: Project Site for Ecolonia within Alphen aan den Rijn, Netherlands

Source: *Team Crazy Kitten. http://www.except.nl/overig/yale/sem5/sustainabledesign/Ecolonia.pdf_accessed 13.11.10*

This demonstration project at Ecolonia according to Rovers (2000) is a remarkable achievement as it endeavours to incorporate the following areas of sustainability in the development;

- emphasis on heterogeneity in urban planning and architecture in order to test different ecological approaches;
- rainwater utilisation;
- use of passive and active solar energy;
- implementation of energy saving concepts;
- reduction of water consumption;
- use of durable materials;
- design of flexible layouts;
- designing special soundproofing;
- Special attention to the aspects of healthy living.

The entire project was conceptualised to demonstrate the usage of the inter-disciplinary approach in ecological urban development. Consequently a joint action of the Netherlands Agency for Energy and the Environment (NOVEM) and the Ministry of Economic Affairs supported by the Ministry of Housing, Physical Planning and the Environment (VROM) yielded the preliminary studies, feasibility studies and the guidelines for environmental building and conservation. The aim was to achieve a far-reaching consensus on the guidelines of environmental building and environmental conservation principles in order to identify the greatest possible basis for a sustainable estate (Rovers 2000). Subsequently, national policy guidelines for ecological urban planning paid special attention to the areas of **energy extensification, flow management,** and **quality improvement**.

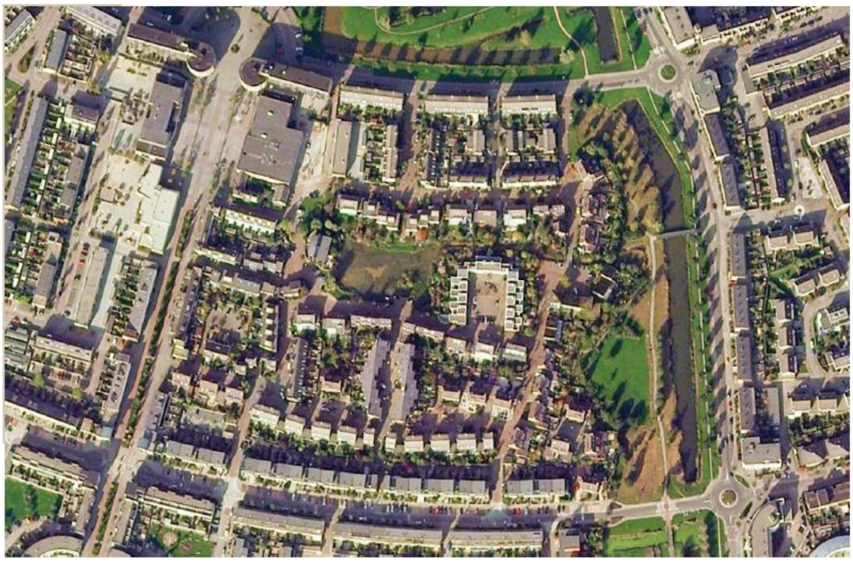


Figure 6-5: Aerial View of the Ecolonia Project

Source: Team Crazy Kitten[54].

The following ecological concepts have been put into practice:

1. Energy efficiency;
2. Minimisation of heat loss;
3. Solar energy use;
4. Organic architecture and durable materials;
5. Flexible construction;
6. Soundproofing;
7. Healthy building;
8. Bio-ecologically sound buildings;
9. Water consumption minimisation;
10. Traffic control;
11. Landscape concepts;
12. Social community concepts.

In addition to the above the architects had to consider that the demonstration projects had to comply with the requirement of creating serialised buildings which are not limited to specific target groups but which will attract a wide range of buyers and will be affordable to most people. Thus the three focal areas of eco-responsiveness as explained by rovers (2000) were;

a. **Energy extensification:**

   - the loss of heat should be reduced by the insulation of the individual houses, the installation of shutters (outdoors), and favourable positioning in relation to insulation;
   - solar energy should be used through the incorporation of special garden rooms and sun lounges, as well as the particular zoning of room space;
   - Energy consumption should be reduced by a conscious building process and the energy consumption per residential unit was limited to a maximum of 300 MJ / m^3 (low energy building materials, avoidance of energy-consuming construction methods).

b. **Flow Management (Integral chain management):**

[54] http://www.except.nl/overig/yale/sem5/sustainabledesign/Ecolonia.pdf_accessed 13.11.10

- extra thought has to be given to the reduction of water consumption and the re-use of building materials (installation of flush toilets with minimal water usage, low-flow showers, apparatus with water-saving fixtures, selection of re-usable and renewable building materials, maximisation of the number of components that can be easily dismantled for re-use, installation of wooden floors between storeys as well as mineral wool in ceilings as a measure for noise insulation);
- special attention should be given to the use of ecological materials and the commitment to so- called organic architecture (careful selection of materials and components [e.g. cedar wood or European or Canadian hardwood instead of tropical woods], maximum use of granules from used concrete and brick, careful choice in the form and structure of spaces and building elements);
- The planning and implementation process should be open to flexible changes in construction and functions (creation of adaptable and easily extendible buildings, catering for combinations of living and working in the houses).

c. **Quality improvement:**

- one focus of quality improvement should be noise insulation inside and outside the house (especially soundproofing in facades and between rooms and installations, integration of a hanging system with rail of boards as fixed elements in order to avoid hindrance from drilling of holes in walls, provision of removable inner walls);
- health and safety should also receive special consideration (provision of open crawls in order to avoid radon gas, placing of smoke detectors in living and sleeping areas, use of fireproofed materials, extra fireproofed doors, fire escape routes with an attic window, placing of a straight staircase, entrance doors with safety glass, washing and drying facilities on the same floor, use of floor heating, avoidance of skirting-boards and wooden thresholds, installation of hanging kitchens and toilets, no dust collection corners);
- Use of bio-ecological building principles and materials (avoidance of negative electromagnetic fields, use of non-toxic and water-soluble paints etc.).

In accordance with the construction guidelines the builders had to integrate certain themes of sustainability apart from the unique ecological profile of each of the nine Architects who were engaged for the project. In brief, 61 dwellings of the total of 101 buildings have heat-recovery controlled ventilation systems, 32 have mechanical ventilation without heat recovery, and the remaining eight dwellings are naturally ventilated. At nearly 80 dwellings solar collectors have been installed to the south. The east-west oriented buildings had not been equipped with solar collectors as the energy savings proved to be too low. Photovoltaic were rejected on financial grounds.

More so, the minimisation of heat loss was the theme of a group of eighteen dwellings. Measures include wall construction of 120 mm thick limestone and a 130 mm thick solid thermal skin covered with 15 mm of plaster, the installation of blinds to provide shade in the summer, the equipping with particularly small windows to the north side and large ones to the south. Ten dwellings in five twin houses were especially designed to experiment with the use of solar energy. These buildings use passive solar energy, as living areas are oriented towards the south and are fronted by a single-glazed conservatory for passive solar energy gains. All buildings are fitted with solar collectors for water-heating. Another group of eleven buildings incorporate passive and active solar energy use as they have additional solar collectors on the roof. Although organic architecture was the theme of another twelve houses, ecological criteria like durability, maintenance level and embodied energy were all fundamental principles of their design. Cavity masonry of lime stone and burnt bricks were selected for massing. The roofs were covered with ceramic pan tiles whilst European wood was used for the windows and untreated cedar wood was selected for other wooden parts.

Ten buildings demonstrate the advantages of flexible dwellings. Such houses have flexible external wall modules, changeable floor plans, moveable interior walls and variable installations. The inhabitants can alter both a room's space as well as its function. An ensemble of staircase, supply shaft, and WC forms the core of the floor plan. The remaining rooms, including the kitchen, can be expanded or removed. Other ten buildings, which are designed by the Eindhoven Technical University, are test cases for soundproofing. The measures include low-noise heating and ventilation systems, the concentration of high noise-level rooms (kitchen, bathroom, stairwell, entrance) at the back of the building, noise protection in the remaining rooms by 150 mm limestone walls, and special construction of the bedroom (the quiet room) with an extra insulated timber frame and sound-deadening doors.

Apart from that the twelve ”healthy buildings” which were also part of the demonstration pay tribute to the fact that health risks, such as allergies or psychological well-being, are increasingly becoming important factors of building design. The special design of these houses is characterised by sub-floor space heating, a vacuum system for the prevention of dust circulation and small landings on staircases where as particular attention was given to the prevention of ”cold bridges”. Finally, the area of bio-ecologically sound building saw the equipping of eight buildings with a solar collector for radiant heating walls which are developed in co-operation with industry. The problem of electromagnetic smog was dealt with by covering the floors with 20 mm thick cork flooring and the painting of walls with natural paints while all these buildings were naturally ventilated.

However, some challenges were also experienced during the implementation process. The co-ordination process proved to be very time-consuming as departmental responsibilities had not been bundled up. Administrative insistence on sole responsibilities and inexperience in executing a sophisticated model project had to be overcome at a number of workshops and informative sessions. In consequence, the funding approval process came under pressure and, therefore, a lowering of the ecological standards had to be accepted. Nonetheless, in order to disseminate the acquired know-how on sustainable methods of town planning, an information centre was established.

6.3.2 Slagelse, Denmark[55]

The municipality of Slagelse is the largest of four urban centres in Vestsjaelland County in Denmark. The town is situated 80 km south-east of Copenhagen and has 35,000 inhabitants (30,000 of which live in the town of Slagelse). It is a regional economic centre located on the main road and rail connection between Sjaelland and Fyn. The "Green City" project of the Danish town Slagelse is the heading for a number of urban renewal and development projects which over the last decade have positioned Slagelse as one of the leading municipalities in the promotion of sustainable urban environment. The general objectives are to integrate environmental and ecological considerations in strategies of urban planning and to promote and intensify the instances of public participation. In 1986, the Municipality of Slagelse embarked upon the "Slagelse Green City" project, an overall strategy to incorporate "green ideas" in both private and public activities. In the frame of the project, many major subjects' areas dealing with effects on the urban environment are touched: waste, water, energy, urban green spaces, ecological building renewal, or traffic. At the national level Slagelse Green City has functioned as an exemplary pilot project from which valuable conclusions have been derived. The Slagelse "Green City" project is an outstanding and exemplary initiative for several reasons:

- the project is explicitly shaped to bring environmental problems to public consciousness,
- it provides and improves opportunities for public participation,
- principles of integrated planning at municipal level are developed and applied,

[55] http://www.eaue.de/_accessed_18th_January_2011

- besides technical aspects, social, aesthetic and artistic aspects of the project are considered,
- It aims at national dissemination.

The "Green City" project is centred on the renewal of an area comprising eight blocks with 770 dwellings and 1,500 residents in the old centre of Slagelse. Dilapidated housing, poor public space conditions and a heterogeneous population, many with low or no income, had led the area to fall prey to urban and social decay and had necessitated alleviating and precautionary action by the municipality. While the Municipal Council was considering to subject the district to urban renewal measures, it was approached by a group of architects, engineers, and planers interested in developing and testing ecological urban renewal concepts. As a follow up to the implementation of the ideas from this project, The Danish Ministries of the Environment and Energy and of Housing and Building have initiated exemplary international standards which is used to measure nationwide taxes on ambient and solid discharges or on energy use and the publication of guidelines, e.g. for the re-cycling of building materials.

Thus, experiences from the Slagelse Green City project are mirrored in national activities while at the same time national initiatives have often influenced the choice of individual sub-projects and substantially supported their execution. Therefore, the Slagelse Green City project pursues several interlacing goals. First and foremost, the aim is to improve the environmental and living quality in the district for the benefit of the inhabitants. This concerns purely physical improvements of the dwellings and communal space, such as reducing discharges and pollution or improving the urban climate. It also concerns the enhancement of the social, interactive characteristics of the area. Closely connected to the latter concern is the goal to involve the residents with their concrete ideas in designing and carrying out the individual projects. The aim is to give them a sense of responsibility for their neighbourhood and its environmental condition as well as a meaningful and viable opportunity to act on it. In this process, different approaches to public participation in planning and implementation are explored.

In 1988, execution of the first projects began. Since then numerous projects have been carried out in the 'Green City' district but also in other parts of the town. Strategic mainstay of the "Green City" project is to proceed in phases by implementing several smaller trial projects. This allows testing different approaches and measures. Another advantage is that these consecutive projects can more easily be scheduled in accordance with financial means available at the time.

The Municipality's Division of Technical Services and the Department of Planning held the responsibility and took over the day-to-day planning of the project supported by the participation of the residents and owners of the area. To this effect, a *Green City Office was set up* to encourage public participation in the ecological renewal. Thus the Green City office which functioned as an informational and communicational link between the municipality and the residents was maintained within the renewal district from 1988 to 1990. Its main objective was to inform the residents and owners of the district as well as the rest of Slagelse of the projects planned and their opportunities to get involved. In addition, it sponsored public meetings and film presentations, excursions to renewable energy facilities and other educational programmes, and kept close contacts to the local media. With the objective of implementing a project that would access information on Green City whilst increasing both the green infrastructure and bio-diversity, it manages to achieve it water recycling objectives. Slagelse Green City project also had increment of the usage of eco-responsive building materials and usage renewable resources whilst reducing energy consumption and water consumption as additional objectives. To achieve this goal the city used the following strategies;

a. Making the project a demonstration and a pilot one
b. Usage of integrated planning approach
c. Preparation and usage of new environmental policies and regulations
d. Usage of public participation

Consequently the resultant ecological –responsive interventions include;

I. Passive and active solar energy use which was introduced in one of the first projects initiated in 1989 was the renewal of the three typical residential buildings as demonstration projects for passive and active solar energy use.
II. Reduction of waste. From 1990 to 1992, first experiments with waste sorting were carried out in the *Green City district.* Paper, glass and compostable waste were separated and transported to centralized recycling and composting facilities. During implementation, the municipality tested different approaches toward informing the residents about the issue and motivating them to participate in the project. The residents were instructed about the system through the press, mailed out leaflets of different formats, and through questionnaires and interviews. Another method was to leave notes in the waste bins in cases of incorrect sorting. In subsequent waste projects in other quarters of Slagelse home composting was introduced (provided the required yard space is available), which led to much greater success than centralized methods (in a very homogeneous area with detached

houses, the participation rate was close to 100%). Since the residents can utilize the compost produced themselves, they are more easily motivated to participate.

III. *Re-creation of open space in the Valdemarsgade Area which helped* establish ecological open space areas within two blocks of the area and re-builds the street as a semi- private zone where people can interact. The aim is to demonstrate a wide range of examples of how ecological considerations can be met in areas like these. The project area covers the two blocks north and south of Valdemarsgade and comprises about 148 houses with approximately 260 residents. It contains roughly 4,000 m2 of communal area open space, adjoining 6,600 m2 of private yards.

After a decade of experiences gathered from the Slagelse Green City project, many results have become visible. On the whole, success of the projects to a great extent hinges on the engaged and enthusiastic involvement of individual councillors, administrators, and residents. In first evaluations it was possible to draw some important lessons and give important procedural hints for future activities.

As far as tangible results are concerned, the Green City Project has so far been a success. For example, an immediately visible result of the Valdemarsgade open space project is that insects such as dragonflies and water striders and other animals have arrived. As the plants mature over the following years, these are expected to become even more noticeable. On the whole, living quality has been increased substantially. Through the project, at least among those of the residents actively involved, social networks and exchange have been developed and strengthened. Similarly positive responses were expressed by the residents of the renewed buildings.

Regarding economic considerations, experiences from the projects show that many initiatives for ecological measures can be taken at no or only limited extra costs compared to regular spending levels for urban open space improvement. These measures include the choice of alternative materials for fencing, planting and paving and singling out areas for purposes such as gardening or domestic animals. At only limited extra costs, rain water filtration and butts, local composting facilities and small solar cells, e.g. for outhouses, can be integrated. Substantially exceeding the normal cost range are measures such as large-scale solar installations, green houses, or espalier constructions. Instructive results could also be derived from the public information and participation campaigns carried out. Participation proved to be most effectively encouraged through direct contacts with the residents, e.g. in interviews, and by regularly informing them.

Regarding the level of public participation in more comprehensive projects, several important conclusions for the procedural structuring of future projects could be drawn:

1. To instigate public interest and involvement, projects must concern issues that are important to the people in an immediate and day-to-day way, i.e. activities should be concrete and not remain on a theoretical level. Positive results were obtained from initiating social activities to bring the residents together.
2. Sustained and long-term involvement of the residents in the renewal demands that their ideas are not only welcome as contributions to the discussion process but that they also become visible in actual features of the project itself.
3. Even though substantial time is required to mediate, initiate and follow up public participation efforts, the project time frame should be kept as limited as possible. Projects carried on over long periods without concrete results - i.e. with planning stages exceeding 6 months - are prone to lose the public's interest.
4. With respect to the personnel involved from the Municipality, administrators with skills in human resources are much more important for continued public participation than those with professional skills. To the active residents it is decisive that they meet people in the municipal system that can understand their concerns and respect their view-points.
5. Therefore, in addition to outward-directed public participation efforts, the compartmentalized municipal administration is well advised to find ways of internal, cross-divisional cooperation. This has proved to be difficult to achieve in Slagelse, although the newly established post of a green coordinator to mediate contact between the municipal divisions can be interpreted as a first meaningful result.

In summary, the Green City project has positioned Slagelse as one of the leading municipalities in the promotion of sustainable urban environments which has generated considerable political backing. Consequently, evaluation of the Green City project is continuing in order to disseminate the lessons of the project and further productive results are to be expected from future projects.

6.4 LESSONS AND DISCUSSION

From the above five European examples, it can be seen that despite the numerous imminent barriers the cities chalked some successes through collective efforts and leadership. From the above case study analysis, it is quite clear that energy efficient urban management is a core policy tool that can be utilised to achieve significant energy savings. However, the scale of interventions required for this policy in developing country cities is immense because of the complexity of their energy challenge (Nandi, et al., 2010, p.2).

The advisory and information centres set up for the citizens are what TSSA needs most. A lot of waste and inefficiency in the system could be attributed to ignorance and attitudinal problems. More so, when energy data collection and management for the various sectors are done with prudence, it helps in planning and forecasting which eventually leads to efficiency as well. Though most of the power plants and the systems used in this countries might be some centuries ahead of most communities in TSSA, the strategies utilised to achieve efficiency is timeless. The setting up of free training facilities for Solar Architecture and incentives for renewable energies and well as provision of research funding for universities and institutions can be achieved if there is the political will. All that needs to be done is to cut the budget for military and arms and increase that of research and development whilst corruption is made unattractive through good governance and vigilant law enforcement.

PART - 2

Analysis Of Second Level Case Studies

7 ANALYSIS OF SECOND-LEVEL CASE STUDIES

7.1 ELEMENTS AND STRUCTURE OF THE CASE STUDY ANALYSIS

The second level of case studies focuses on a number of selected study areas around the world which have successfully attempted to incorporate both concepts of Energy Efficiency and Eco-Responsiveness in the city development and growth. These are also grouped into two sections as indicated in figure 6-1 above. Due to the fact that the concept of Green cities development is still at the experimental stage in most regions of both develop and developing worlds, regional and climatic relevance to the focal case study was not included. In other to filter the numerous project with no or little relevance to the geographic setting of focal case study, the under listed quick analysis qualification criteria was utilised. These criteria for this selection were:

a. Representation for current Green Developmental trend;
b. Representation as either a demonstration or experimental project;
c. Availability of data and materials needed for the analysis;
d. The inclusion of Eco-Responsiveness and Energy efficiency as a criteria in the concept development of the project; and
e. Addresses one or more aspects of the research questions.

Consequently a section of these qualifying cases included selected **realised projects** which outline demonstration Green Cities like; Curitiba in Brazil and the Ecological city of Kronsberg, Germany. The second section of case studies analysed includes **on-going or planned projects** like; Dongtan Project in China; Masdar City Project in Abu Dhabi; and the Tianjin Project of Sino-Singapore located in China. A desk analysis of the project documentary papers, publications, journals, movies and maps was carried out to glean the relevant lessons that can be adapted for use in the TSSA geo-physical and socio-economic environment. The selected projects however represent a profile of the best practices of demonstrated cases as well as on-going ones.

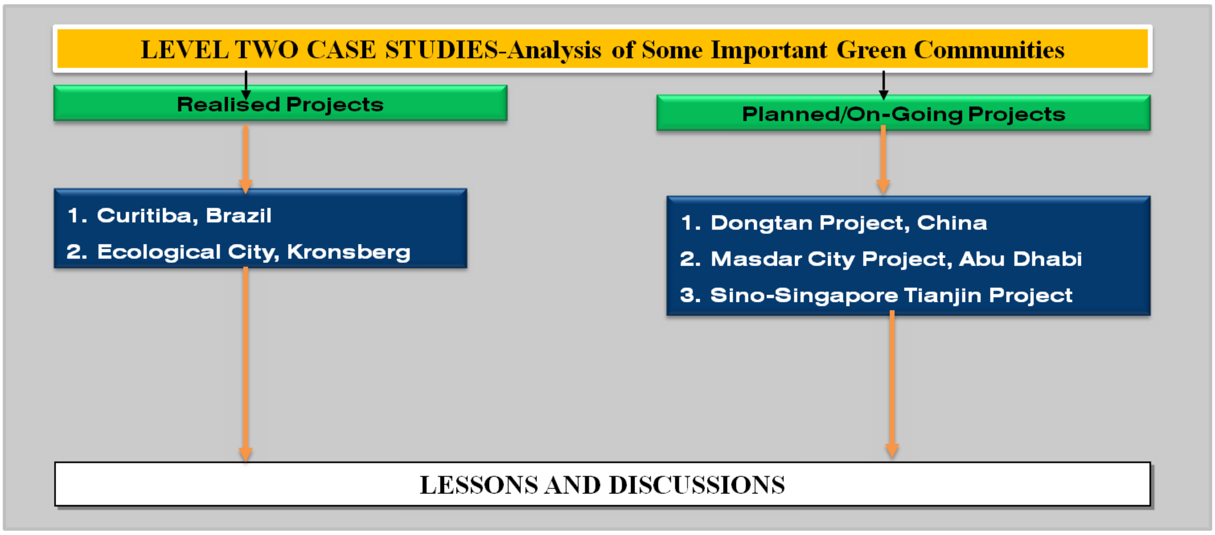


Figure 7-1: General Overview of Level Two Case Study

These past and current flagships of the Green city concept are endowed with many good and bad lessons that can help TSSA countries leapfrog into development of appropriate AFRO-GREEN cities.

The major selection criteria for this level of case studies are;

I. Representation for current Green developmental trend
II. Representation as either a demonstration or experimental project
III. Availability of data and materials needed for the analysis
IV. The inclusion of Eco-Responsiveness and Energy efficiency as a criteria in the concept development of the project
V. Addresses or more aspects of the research questions

In other to analytically describe those cases selected to glean the lessons for application to communities at TSSA, the elements were group according to the main objectives set out to obtain the goal. The objective elements were further expatiated into criteria. Further elemental indicators were also extrapolated from these criteria to enable a comprehensive descriptive analysis to be done. The content of the descriptive analysis of the case studies were categorised into three main objective elements comprising; Project Local Context; Project Urban Content; and Project Eco-City Context. These elements were further expatiated into the specific criteria that describe the named objective. The project eco-city context gives the local context a 3-Dimensional perspective and view of objectives which reflect in the criteria and indicators as well.

Figure 7-2: Structure of the Second Level Case Study Analysis

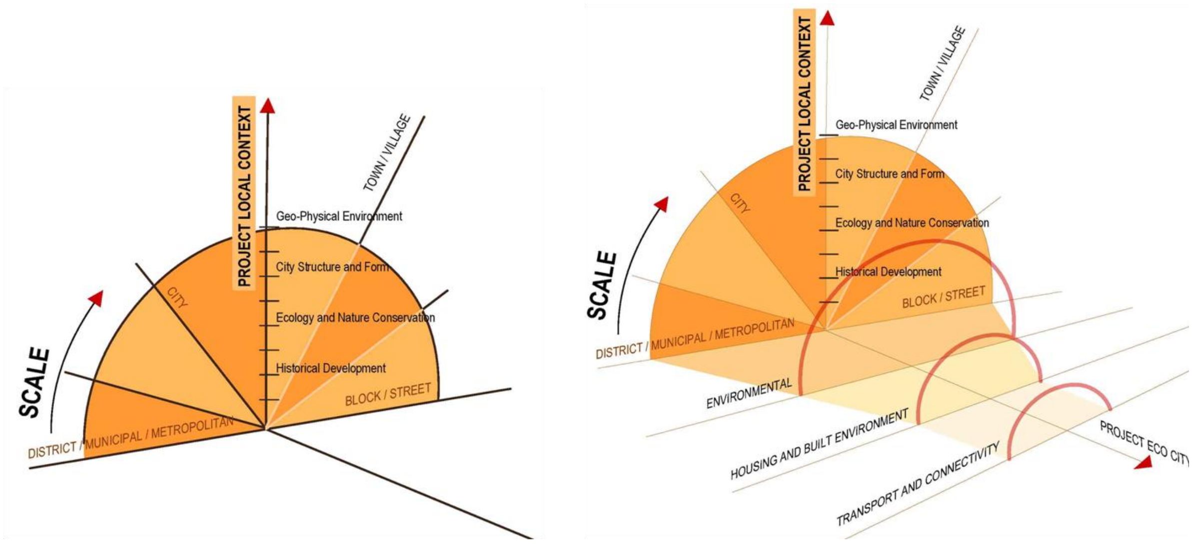
OBJECTIVES	CRITERIA	INDICATORS
PROJECT LOCAL CONTEXT	**Geo-Physical Environment**	✓Ground Conditions and Soils ✓Hydrology,Surface and Ground Water Resources ✓Topography and Geology ✓Climate, microclimate and exposure ✓Air Quality
	City Structure and Form	✓Land Use & Location ✓Image of the city ✓Size and Density ✓Urban and Open Spaces ✓Urban Shape and Pattern
	Ecology and Nature Conservation	✓Terrestrial & Acquatic Haitats and Communities ✓Plant and Animal species ✓Landscape Setting,strcture and type ✓Bio-Capacity ✓Ecological Footprint
	Historical Development	✓Formation and Growth ✓Change and Transformation ✓Demographic trend
PROJECT URBAN CONTEXT (Scale)	**District /Municipal/ Metropolitan**	✓Form ✓Activity ✓Features ✓Paths ✓Centres ✓Intrusions ✓Change ✓Improvement ✓Activity Structure ✓Orientation
	City	
	Town / Village	
	Block /Street	
PROJECT ECO-CITY CONTEXT	**Environmental**	✓Innovative, non-conventional, practical and sustainable. ✓Cost effective. ✓Easily maintainable. ✓Simple in design. ✓Creating visible impact. ✓Replicable. ✓Providing multiplier effect. ✓Using locally available materials and artwork. ✓Adopting design concepts that appeal/suit the local people. ✓Custom made state-of-art designs to suit local conditions. ✓Play a catalyzing/demonstrating effect.
	Housing and Built Environment	
	Transport and connectivity	

7.1.1 Project Local Context

This element seeks to reinforce the geo-physio-anthrogenetic dimension of the socio-cultural attributes of the community. These ranges from the analysis of the historical development of the city of project to the geo-physical environmental condition as indicated in figure 39 above. The criteria however include;

- Geo-Physical Environment
- City Structure and Form
- Ecology and Nature Conservation
- Historical Development

Figure 7-3: Modelling the form of the Case Study Analysis



Source: Author

- **Geo-Physical Environment**

One of the key factors that determine a projects or community local context is its Geo-Physical environment. The form of the land and its feature with the climate as well as the vegetation goes a long way to determine the form of the city and its local context. The Topography or the landscape can suggest the character of the city. The prominent landscape features like the cliffs, mountain peaks, ranges of hills on the horizon should be carefully noted for every project of community. More so, the local climate determines much of the character and appearance of the landscape and buildings

- **City Structure and Form:**

The city structure refers to the pattern or arrangement of the development blocks , streets, buildings, open space and lanscape which makes up the urban areas (REAL, 2007, p.33). It is the inter-relationship between all these elements and the landscape, settlement and movement that creates the framework for the structure of the city to be appreciated. The structure which provides the basis for detailed designed of the constituent elements also provides a coherent framework for individual designs to be implemented. The city structure provides integration through connection and overlapping of contingent areas; functional efficiency which is reflected in the working together of individual elements (building, streets); Environmental harmony through development forms that are environmentally sustainable and energy efficient and finally create a sense of place.

- **Ecology and Nature Conservation**

In an attempt to plan and develop cities that adjust its demands, lifestyles and technologies to evolve a compatible with the natural and cultural systems within its environments, the aspect of ecology and nature conservation has become vital in local contextualisation. The natural system behaviour and the functions of the provided facilities and land uses need to be synchronised by the taking a resource inventory prior to the planning and design stage. More so in applying ecological and natural conservation strategies in the development processes, fragmentation of habitats which causes loss of biodiversity could be minimised. More so, the scale and type of any potential community development ought to be determined by the capability and resiliency of the eco-system rather than the capacity of the site. Sensitive native plant species need to be identified protected whilst sensitive areas avoided. To crown it all, restoration of native planting patterns should be used when site disturbance is unavoidable during community development.

- **Historical Development**

The Local context of any community is appreciated by its history of development and planning. Hence under the historical development any previous planning and developmental efforts by the city authorities or traditional rulers would be examined and placed in context. This would basically provide the necessary information to explain why certain actions had why the city had developed through a particular pattern and why certain decisions were taken. In the event where neighbourhood re-vitalisation would be necessary, the historical development plays a significant role in identifying what went wrong during the developmental stages. This also serves as a source of information for future policy decisions that would affect the community in question. According to

Speiregen (2003), every city has a history linking to its origin and the present in the minds of the populace. Visible signs of that history can constitute a major aspect of its appearance (Spreiregen, 2003, p.4.3-15).

7.1.2 Project Urban Context

The case study urban context endeavours to assess the city's characteristics of culture, growth, and development in an urban nomenclature (Spreiregen, 2004; 4.3-10). This nomenclature is reflected in the physical form physical form and visible activity. However within the urban enclave with all the visible activity and form lies a sort of complexity which is usually taken as confusion (Spreiregen, 2004; 4.3-10). This complexity is an intense intermixture of complementary activities. Thus the criteria to assess this include analyzing the scale of the project and its morphology which includes;

I. District/Municipal/Metropolitan
II. City
III. Town/Village
IV. Neighbourhood
V. Block/Street
VI. Building

However within the urban enclave with all the visible activity and form, lies a sort o complexity which usually taken which is taken to be confusion or chaotic. This as explained by Spreiregen (2004) is an Intense intermixture of complementary activities which usually serves as a pivot for liveable community. The indicators used for the expatiation and analysis the above criteria comprise of;

- ✓ **Components:** What is the principal component the case study area (CSA)? Where do they begin and end? What are their characteristics, physically and as defined by activity? How apparent are they?
- ✓ **Size**: What is the size of CSA—its shape, density, texture, landmarks, space?
- ✓ **Appearance:** Regarding their physical appearance, what are the characteristics of building forms, building density, signs, materials, greenery, topography, route-pattern landmarks? What is the nature of the mixture of different building types?
- ✓ **Activity:** Regarding visible activity, what are the principal clues of the activity of an area—the kinds of people, when and how they move about? What are the key visual elements—the things principally seen—which establish the character of a district?

- ✓ **Threats:** What are the threats to a district? What external elements, such as a through road, threaten the health and survival of district? How is the CSA changing? Is it changing its position? Is an edge decaying? Is an edge advancing, perhaps into a peripheral district?
- ✓ **Emergence:** Are there latent districts or communities struggling to emerge, such as a new in-town residential section?
- ✓ **Relation:** How do all these parts relate to each other and especially to the route patterns of the CSA? Finally, what are the areas in a project area that cannot be classified easily, that lack cohesion in form and character? Are some of these targets for urban design work? (Spreiregen, 2004)

7.1.3 Project Eco-City Context

This is the objective that represents the overview of the eco-responsive interventions, visions or goals of project or case study under consideration. The main elemental objective chosen is a portion of the factors for sustainable communities as indicated by the Eghan's review report (Office of the Deputy Prime Minister, 2004).These include;

I. **ENVIRONMENTAL** – Providing places for people to live in an environmentally friendly way
II. **HOUSING AND THE BUILT ENVIRONMENT** – A quality built and natural environment
III. **TRANSPORT AND CONNECTIVITY** – Good transport services and communication linking people to jobs, schools, health and other services

Furthermore, a number of indicators which are used to ascertain the Eco-City Applicability[56] of the criteria above are also applied. In this regard a careful analysis of the various elements to identify if they conform to the basic standard of an Eco-City Project is carried out to ascertain that if the project is;

- Innovative, non-conventional, practical and sustainable.
- Cost effective.
- Easily maintainable.
- Simple in design.
- Creating visible impact.
- Replicable.
- Providing multiplier effect.
- Using locally available materials and artwork.
- Adopting design concepts that appeal/suit the local people.

[56] http://www.urbanecology.org.au/library/cities/ecocities/makecitiessustainregister.html

- Custom made state-of-art designs to suit local conditions.
- Play a catalyzing/demonstrating effect.

7.2 REALISED PROJECTS

In other to critical assess the Eco-City concept to ascertain its viability and develop-ability in contemporary times; some selected cities which that have adequate attributes to be termed as 'Green' are assessed. The cities chosen are;

(1) Curitiba, Brazil;

(2) Ecological city of Kronsberg, Germany;

CURITIBA, BRAZIL

Figure 7-4 (a): Panoramic view of Curitiba

Source: http://en.wikipedia.org/wiki/Curitiba

(b) Curitiba Streetscape (c) Bus stop waiting tu*bacityphotos.blogger.com.br/*

7.2.1 Curitiba, Brazil

In an era of global green revolution in every sphere of development, cities and urban planners are trying to devise ways to adapt to the new eco-responsive and energy efficiency planning guidelines and principles; Curitiba in Brazil has been ahead of the game for thirty years. Curitiba is an important cultural, political and economic centre in the country (Wikipedia, 2011).The Portuguese who founded a village in 1693 gave it the name of "Vila da Nossa Senhora da Luz dos Pinhais" (Village of "Our Lady of the Light" of the Pines). The name was changed to "Curitiba" in 1721. Curitiba officially became a town in 1812, spelling its name as Curityba. After much deliberations and changes a decree in 1919 settled the dispute by spelling the city name Curitiba. Curitiba's master plan helped forge a vision and strategic principles to guide the development of a model Eco-City. However, that vision was transformed into reality by reliance on the right systems and incentives, rather than on dogmatic implementation of a static plan (Fazzano, et al., 2004). As one of the fastest growing cities in a nation of urban booms, its metropolitan area mushroomed from 300,000 citizens in 1950 to 2.1 million in

1960. Its economic based changed drastically from agricultural product processing centre to an industrial and economic power house. The resultant impacts include: unemployment, squatter settlement, congestion and environmental degradation (Rabinovitch, et al., 2009, p.320).

Progressive City administrations turned Curitiba into a living laboratory for a style of urban development based on a preference for public transport over private automobile, working with the environment instead of against it, appropriate rather than high-technology solutions, and innovation with citizen participation in place of master planning (Rabinovitch, et al., 2009, p.321).

A. Project Local Context

- **Geo-Physical Environment**

Curitiba is a metropolitan area approximately 400km southeast of Sao Paulo, Brazil that stands on a plateau 932 m (3107 ft) above sea level in the Subtropical Zone of Southern Brazil. The City of Curitiba, according to Secretariat of the Convention on Biological Diversity (SCBD), is located in the First Plateau *Paranaense*, between the *Serra do Mar* (Mountain Range of the Sea) and the Devonian Escarpment of *Sao Luiz de Puruna*. The city is geologically based on rocks of Proterozoic Crystalline Basement (between 2.6 and million years old), Cenozoic Sedimentary Basin (up to 65 million years old) and Alluvium Sediments from the Quaternary and Cenozoic period. The entire metropolitan area is 430km² with a population of 2.3 million people, 1.6 million of which live in Curitiba proper (Fazzano, et al., 2004, p.4). First founded as a gold-mining town in the seventeenth century, the city of Curitiba was also part of the cattle-driving route to Sao Paulo. From there it gradually evolved into a trading post, attracting merchants at first, and then expanding into a developed city by the end of the nineteenth century. In 1854, Curitiba became the capital of the state of Paraná. Around the turn of the twentieth century, the region witnessed a large European immigration that left a deep impact on the city's culture. As a result, there is a distinct mixture of German, Polish, and Italian influences. The temperate climate - seasonal fluctuations only range from 13°C to 21°C – made the area ideal for agriculture (Fazzano, et al., 2004, p.4). The land is predominantly flat with flooded areas, which are qualities that contribute to the typical mild and humid winter in Curitiba, where the temperature ranges from 0 to 13 degrees Celsius. During the summer, temperatures are between 21 and 32 degrees Celsius. The city is located in a transitional zone between two types of Ombrophilous Forests - Mixed (Araucaria) and Dense (Atlantic) (SCBD,2008).

Figure 7-5: Location of Curitiba in Brazil

Source: Wikipedia, 2011

- **City Structure and Form**

It is much more compact and has a grid shape, with much higher density along the BRT (Bus Rapid Transit) corridors. In comparing density profiles and average distance per person to CBD (Central Business District) related to build-up area, Bertraud (2001) shows that both cities have an erratic profile but the distance to downtown in Curitiba is three times lower than in Brasilia, not exceeding 7.5 kilometres. Suburban cities in Curitiba are located at the immediate edge of the city, forming a ring around it. Less dispersion and shorter distances to CBD result in much smaller networks and shorter trips, and a much more efficient city. Curitiba is also a city shaped by urban ideology and utopia (Bertraud, 2001). Planners have conceived the city in such a way that urban form results in a pre-established pattern—a combination of land use zoning/regulation and transport transit planning—with three high-density corridors running from the centre to the periphery to optimize bus transport circulation. These corridors define a mono-centric structure concentrating jobs and establishing a density gradient. A clever mechanism allows property owners in low-density areas near the corridors to trade vertical development rights with developers who want to build areas of higher density in the transport corridor. Low-income high-density housing was built at the edge of the corridors. In terms of density distribution patterns, Bertraud (2001) reveals that due to the land market effect, higher densities are pushed to the edge of the corridors, resulting in a city where trips are much longer than they would have been if land use was not so strongly controlled and density gradients were solely free market shaped—decreasing from centre to periphery.

- **Ecology and Nature Conservation**

As indicated by the SCBD, (2008) 17.9% Curitiba's total area, is classified green area, and the ratio of green areas per inhabitant is 51.5 m2. Due to the large number of trees planted (300,000), differences in the date of planting and variation in size and height, urban trees are difficult to maintain. It is estimated that the trees resulting from urban afforestation activity contribute for a ratio of green area of 3.40m^2 per inhabitant. Of all the plantations made, there is a loss of 20-50%, depending on weather conditions, quality of the plant or vandalism.

The SCBD, (2008) goes further to explain that Curitiba is home of many species such as:

- 37 species of fishes, the most common being from the *Astyanax spp.* (lambaris);
- 35 species of reptiles, with a predominance of snakes (*Liotyphlops beui, Atractus reticulatus, Philodryas patagoniensis, Liophis miliaris, Sibynomorphus neuwiedi, Oxyrhopus clathratus*);
- 8 species of amphibious (*Bufonidae, Leptodactylidae and Hylidae families*);
- 200 different types of birds (*Turdus rufiventris, Pitangus sulphuratus, Furnaris rufus, Rupornis magnirostris, Polyborus plancus, Vanellus chilensis, Columbina talpacori, Troglodytes aedon, Zonotriachia capensis,* etc);
- 37 species of mammals such as wild dogs (*Cerdocyon thous*), agutis (*Dasyprocta azarae, Aguti paca*), squirrels (*Sciurus ingrami*), deers (*Mazama spp.*), otters (*Lontra Longicaudis*), bats (*Chiroptera*), marsupials (*Didelphimorphia*), rodents (*Rodentia*), capybaras (*Hydrochaeris hydrochaeris*), nutrias (*Myocastor coypus*), armadillos (*Dasypus novemcinctus*), Brazilia guinea-pig (*Cavia aperea*), skunks (*Didelphis sp.*)

Nevertheless, SCBD, (2008) points out that many mammalian species that originally occupied the region are threatened or already extinct. According to the organization, this may be due to habitat loss and fragmentation of natural fields and forests, draining of marshes and pollution of rivers and lakes and the sealing of the soil due to the process of urbanization (i.e. paving of streets), have impeded or halted the reproduction of many species, causing severe reduction and even the disappearance of species that a few decades ago could be considered common in the municipality.

In this case may be mentioned species that need large protected areas, such as large cats (Felidae family) like the Panther and the Felis concolor; species that depend on continuous wooded areas such as the Cebus apella primate (monkey-nail) and the Alouatta guariba (Red Howler Monkey); and species that have suffered intense pressure from hunting, such as the Tapirus terrestris (anta).

Historical Development[57]

The Early Years to the 19th Century

According to the WGBH Educational Foundation (2003), Curitiba was founded in 1693 by Portuguese explorers, the small village of Nossa Senhora da Luz e Bom Jesus dos Pinhais was an early waypoint for prospectors. By 1721, cattle herders had replaced unsuccessful gold seekers in this agriculturally rich region, and they renamed their new home "Curitiba." It was Curitiba's early leaders who first established building regulations, such as limiting the number of trees that could be cut and requiring homes to have tile, not wood, roofs. The Foundation indicates further that in 1854, Curitiba became the official capital of Paraná, one of Brazil's southernmost states, known for the world-famous Iguaçu Falls just a few hundred miles away, on Paraná's border with Argentina. By the end of the century, when a tide of European immigrants arrived in southern Brazil, Curitiba's population had surpassed 50,000 (WGBH Educational Foundation, 2003).

Curitiba's First Urban Plan: 1940s

By the 1940s, Curitiba was experiencing rapid growth. Word of the region's thriving agriculture industry attracted new settlers from such nations as Japan, Syria and Lebanon. Now at three times its turn-of-the-century population, Curitiba was confronted with increasing demands for improved services, housing and transportation. The city hired French planner and architect Alfred Agache to help ease the growing pains. Agache expanded Curitiba's sewer system and rerouted its traffic patterns. Sweeping arclike patterns now radiated out from the city center to better manage the flow of cars and buses that were clogging city streets.

Unchecked Growth: 1960s

Curitiba's population swelled to more than 430,000 people in 1960. French architect Alfred Agache's plan from the 1940s hadn't considered future waves of newcomers. Some Curitibanos feared that sprawl, fewer green spaces and lost character would follow the increasing numbers of people. In 1964, Mayor Ivo Arzua issued a call for proposals to prepare Curitiba for new growth. A team of young, idealistic architects and planners from the Federal University of Paraná, led by Jamie Lerner, answered. Their proposal laid out plans to minimize urban sprawl, reduce downtown traffic, preserve Curitiba's historic district, and provide easily accessible and affordable public transit. Improving upon Agache's plan, Lerner's team also proposed adding main linear transit arteries to Curitiba to provide direct, high-speed routes in and out of the city. Their proposal was adopted and eventually came to be known as the Curitiba Master Plan.

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[57] Source: http://www.pbs.org/frontlineworld/fellows/brazil1203/master-plan.html _accessed_20th December,2010

Implementing the Master Plan: 1970s

After his plan for Curitiba was adopted in 1968, leading architect Jamie Lerner created the city's first urban planning department to help organize and direct further redevelopment efforts. Among the department's innovations in the 1970s was Rua Quinze do Novembro, the heart of commercial Curitiba andBrazil's first pedestrian-only street. The city also adopted a trinary road design, called the Sistema Trinário, to minimize traffic in the city, whose population had now surpassed 600,000. The new system sandwiched a central two-lane street restricted to buses and local car traffic between wide, fast-moving one-way streets. With regards to attracting businesses, Curitiba began developing an industrial zone on the city's outskirts, which they called Industrial City.

The Green Era: 1980s

The 1980s was a decade marked by widespread economic recession, rising urban poverty and increasing deforestation rates in Brazil. Yet, now with more than 900,000 people, Curitiba rolled out a number of eco-friendly and social programs during the 1980s.

- "Green areas" protected from future development were established in Curitiba, and a number of parks were dedicated to the city's different ethnic and immigrant groups;
- Curitiba's transit system was expanded, and a color-coded system for the various bus lines was created;
- Regional administrations were established to decentralize government;
- A citywide recycling program was initiated in which Curitibanos separated organic waste and trash, plastic, glass, and metal. The city sold the salvage to cover the costs of operation.

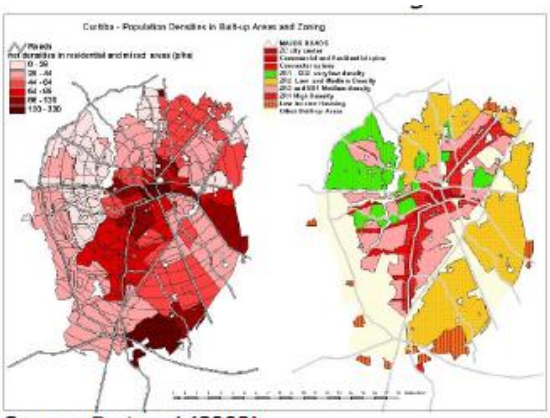
International Recognition: 1990s

Curitiba had grown to more than 1.4 million people when it hosted, in 1992, the World Cities Forum, an advance event leading up to the United Nations Conference on the Environment and Development, Earth Summit. The event brought international attention to Curitiba for the city's bold urban planning. Throughout the 1990s, Curitiba continued to add to its stock of green spaces and cultural sites, with the building of a new botanical garden and an opera house located on the site of an abandoned quarry. Curitiba also succeeded in attracting new industry to its Industrial City, with automobile companies Renault, Audi/VW and Chrysler moving in. New red multicabin buses, carrying up to 270 people each, were integrated into its transit system, and high-speed bus stops, called tubes, were created.

B. Project Urban Context

The Eco-responsiveness of the Curitiba wonder permeates through the entire urban fabric and reflected in entire Metropolitan area with trickling effects seen in the districts and the neighbourhoods. Curitiba as a Municipality has an Area of 430.9 km^2 (166.4 sq mi) but 15,416.9 km^2 (5,952 sq mi) as a Metropolitan area (Wikipedia, 2011). According to IBGE[58] the Population (2009) - Municipality of Curitiba stood at 1.746.896 which is the 8th Largest in Brazil. As a Municipality, the IBGE put the population density at 4,062/km^2 (10,523/sq mile) but the Metropolitan region of curitiba, population of stood at 3.168.980 inhabitants with a Metro-population density of 210.9/km^2 (546.2/sq mi) (Wikipedia, 2011). According to Lowry, in 1961 nearly 70 percent of the state's population lived in rural areas, and by 1991 nearly 75 percent of the population lived in urban places (Lowry 2002; Campbell, 2006, p.7) The city's population grew at 3.03% and 3.44% from the periods of 1980–1991 and 1991–1996, respectively (IPEA et al. 2001a: 103–104, 360; Campbell, 2006)

TFigure 7-6 Density Gradient in Curitiba

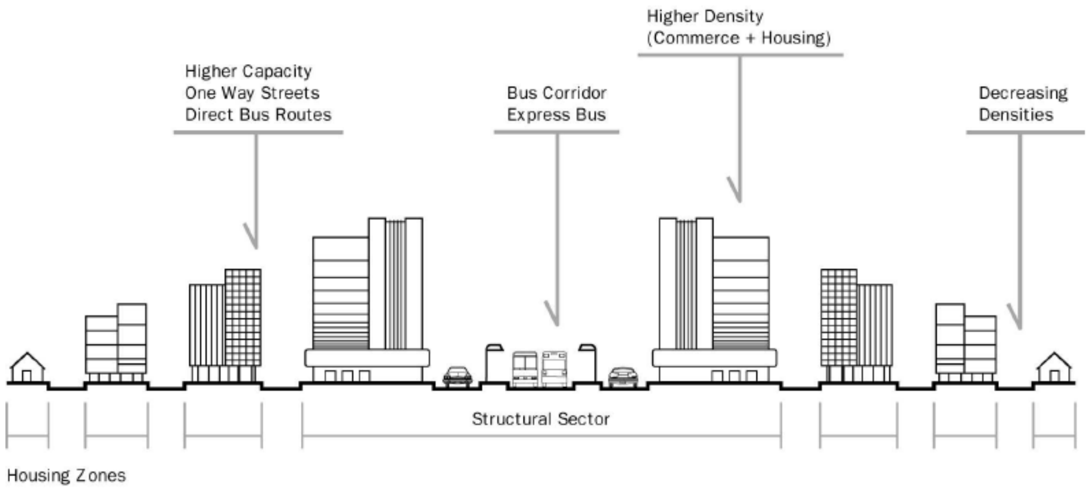


Source: Bertraud (2002)

[58] "Brazilian Institute of Geography and Statistics or **IBGE** (Portuguese: *Instituto Brasileiro de Geografia e Estatística*),". 2008. Retrieved 2007-06-27. "@Cidades"

In 1973, a complementary law was approved, which established the creation of nine metropolitan regions. The Metropolitan region of Curitiba (RMC) was created that year, along with other eight metropolitan regions (Alves Pereira, et al., 1999). Curitiba was divided into nine regional governments or districts who manage the 75 districts of the municipality. Its metropolitan area comprises 26 municipalities with a total population of over 3.2 million (IBGE estimate in 2006). The *Rua da Cidadania* ("Street of Citizenship") is the symbol of administrative decentralization; it is a reference point and meeting place for the user of municipal utilities, in a regional context, taking into account the needs and rights of the citizen in trade, leisure and services, facilitating the access of the population for different services in the areas of health, justice, policing, education, sport, house, environment, urban planning, social service and supply, etc. Several units work annexed to the terminals of public transport in Curitiba.

Figure 7-7: Schematic arrangement of the Structural Axis of Curitiba



Source: IPPUC 1986; Rabinovitch et. Al, 1993; Cevero, 1995)

Their nuclei offer services in the local, state and federal areas[59]. Bairros (neighbourhoods) of Curitiba are geographical divisions of the city. There is no delegation of administrative powers to neighbourhoods, although there are several neighbourhood associations devoted to improve their own standards of living. Curitiba is divided into 9 regional governments (boroughs) covering the 75 neighbourhoods of the city. All districts are served by the system of integrated urban transport. Most districts of Curitiba was born of colonial groups formed by families of European immigrants in the second half of the nineteenth century. The centro ("Downtown" in American English or "CBD" –

[59] http://en.wikipedia.org/wiki/Curitiba_accessed_08_09_2010

central business district – in other English use), place of foundation of the city is the most bustling area, which concentrates most of the financial institutions of Curitiba.

Curitiba is the capital of the State of Paraná, a mainly agricultural state in southern Brazil. The city had few outstanding historical or natural features, but its architects and urban planners have transformed it into a vibrant centre with good quality of life that draws many tourists. Curitiba's population has doubled to 1.6 million over the past 30 years. Despite major challenges that came with rapid growth, significant improvements have been made to the city's quality of life in areas including public transportation, preservation of the city's cultural heritage, expansion of parks and green areas, and social and environmental programs. Curitiba has a long tradition of innovative and integrated urban planning geared toward the strategic imperative of making the city a better place to live, as outlined in the city's Master Plan of 1965. This is what's most unique about the city's strategy: it maximizes the efficiency and productivity of transportation, land-use planning and housing development by integrating them so they support one another to improve the quality of life in the city.

Box 7-1: BAIRROS (NEIGHBOURHOODS) OF CURITIBA ARE GEOGRAPHICAL DIVISIONS OF THE CITY

List of neighborhoods by regional classification:

a. **Matriz:** Centro, Centro Cívico, Batel, Bigorrilho, Mercês, São Francisco, Bom Retiro, Ahu, Juvevê, Cabral, Hugo Lange, Jardim Social, Alto da XV, Alto da Glória, Cristo Rei, Jardim Botânico, Prado Velho and Rebouças;
b. **Santa Felicidade:** Santa Felicidade, Lamenha Pequena, Butiatuvinha, São João, Vista Alegre, Cascatinha, São Brás, Santo Inácio, Orleans, Mossunguê, Campina do Siqueira, Seminário, CIC (north region) and part of Campo Comprido;
c. **Boa Vista:** Boa Vista, Bacacheri, Bairro Alto, Tarumã, Tingüi, Atuba, Santa Cândida, Cachoeira, Barreirinha, Abranches, Taboão, Pilarzinho and São Lourenço;
d. **Cajuru:** Cajuru, Uberaba, Jardim das Américas, Guabirotuba and Capão da Imbuia;
e. **Fazendinha/Portão:** Portão, Fazendinha, Santa Quitéria, Vila Isabel, Água Verde, Parolin, Guaíra, Lindóia, Fanny, Novo Mundo and part of Campo Comprido;
f. **Boqueirão:** Boqueirão, Xaxim, Hauer and Alto Boqueirão;
g. **Pinheirinho:** Pinheirinho, Capão Raso, Tatuquara, Campo de Santana and Caximba;
h. **Bairro Novo:** Sítio Cercado, Ganchinho and Umbará;
i. **Cidade Industrial de Curitiba:** CIC (center and south region), Riviera, Augusta and São Migu

Source: http://en.wikipedia.org/wiki/Curitiba_accessed on 20th March, 2011

C. Project Eco-City Context

As city that was able to transform a vision into reality, it attained the eco-city status by reliance on the right systems and incentives, not on slavish implementation of a static document (Rabinovitch, et al., 2009, p.326). Some of such innovations were the provision of public information about land (Rabinovitch, et al., 2009, p.326), transformation of the city centre into pedestrian walkway on which cars are prohibited and flood control areas being turned into parks and recreational areas. Ready access to information helps to avoid land speculation. Owners of land in the city's historic district can transfer the building potential of their plots to another part of the city. Businesses in specified areas can buy permission to build up to two extra floors beyond the legal limit. Payment can be made in the form of cash or land that the city then uses to fund low income housing. As an Eco-City, green areas have been enhanced from less than 1 square metre per capita in 1970s to 51.5 square metres per capita as of 2009. There are about 34 parks in the city and green areas cover about 18% of the urban land (Curitiba S.A., 2007). Instead of using mowers and with diesel or fuel to keep the parks, sheep were kept in the parks to eat the grass and provide natural fertilizers which reduced the maintenance cost about 80%. About 70% of the city's trash is being recycled and 20% of the city is parkland with volunteers planting about 1.5 million trees along the streets. Although the car owner per capita in Curitiba is higher than anywhere in Brazil, with the population being doubled yet the auto traffic decreased by 30%.

One of Curitiba's first successes was controlling the persistent flooding that plagued the city centre during the 1950s and early 1960s. Construction of houses and other structures along the banks of streams and rivers had exacerbated the problem. In 1975 stringent legislation was enacted to protect the remaining natural drainage system. To make use of these areas, Curitiba turned many river banks into parks, building artificial lakes to contained floodwaters (Rabinovitch, et al., 2009, p.321). Incentives and systems for encouraging beneficial behaviour also work at the individual level. Curitiba Free University f0r Environment offers practical short courses at no cost for home makers, building superintendents, shopkeepers and others to teach the environmental implications of the daily routines of even the most common jobs (Rabinovitch, et al., 2009, p.326). More so, the 'Paperboy/Papergirl Program' gave part-time jobs to schoolchildren from low-income families as Curitiba has repeatedly rejected conventional wisdom that emphasizes technologically sophisticated solutions to urban woes.

Curitiba's road network and public transport system are probably the most influential elements accounting for the shape of the city. Each of the five main axes along which the city has grown consists of three parallel roadways. The Land-use legislation has encouraged high-density occupation, together with services and commerce, in the areas adjacent to each axis. (Rabinovitch, et al., 2009, p. 232) The city augmented these adjacent these spatial changes with a bus-based public transportation system designed for convenience and speed. An inter-district and feeder bus route complements the express bus lanes along the structural axes. Large bus terminals at the far ends of the five express bus lanes permit transfers from one route to another, as do medium-size terminals located approximately every two kilometres along the express routes. A single fare allows passengers to transfer from the express routes to inter-district and local buses (Rabinovitch, et al., 2009, p.323)

The reasoning behind the choice of transportation technology was not only efficiency but also simple economics: to build a subway system would have cost roughly 70million USD per kilometre whereas the express bus highways came in at 200,000 per kilometre including the boarding tubes

(Rabinovitch, et al., 2009, p.323). Based on the 1991 traveller survey results, it was estimated that the introduction of the BRT had caused a reduction of about 27 million auto-trips per annum, saving about 27 million litres of fuel annually. Curitiba uses about 30% less fuel per capita resulting in one of the lowest rates of ambient air pollution in the country. As of 2006, 1100 buses made 12,500 trips every day serving more than 1.3 million passengers which was about 50 times the number in 1986.

So far Curitiba has served as one of the best practices for Eco-City development worldwide due to its Innovative, non-conventional, practical and sustainable interventions it has and been implementing. Apart from providing multiplier effect, it has also played a catalyzing and demonstrating effect in the evolution of the Eco-City Concept internationally.

ECOLOGICAL CITY, KRONSBERG-HANNOVER

Figure 7-8 (a): Panoramic view of Hannover

Source: http://upload.wikimedia.org/wikipedia/comm

(b) Aerial View of Kronsberg (Source: Johaentges, K., 2003)

7.2.2 Ecological City, Kronsberg

- **Project Local Context**
    - **Geo-Physical Environment**

Hannover is the capital of the federal state of Lower Saxony (Niedersachsen) in Germany. It covers an area of 204 square kilometres. The wider conurbation of Greater Hannover has some 20 municipalities and a total population of 1.1 million. It covers an area of 2,300 square kilometres which is equal to the size of the small German state of the Saarland (Landeshauptstadt Hannover , 2001). Hannover is also well-known as the host of important exhibitions like the world-wide biggest industrial exhibition, the computer fair CeBit, and many other specialised fairs. In the year 2000 the EXPO 2000 took place in the city (Landeshauptstadt Hannover, 2001). The **Kronsberg**[60] is the second highest peak in the Hannover city. There is a large hill on the south-eastern outskirts of the city's Expo Park in Hannover. With its current elevation, it is only 4 m lower than the trash mountain *Monte Müllo* on the grounds of the landfill in the north-eastern district of Lahe. The Kronsberg *natural* is the highest elevation of the town and consists mainly of marl. **Marl** or **marlstone** is a calcium carbonate or *lime*-rich mud or mudstone which contains variable amounts of clays and aragonite. Marl was originally an old term loosely applied to a

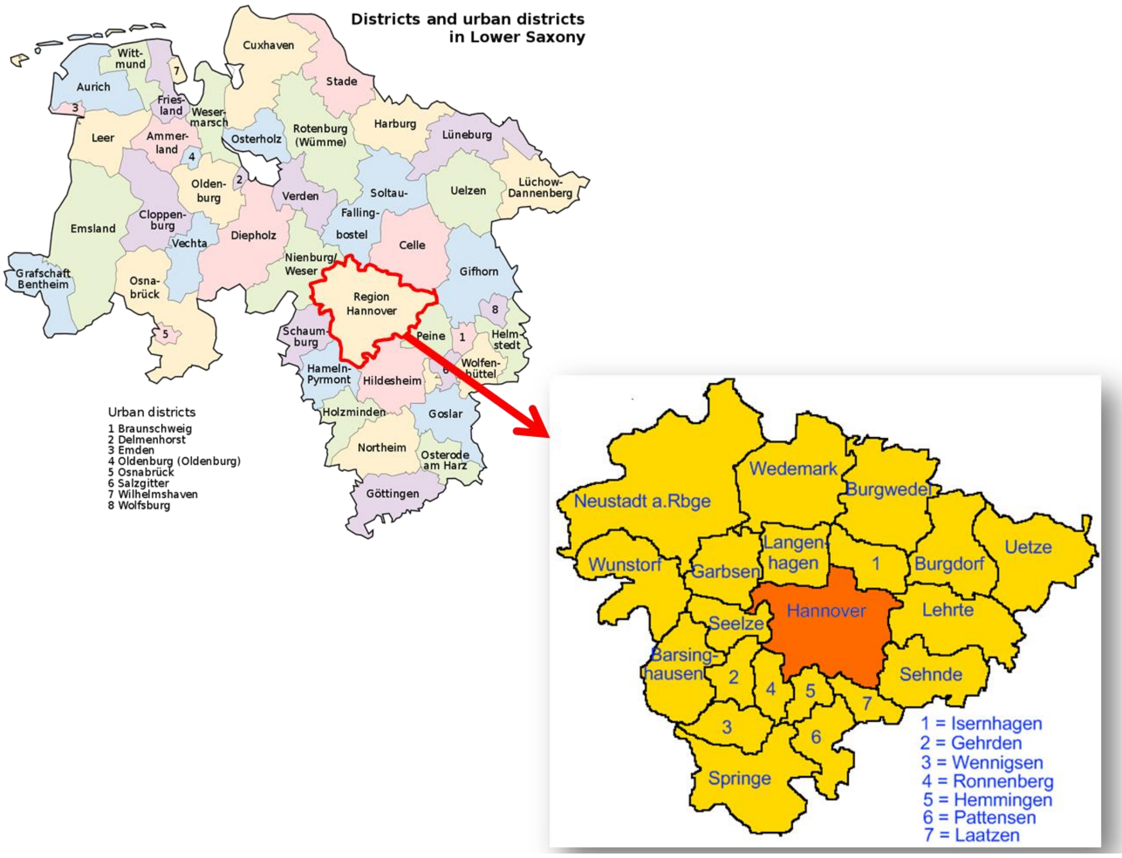
Figure 7-9: Federal States in Germany

Source:http://couuploads/2011/09/German-Maps.jpg

[60] http://en.wikipedia.org/wiki/Kronsberg

variety of materials, most of which appear as loose, earthy deposits consisting chiefly of an intimate mixture of clay and calcium carbonate, formed under freshwater conditions; specifically an earthy substance containing 35-65% clay and 65-35% carbonate.

Figure 7-10: Hannover Region



Source: http://en.wikipedia.org/wiki/Hanover_accessed_10-3-11

Kronsberg was built for the 2000 World Exposition on a 1,200 hectare site located in the southeast city limits of Hannover, Germany (City of Hannover, 2004b) as a demonstration of a new "sustainable district." On the Kronsberg hill, south-east of Hannover and adjacent to the EXPO site, a long-term construction project was developed to build homes for 15,000 people. Salient features are urban and landscape planning, ecology and technology, infrastructures and the social habitat under an umbrella of co-operative project development (Landeshauptstadt Hannover , 2001).

Figure 7-11: Aerial View of Hannover

(Source: Mönninghoff, 1998)

- **City Structure and Form**

Kronsberg is close to the countryside, yet enjoys all the advantages offered by an urban neighbourhood (excellent transport connections, jobs, cultural, commercial and leisure centres and facilities). The urban quality of the townscape and the built-up is the result of design parameters that set and regulated the number of - storeys, building heights and building lines along the main streets. Along with the demand for compact structures and medium density occupation, an important condition was that all corner plots should be built on.

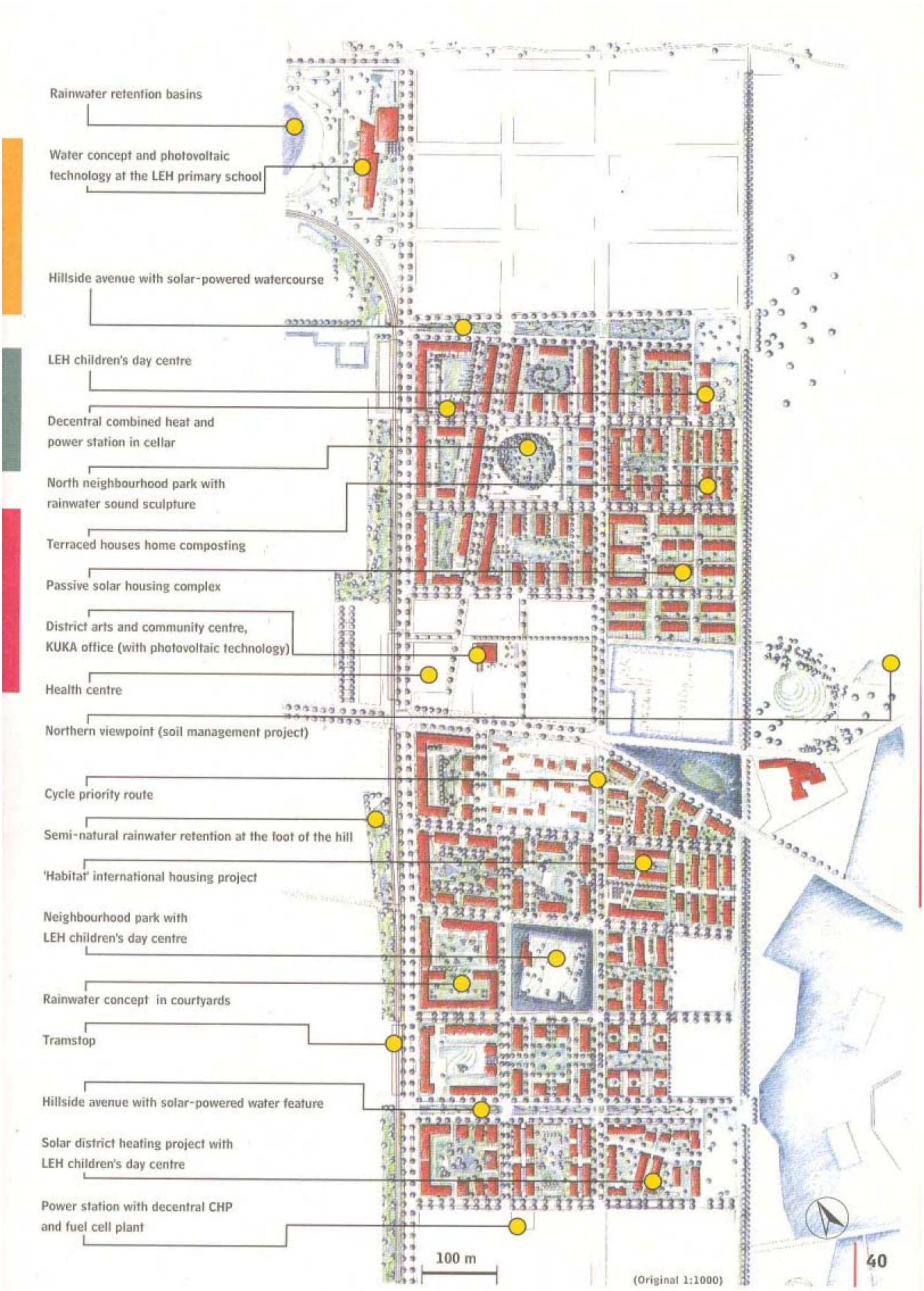
The grid layout of the blocks, the avenue-like streets and the open space planning unite many different construction forms and architectural styles in a harmonious townscape. The new district runs roughly north-south along the western slope of Kronsberg hill beside the new tramline, thus linking the older district of Bemerode with the World Exposition grounds (City of Hannover, 2004, P.10). Most of the buildings are aligned to the contours of Kronsberg hill, which makes the best use of natural light from the east and west. Many buildings have stepped storeys with gently sloping single-pitch roofs, often combined with rooftop terraces. The Façades however are typically of light-coloured rendering or red brick (City of Hannover, 2004, p.11).

Figure 7-12: Kronsberg Eco-City Layout

Source: Altevers, et al., 2003, p.1

At a total cost of €2.2 billion, the project aimed to build an ecologically-sound suburban community with the hopes of inspiring worldwide replication (City of Hannover, 2004a). Once built-out, Kronsberg is expected to have a total population of 15,000 residents and approximately 6,000 dwelling units (Rumming, n.d.). As of 2004, approximately 3,000 dwellings have been built with a population of nearly 6,600 residents (City of Hannover, 2004a). Kronsberg is projected to have a maximum net density of 108 people per acre or 44 dwelling units per acre (UPA). At present, the net density is approximately 48 people per acre or 22 UPA. Kronsberg is comprised of predominantly high-density apartment style dwellings with no single-detached dwellings (Figure 4.1). Three train stations within the community link Kronsberg to the city centre and ensure train service is no more than 600 metres walking distance for residents (City of Hannover, 2004a). Transportation is a vital aspect of the development since Kronsberg is located 30 to 40 minutes by car from the central city and 20 minutes by rail (Der Kronsberg: Schnell in die City, n.d.). Overall, Kronsberg offers a full range of services within the community such as daycares, schools, healthcare facilities, shopping, and jobs in order to minimize the need for travel.

Figure 7-13: Kronsberg Eco-City Detailed Layout Plan



Source: Benstem, et al., 1998, p.40

- **Ecology and Nature Conservation**

  a. The Kronsberg Countryside

The eastern edge of the development which is defined by a double row of trees lining the border avenue, have the Common Beyond them and is used for several purposes – open grassland cared for through extensive mowing or grazing. Where the green corridors come up to the crest of the hill, the Common is landscaped with viewpoint hills and copses of trees offering spaces for play and exercise. Children's playgrounds set into the residential area at these locations create close connections between settlement and countryside. Recreational space close to home is provided especially by the new woodland planting on the crest of Kronsberg hill, a transitional area between the leisure space near the settlement and farmland on the eastern hillside(City of Hannover, 2004, p.15). As part of its ecological and nature conservation strategy, Hillside Park Corridors and Green Streetscapes was planned for and implemented. The green spaces between sections of the district were created as park corridors to connect the residential areas with the hilltop woodland and to continue into the countryside. These park corridors have thus a dividing and a linking function, defining neighbourhoods and tying the countryside into the built-up. They are distinctively landscaped, offering various ways of using them and designed in clear contrast with the surrounding countryside. There are breaks in the hilltop woodland where it intersects with the park corridors, dividing it into sections. At the end of each park corridor is a viewpoint plateau from where one see back over the city and out into the countryside. In the rectangular layout of the district, trees define the streetscape. All streets are laid out as avenues, and a different variety of tree in each neighbourhood contributes to its particular character. Soak away hollows and gravel-filled trenches to infiltrate rainwater runoff are integrated in the grass verges. The transition to built areas is marked with front gardens. The sylvan character of the streetscape makes them both pleasant places to linger and important links in the open space network (Benstem, et al., 1998, p.16).

- **Historical Development**

In the 1970s most of the area which includes the Kronsberg Project site was bought up by the City Council as reserve building land but it was not until 1988 that the decision to develop was made. Hence by 1992 an Urban and landscape planning competition was conducted and later in 1993 urban planning competition for The 'Bemerode Ost' district. By 1995 development planning of the area was started 1996 Construction starts on public services infrastructure (sewage, roads etc.). Construction on residential buildings started around 1997 (around 30 different developers) and by 2000, approx.

3,000 homes were completed as part of this model project of the EXPO 2000 and some reserved land to the north and south was left for further 3,000 homes.

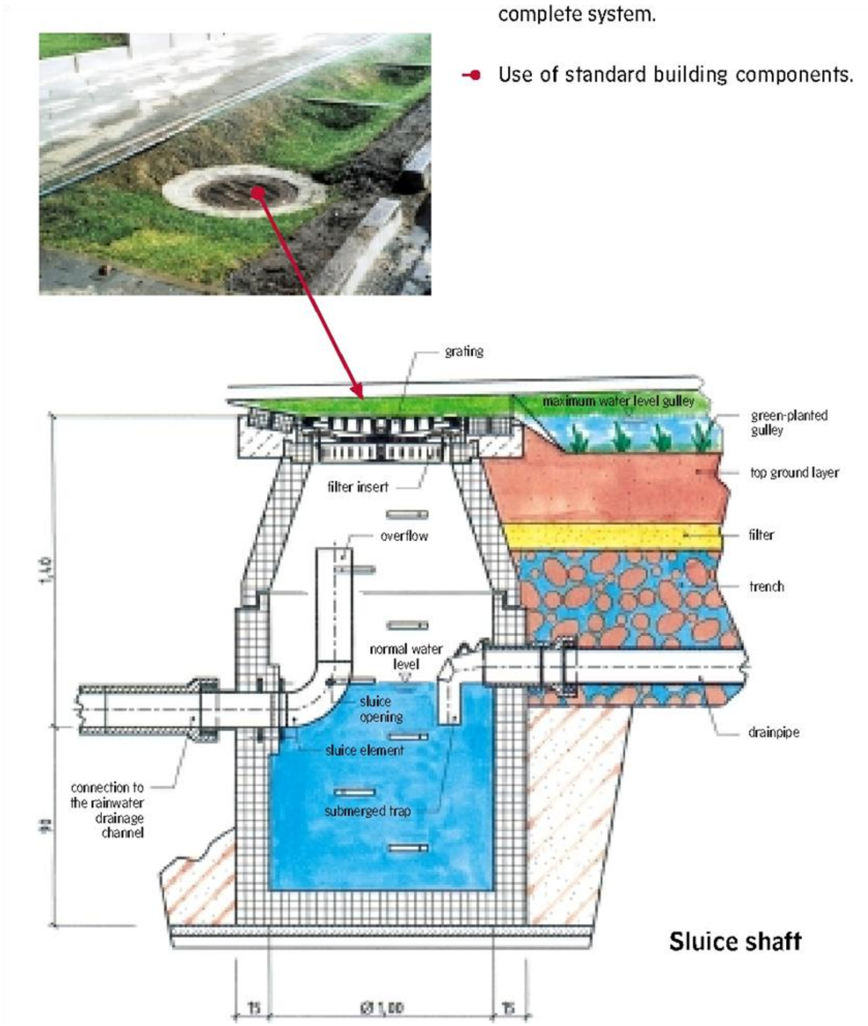
- **Project Urban and Eco-City Context**

The Project area has the ethos of the urban Hannover and the scenery of rural Lower-Saxony. The effective transportation connection also ensures easily mobility with fewer emissions. Three tram stops are so located that nobody has to walk more than 600 metres to catch a tram. The main motorised traffic-flow is channelled along the edge of the development beside the tramline to minimise nuisance to residents. Planning of the residential street layout permits no through traffic. Narrow sections on the roads, 30 kph zones, and priority to the right at junctions, are effective traffic calming measures. Car parking spaces are mainly arranged in small areas, either set into the hill-side or at ground level. To reduce the parking space needs in the inner courts, a parking space ratio of 0.8 per apartment was set at Kronsberg. This was compensated for by a 0.2 increase in the ratio for parking spaces on the public streets, which means that they are better used over the day, and the area needed for motorised access in built-up areas is reduced. A cycle-friendly street layout with a designated cycle street running the length of the district offers, together with a dense network of rural and urban footpaths, an attractive alternative to private motorised transport (City of Hannover, 2004, p.12). Along the tramline and the main access road, an attractive location for shops and offices has developed. At the mid-point of the present settlement these uses are concentrated with a shopping centre, a district square, the 'KroKus' arts and community centre, a health centre and a church (City of Hannover, 2004, p.14).

The proportion of open space in the Kronsberg district was raised by 5–10 % compared to conventional urban planning. The shaping elements of open space in the district – five transverse green corridors and the hilltop woodland parallel to the development– create the most important primary links with the adjacent countryside. A differentiated system of interconnected public, semi-public and private areas close to the homes offers numerous and differing green- and open spaces (City of Hannover, 2004, p.15). As part of its strategies to reduced CO_2 emissions at the project site and mitigate impacts of such urban developments on climate change. During its implementation, the construction methods utilised pursued elimination of thermal barriers; low-energy house construction; on-toxic and credited eco-materials use; water-saving fixtures and as well as energy-saving appliances. Despite the acute problems that the existing soil condition poses for the inhabitants, pragmatic steps to consolidate the site ecology was done. There was a great effort to both in the private and the public spaces incorporate the necessary rainwater retention and infiltration areas and hence were diversely integrated in the designs. Storm water retention and collection system and effective waste management innovations were instituted in the community whilst the excavated soil was also re-used on site. 1350 m2 solar collectors, 32 terraced 'Passive Houses'; 3 wind turbines, 3.6 MW.

Kronsberg Eco-City Project which was part of the EXPO 2000 Fair played a catalyzing or demonstrating effect which could be replicable and also providing multiplier effect in other parts of Germany. As an Eco-City Project the integrity of its ecological responsiveness had been expatiated through its easily maintainable, cost effective and the usage of locally available materials and artwork. Though it has an exciting visual impact the project can pride itself of the simplicity in the design. This is partly because it adopted design concepts that appeal/suit the local people and also had custom made state-of-art designs to suit local conditions.

Figure 7-14:Typical example of innovative water concept at Kronsberg Eco-city Project



Source: Altevers, et al., 2003, p.17

Figure 7-15: Green Infrastructure Network at Kronsberg Eco-City

Source: (Altevers, et al., 2003, p.11)

Figure 7-16: Green Infrastructure Network serving as Grazing Field and enhancing Mobility

(Benstem, et al., 1998)

Another striking Eco-City Strategy in place was the environmental education concept for the suburb.

The environmental educational concept is laid down as an essential principle, so that themes will be continued with no break from kindergarten through to junior school. The essential element is behaviour with natural resources (Altevers, et al., 2003, p.9).

The Kronsberg Environmental Liaison Agency (KUKA) was set up on site by Hannover City to facilitate coordination of the different projects together with City administration, disseminate information, and provide information and training to all stakeholders. The City of Hannover determined that Kronsberg could reduce CO2 emissions by 60% compared to typical residential developments, "through savings on heating, hot water, and electricity use with no reduction in living comfort or homeliness." It was mandatory that all building construction adhere to Low Energy House (LEH) standards, which would work in conjunction with renewable energy sources to achieve this 60% reduction goal. Environmental communication makes use above all of the instruments of information, publicity, advice, education and qualification. Every group connected with the suburb was supposed to be reached with the communication concept of the Eco-City Concept. These include:

- the residents;
- building sponsors and owners;
- the building artisans and craftsmen;
- educationalists and consultants;
- visitors;
- specialists(scientists, architects, engineers);
- the specialist public and media;(Altevers, et al., 2003)

As part of the strategy to disseminate information and advice on the ecological sustainability of Kronsberg, various down-to-earth and simple activities were instituted. For example, exhibitions on environmental projects in the suburb are on view in the suburb’s central library. The significance of water to all of life, and how it is treated in the suburb, is visualised there (Altevers, et al., 2003, p.9). Information boards have also been provided in various places in the suburb, boards are located, which draw particular attention to one or other aspect of the water concept. Simple, easy-to-understand sections of the overall system are presented. (Altevers, et al., 2003, p.9). Most importantly, the magazine „Kronsberg aktuell „which is a magazine that appears six times a year have been launched. It reports on the latest developments in the suburb, and occasionally on matters of particular importance, e.g. water. (Altevers, et al., 2003, p.9)

DONGTAN CITY PROJECT

Figure 7-17(a): Aerial View of the Proposed City Centre of the Dongtan Project after completion

(b) Night Impression of the Proposed Dongtan Project on Complete residential blocks in the Dongtan City

Source: http://www.designbuild-network.com/projects/dongtan-eco-city/_accessed_10_10_10

7.3 ON-GOING AND PLANNED PROJECTS

7.3.1 Dongtan Project

The Dongtan Project which was commissioned in 2005 was scheduled to break ground around 2008 and was to be based on 'Chiongming Island which is in the mouth of the Yangtze river 15km north of Shanghai in China'[61]. Though the entire island or site is about 120,000 hectares, the project site occupies about 8600 hectares (86 km2) which is about 20% of the size of Bremen and half the size of Freiburg and was anticipated that by 2020 about 630 hectares of it would have been developed. The vision was to create a community with low energy consumption that will be carbon free. The buildings at Dongtan was planned to help reduce energy use, making efficient use of energy sources and generating energy from renewable sources. Processes to capture and purify rainwater and insulation to minimise the waste of energy all buildings was adequatel planned for.More so, organic waste such as rice husks and vegetable peels was anticipated to be recycled to generate biogas(electricity).Whilst the first phase was planned to be completed by 2010, and the whole city within a 40 to 50 years span, the entire project came to a dissapointing halt as it was postponed indefinitely.

A. Project Local Context

- **Geo-Physical Environment**

The Dongtan Project site is a very delicate wetlands located adjacent Ramsar site for migrating birds and wildlife, has been one of the driving factors of the city's design. The project planners planned to enhance the existing wetlands by returning agricultural land to a wetland state and also create a 'buffer-zone' between the city and the mudflats - at its narrowest point, this 'buffer zone' was to be 3.5 kilometres wide. It was anticipated that only around 40% of the land area of the Dongtan site would be dedicated to urban areas and the city's design aims to prevent pollutants (light, sound, emissions and water discharges) reaching the adjacent wetland areas.

Figure 7-18: Location of Dongtan

Source:http://www.designbuild-network.com/projects/dongtan-eco-city/_accessed_10_10_10

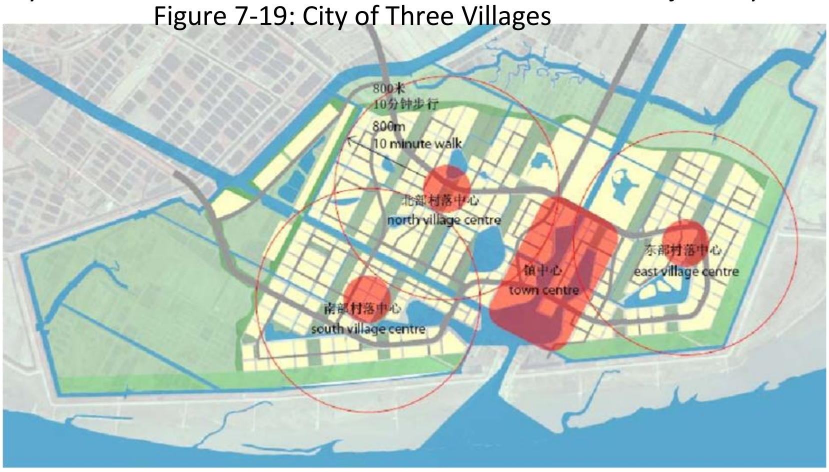
[61] http://www.london.gov.uk/londoner/06may/p13a.jsp?nav=green

Chongming Island which is 1,200 square kilometres (120,000 hectares) happened also to be the largest alluvial island in the world (formed by sedimentary deposits washing down the Yangtze River).

- **City Structure and Form**

Tagged as the Town of Three Villages, and having these villages that meet at a commercial centre, Dongtan would feature a compact layout that would minimise the need for motorised journeys within the city. A compact city (made of three villages) reduces infrastructure costs as well as improving amenity and energy efficiency to public transport systems.

Figure 7-19: City of Three Villages



Source: ARUP, 2007

According to Arup, all housing was planned to be within a seven-minute walk of public transport. Businesses, schools, hospitals and the like should also be easily accessible. Dongtan was planned to be a city linked by a combination of cycle-paths, pedestrian routes and varied modes of public transport, including buses and water taxis. Public transport with reduced air and noise pollution would enable buildings to be naturally ventilated, and in turn reduce the demand on energy. Arup claims that such accessibility would have reduced travel distances, thereby lowering CO_2 emissions by 400,000t annually. Visitors would park their cars outside the city and use public transport within the city. Transportation options within the city according to the plan include cycling, walking, hydrogen fuel-cell buses and solar powered water taxis. Canals, lakes and marinas will permeate the city, providing a variety of recreation and transport opportunities. In Dongtan, all vehicles was planned to run on batteries or hydrogen fuel

Figure 7-20: Proposed Road Network at Dongtan

Source: ARUP, 2007

cells. These energy-efficient vehicles were supposed to emit practically no greenhouse gases. Improved accessibility in Dongtan will reduce travel distances by 1.9 million kilometres, reducing CO2 emissions by 400,000 tonnes per year.

- **Energy, Ecology and Nature Conservation**

According to Arup's project fact sheet, compared to a 'business as usual' development model, Dongtan eco-city was planned to have:

- 60% smaller ecological footprint
- 66% reduction in energy demand
- 40% energy from bio-energy
- 100% renewable energy for in-use buildings & on-site transport
- Waste to landfill down by 83%
- Almost no carbon emissions

A combination of traditional and innovative building technologies was projected to reduce energy requirements of buildings by up to 70%. When it is completed it was anticipated that the energy used within the city would not have added to the level of greenhouse gases in the atmosphere. Energy in the form of electricity, heat and fuel would have been provided entirely by renewable means. In buildings, this would have been achieved by specifying high thermal performance and using energy efficient equipment and mechanisms to encourage building users to save energy. Where possible, labour and materials were supposed to have been sourced locally thereby reducing transport and embodied energy costs associated with the construction process. The buildings with green roofs would have also contributed to the improvement of insulation and water filtration. Public transport with reduced air and noise pollution will enable buildings to be naturally ventilated, and in turn reduce the demand on energy.

Transport energy demand would be reduced by eliminating the need for a high proportion of motorized journeys, and judicious choice of energy-efficient vehicles. Energy supply in Dongtan would have been via a local grid and electricity and heat supplied by:

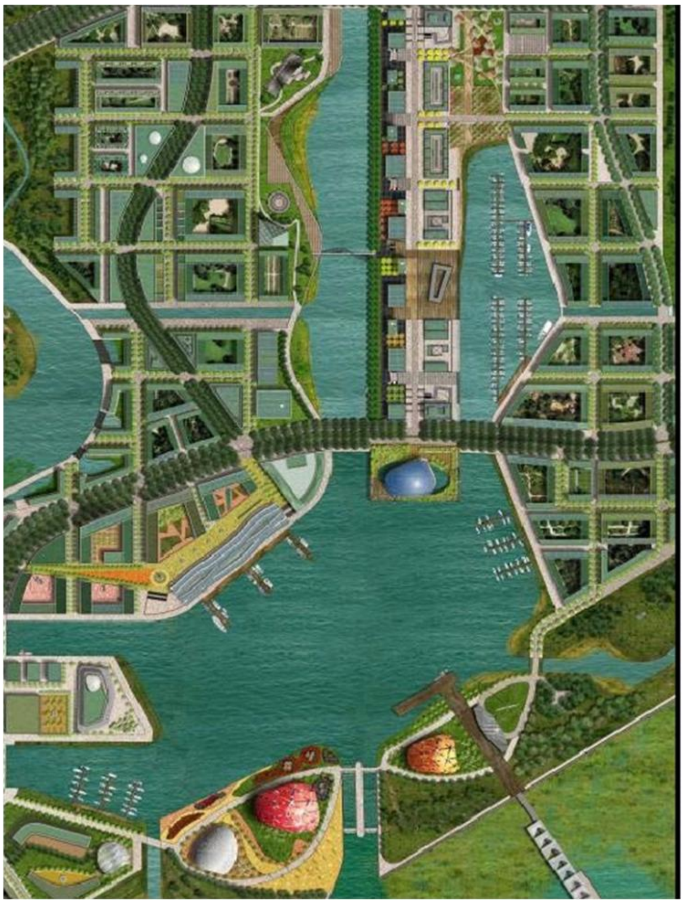
i. A combined heat and power (CHP) plant that runs on biomass in the form of rice husks, which are the waste product of local rice mills
ii. A wind farm
iii. Biogas extracted from the treatment of municipal solid waste and sewage
iv. Electricity generated within buildings using photovoltaic cells and micro wind turbines

More so, some of the electricity generated would have been used to charge the batteries of electrically-powered vehicles or to produce hydrogen for vehicle fuel cells. Strategically, a key feature of energy management in Dongtan would be the level of information provided to consumers to encourage them to conserve energy by means such as smart metering and financial incentives. A visitors' centre located close to the energy centre would explain how cities can be sustainable in energy terms.

As part of the Resource and Waste Management to enhance the Nature conservation and sustainability, Dongtan planned to collect 100% of all waste within the city and to recover up to 90% of collected waste. Part of the waste that is recyclable would be recycled and organic waste will be used as biomass for energy production. Apart from that it was also planned that there would be no landfill in the city and human sewage will be processed for energy recovery, irrigation and composting

- **Historical Development**

Figure 7-21: Block Layout of the City Centre of Dongtan



Source: ARUP, 2007

The Dongtan 8,600 hectares site was supposed to be developed in phases and by 2010, a one square kilometer (100 hectares) area representing the first phase would have been developed to accommodate up to 5,000 people had it not been postponed indefinitely. This first phase to be developed would have been the South Village which contains part of the marina and includes nearly a square kilometre of open space and parkland which would have included around 2,500 to 3,000 dwellings. It was also anticipated that by 2020 the 6.5 square kilometer (650 hectares) start-up area would have been developed, to accommodate up to 80,000 people.

Consequently, by 2050 the rest of the development would have been done to accommodate up to 500,000 people on around 30 square kilometres (3,000 hectares). As part of their long term development plan for

Chongming Island, the Shanghai Municipal Government started the construction of a bridge and tunnel to link the Island with the Shanghai mainland. It was scheduled to be complete in 2009 but it is still on-going.

- **Project Urban and Eco-City Context**

According to Arup, the project Engineers, strategically, Dongtan was planned to these key principles of the sustainability framework:

- To preserve the wetland habitat;
- To create an integrated, vibrant and evolving community;
- To improve quality of life and create desirable lifestyles;
- To create an accessible city;
- To ingrain contemporary Chinese culture into the city fabric;
- Managing the use of resources in an integrated manner;
- Working towards carbon neutrality;
- Utilizing governance to achieve long term economic, social and environmental sustainability.

From the onset of the conception of the project's Eco-City Context, many described the project as utopian. In that, even farmland within the Dongtan site was supposed to have used organic farming methods to grow food for the inhabitants of the city, where nutrients and soil conditioning will be used together with processed city waste. All housing was supposed to have been located within seven minutes walk of public transport and easy access to social infrastructure such as hospitals, schools and work. Although some may have chosen to commute to Shanghai for work, there would have been employment for the majority of people who live in Dongtan across all social and economic demographics. Dongtan as described by ARUP would have produce sufficient electricity and heat for its own use, entirely from renewable sources. Within the city, there would have been practically no emissions from vehicles since they would have been battery or fuel-cell powered. The development of techniques that increase the organic production of vegetable crops would have meant that no more farmland will be required than is available within the boundaries of the site's Eco-City applicability of Project could not be assessed to ascertain since the integrity of the ecological responsiveness were stalled abrupt implementation plan.

This brings into question whether the project was really Innovative, non-conventional, practical and sustainable. The cost effectiveness and its simplicity in its design could not be vouched for because most of the introductions into the city were seen as not very easy to be maintained. It however had a very powerful interesting visual impact and could have been replicated in other provinces in China. This could have sparked a multiplier effect in the negative direction. Though locally available materials and artwork were planned to have been used it did not adopt the design concepts that appeal or suit the local people but rather conformed to the ideals of the western architectural experimentation. Also although it possessed a catalytic and demonstrating effect, the lessons seems to be a very good example of what should not be done.

MASDAR CITY PROJECT

Source: http://www.masdarcity.ae/en/index.aspx

7.3.2 Masdar City Project

The capital of United Arab Emirates, Abu Dhabi, sprang up half-way through the eighteenth century as a fishermen and hunters' village. It was transformed when petroleum was discovered there in the mid-twentieth century and the United Arab Emirates came into existence in 1971 (Larsen, 2009). Abu Dhabi's economy is heavily dependent on its vast reserves of oil and gas. According to the CIA country report 2008, the UAE is the 11th largest oil producing country in the world and nearly about 40% of the country's output is based on oil and gas output. Named "Masdar", which means "source" in Arabic, the Masdar Initiative was to create a sustainable city designed as a model for eco-design worldwide. The project has four goals which included: to diversify the economy of Abu Dhabi, to expand Abu Dhabi's position in global energy markets, to position the UAE as a developer of sustainable technologies, and to make a meaningful contribution toward solving some of the world's most pressing problems (Masdar Institute, 2008).

A. Project Local Context

- **Geo-Physical Environment**

The Emirate has hyper arid climatic conditions, with hot and dry summers, and mild to warm winters with meagre, sporadic rains. The climate plays a central role in determining the evolution and changes of the land surface. The topography of the Emirate is dominated with large sand dunes that in certain places exceed 250m and belong to the largest in the world, interspersed with sparsely vegetated interdunal plains. Geologically the Emirate of Abu Dhabi and adjacent areas have been relatively stable over the past 600 Ma, with oldest exposed rocks in the emirate occurring in Jebel Dhanna (Environment Agency-Abu Dhabi, 2008, p.xvi). The key issues identified in soil are wind erosion and salinisation and for water, the worsening situation of the Emirates' fresh water resources and increasing demand for water. The meagre volume of rainfall the Emirate receives annually is not enough to meet the excessive and growing demands. Current demands are about 26 times greater than the volume of water which is naturally recharged within the hydrological system. The total groundwater reserves are estimated at 640Km^3 (2.6% fresh, 18.1% brackish, 79.4% saline) 97.4 % are either brackish or saline reserves, with meagre fresh water. This is the natural condition and, whilst the emirate does rely on these groundwater resources for the most part of its non - potable requirements, it relies heavily, and will continue to do so, on the expensive and environmentally sensitive process of the desalination of seawater for drinking water (Environment Agency-Abu Dhabi, 2008, p.xvii)

- **City Structure and Form**

Masdar, a roughly six-square kilometre, 50,000-person city, is touted as being the first carbon-neutral, zero-waste, car-free city (Basantani 2008). One major advantage to building an entirely new city is the ability to selectively employ the latest technologies and materials in order to build a city that has as little impact on the natural environment as possible. The residential density is expected to be about 140 inhabitants / hectare but the daily density would be 245 people per hectare. Intelligent mixture and use of low rise, high density (most buildings are no more than five storeys) has been incorporated to enhance the efficient use of land which is an expensive commodity to prepare. The city according to Larsen (2009) was also planned after the traditional Islamic city approach. Thus it has narrow streets which are naturally shady due to the mutual shading effects of the high density low rise block of buildings, and also possesses diverse open and public spaces. It also promises of a vibrant urban realm. Thus the fabric of the city has much focus on the public spaces between the buildings, as well on the buildings themselves. Thus, the streets and squares invite people to enjoy the outdoors, where they interact and engage with fellow students, residents, professionals and visitors. In the case of Masdar, Larsen (2009) explains that the environmental sustainability and impact of virtually every aspect of the city was carefully considered, from the initial planning and construction stages to the eventual daily functions of the city. Careful advantage has been taken of the orientation and disposition of the various buildings and structures.

Consequently, Masdar has been planned to seek the maximum efficiency gains at the lowest cost, by optimally orienting the city grid and buildings to minimise solar heat gain on building walls and the streets, while maximising cooling night time breezes. As described by Forster and partners the Master Planners of the community, there is a conscious effort to promote Integration of the various aspects of the socio-cultural environment through the disposition of the land uses hence reducing travel time and trip frequencies. All aspects of city life are integrated which enables work, entertainment, recreation and home to all be in close proximity, for convenience and to minimise use of transportation. More so Pedestrian focused urban fabric ensures that there is a strong integration of the various service infrastructures within the city. Thus it means one does not need to walk to many destinations, while convenient transportation also supports this pedestrian focus. Masdar city is touted as a city of high quality of life and would be committed to offering the highest quality work and living experience with the lowest possible environmental footprint.

- **Ecology and Nature Conservation**

'The city designers have also planned mechanisms to deal with the highly saline ground water, and to capture fog and humidity for use as drinking water. They are also looking at measures to reduce or offset the carbon footprint of bringing food to the city from outside. The lack of a precedent to measure against and the lack of local expertise in building low energy buildings in the region may pose a few challenges to the design team as it sets to design buildings that are supposed to achieve these ambitious goals.'[62]An attempt to conserve the natural desert environment however has not been achieved since an oasis is being created out of the dry desert land. Although Masdar is being built in a desert environment where few plant or animal species live, the developers plan to consider the region's biotic communities in their environmental protection assessment report and have pledged to mitigate for any impacted plant and animal populations (ENN, 2008)[63]. Mitigation will occur on comparable habitat sites, as effective conservation is a key element of Masdar's sustainability goals (ENN, 2008). This however is quite debatable looking at the drastic changes that is going to occur by the new introduction of trees and plants that hither-to do not belong to the area.

- **Historical Development**

'The project is headed by the Abu Dhabi Future Energy Company (ADFEC). Initiated in 2006, the project was projected to cost US$22 billion and take some eight years to build, with the first phase scheduled to be completed and habitable in 2009. Construction began on Masdar City in 2008 and the first six buildings of the city were completed and occupied in October 2010. However, due to the impact of the financial crisis, Phase 1 of the city, the initial 1,000,000 square metres (0.39 sq mi), will be completed in 2015. Final completion is scheduled to occur between 2020 and 2025. The estimated cost of the city has also declined by 10 to 15 percent, putting the development between US$18.7 and 19.8 billion'[64].

B. Project Urban Context and Characteristic of Infrastructure Planning

The City of Masdar would consist of Neighbourhood and blocks with a different type of street system from the normal one that exist in a contemporary city. This is because (figure 6-21) the infrastructure provision of which had been planned for Masdar are in layers of Transportation, Energy, Waste

[62] http://www.carboun.com/sustainable-development/sustainable-design/masdar-city-masterplan/

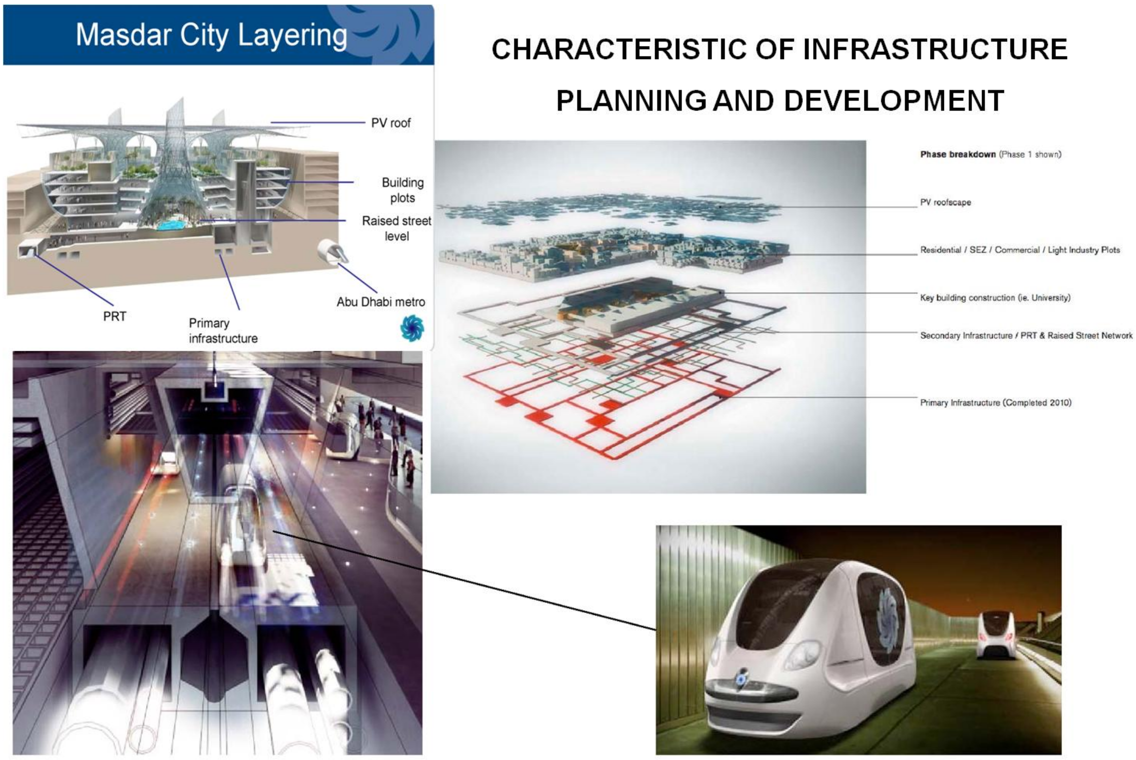
[63] Environmental News Network (ENN). Abu Dhabi unveils plans for sustainable city. (2008, January 14). Retrieved November 22, 2008, from www.enn.com/pollution/article/29161.

[64] (http://en.wikipedia.org/wiki/Masdar_City_accessed_10.20.2011)

Management Water provision and management. In the area Transportation, Masdar would be one f the world's first car-free cities (Biello, 2008; Stilwell et al, 2008). The master plan outlines three primary means of transportation: walking, a light rail system, and an elevated personal rapid transit (PRT) system (Figure 6-21). This integrated system intends to provide a public transit stop within two-hundred meters of any given point in the city (Basantani 2008). There would be about three thousand of the PRT Vehicles with about 85 to 100 station generation about 135,000 trips per day. Due to Masdar's pedestrian-friendly design, walking and bicycling are expected to be the city's most popular forms of transit (Masdar Initiative, 2008).

As previously discussed, streets in Masdar are narrow and shaded to provide a comfortable walking environment that encourages human interaction (Masdar Initiative, 2008). Pedestrian networks in the city are also supplemented by two electric transportation systems designed to efficiently convey people further distances (McGrath, 2008; Stilwell et al, 2008). The first system is a light rail which will connect Masdar to Abu Dhabi City, the adjacent international airport as well as other surrounding communities (Masdar Initiative, 2008). The second transport system developed for use in Masdar is the underground personal rapid transit system (PRT) which relies on compact pod cars to shuttle people around the city (Biello, 2008; Stilwell et al,2008). These pod cars will run on a series of magnetic tracks using electricity and will be fully automated, directly shuttling riders to a multitude of stations throughout the city (Biello, 2008; Stilwell et al, 2008). Convenience was made a priority for each of these electric transport systems, with stations available within a 200 meter radius from any location in the city (Masdar Initiative, 2008). As a city located in a harsh desert climate, a highly efficient water system is a key element of Masdar's sustainability plan. Masdar will derive all of its water from a desalinization plant located just outside the city which will run solely on solar power (ENN, 2008). Masdar's planners took great strides to lower the city's net water demand, achieving a 60% reduction in overall water consumption (McGrath, 2008).

Figure 7-22: Infrastructure Development in Masdar.



Source: Masdar Initiative, 2008

In addition, 80% of all water in Masdar will be re-purified and recycled back for household and irrigation purposes (McGrath, 2008). Masdar will also apply some of the world’s most advanced water recapture technologies to catch and reuse water diverted for landscaping (Sullivan, 2008; Stilwell et al, 2008). Masdar City‘ power infrastructure features a range of renewable energy technologies; including a range of photovoltaic plants(PV), a concentrating solar thermal power plant (CSP), evacuated thermal tube collectors, and a waste-to energy plant. Each technology has certain characteristics that determine how and when the energy produced will be used, its advantages, and disadvantages, and not least, its cost (Nader/Energy Procedia, 2009, p.3953).

Masdar City will rely on intelligent design and innovative urban planning in order to cut energy consumption by about 70% from that needed for a conventional city under Abu Dhabi’s current conditions(Nader/ Energy Procedia, 2009, p.3953). The specifications for the façades of all buildings within Masdar City are extremely high. In a very warm climate such as Abu Dhabi, the loss of cooled air entails significant energy cost. By specifying high quality façades and shading them from the worst of the day’s heat, the need for cooling and for power can be greatly reduced. All Masdar City buildings would be intelligent buildings, incorporating monitoring and control systems, which would facilitate the most efficient possible use of resources.(Nader/ Energy Procedia, 2009, p.3953). Through a combination of careful control of materials brought onto the site and intensive recycling and waste-to-energy technologies, Masdar City would aim for net zero waste. Physical waste would be managed through an integrated, user-friendly and odourless system and biodegradable materials would be composted (Nader/ Energy Procedia, 2009, p.3954).

C. Project Eco-City Context

Masdar City's power infrastructure features a range of renewable energy technologies; including a range of photovoltaic plants (PV), a concentrating solar thermal power plant (CSP), evacuated thermal tube collectors, and a waste-to energy plant. Each technology has certain characteristics that determine how and when the energy produced will be used, its advantages, and disadvantages, and not least, its cost (Nader/Energy Procedia, 2009, p.3953; Stilwell, et al., 2008). Masdar City will rely on intelligent design and innovative urban planning in order to cut energy consumption by about 70% from that needed for a conventional city under Abu Dhabi's current conditions (Nader/ Energy Procedia, 2009, p.3953).

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The City's stone-and-mud walls would be covered in photovoltaic panels, and its pathways would be draped with shades of fabric that convert sunlight into electricity. The city's perimeter wall would form an intelligent outer shell, housing the energy, environmental and recycling services. Masdar is going to be surrounded by a greenbelt featuring agricultural facilities, research fields, greenhouses and a variety of accessible green-spaces (Sustainable Business, 2008; Stilwell, et al., 2008). Soil for agricultural operations will be derived from Masdar's extensive composting operation (Sullivan, 2008; Stilwell, et al., 2008). In addition, irrigation for agricultural operations will come exclusively from the city's recycled grey-water system (ENS, 2008; Stilwell, et al., 2008). Local agriculture is projected to supply a sizable quantity of Masdar's produce, and local markets in Masdar will be required to sell minimal quotas of organic and fair-trade merchandise (ENN, 2008; Stilwell, et al., 2008).

As a city located in a harsh desert climate, the incorporated highly efficient water system promises to be a key element of Masdar's sustainability plan. Masdar shall derive all of its water from a desalinization plant located just outside the city which will run solely on solar power (ENN, 2008; Stilwell, et al., 2008). Masdar's planners took great strides to lower the city's net water demand, achieving a 60% reduction in overall water consumption (McGrath, 2008). In addition, 80% of all water in Masdar will be re-purified and recycled back for household and irrigation purposes (McGrath, 2008). Masdar will also apply some of the world's most advanced water recapture technologies to catch and reuse water diverted for landscaping (Sullivan, 2008; Stilwell et al, 2008).

Through a combination of careful control of materials brought onto the site and intensive recycling and waste-to-energy technologies, Masdar City would aim for net zero waste. Physical waste would be managed through an integrated, user-friendly and odorless system and biodegradable materials would be composted (Nader/ Energy Procedia, 2009, p.3954). Although Masdar will not be able to achieve 100% waste reduction, the city intends to divert 99% of its wastes from landfills (ENN, 2008). In order to accomplish this monumental feat, Masdar will first apply a wide array of compulsory and voluntary waste reduction measures (ENN, 2008). Secondly, Masdar will rely on extensive waste reuse and composting programs to cut down on landfilled items (Sullivan, 2008; Stilwell, et al., 2008). To supplement these measures, Masdar is also constructing several cutting edge recycling facilities that will be capable of processing an impressive number of common and industrial materials (Sullivan, 2008; Stilwell, et al., 2008). Finally, Masdar will divert all feasible remaining waste to a combustion waste-toenergy power plant which will supply a small portion of the city's electricity (Masdar Initiative, 2008; Stilwell, et al., 2008).

Masdar is relying solely on renewable energy to supply 100% of its electricity (Masdar Initiative, 2008). Providing over half of the city's total electricity, solar energy will be the primary renewable technology employed by Masdar. In addition to several photovoltaic power plants located in and around the city, solar panels will also be integrated into the majority of the city's architecture and outdoor spaces (Masdar Initiative, 2008). Besides conventional photovoltaics, Masdar is also planning to generate cheap concentrated solar thermal power which uses mirrors to focus sunlight and create steam (Masdar Initiative, 2008; Stilwell, et al., 2008). Wind turbines are also anticipated to be a central part of Masdar's energy mix. The city's southwest and northeast walls will be lined with large wind turbines and smaller urban wind turbines will be affixed to various buildings throughout the city (Masdar Initiative, 2008). In addition, geothermal ground-sourced heat pumps are planned to play a major role in cooling Masdar's buildings from the harsh desert climate (Masdar Initiative, 2008).

Waste-to-energy technologies will, additionally, provide a small portion of Masdar's electricity (Masdar Initiative, 2008). Finally, Masdar is constructing the world's largest hydrogen plant and is intending to integrate hydrogen technologies into ist renewable fuels mix in the future (Masdar Initiative, 2008). Masdar developers has planned to make Masdar one of the world's first zerocar cities (Biello, 2008) and due to Masdar's pedestrian-friendly design, walking and bicycling are expected to be the city's most popular forms of transit (Masdar Initiative, 2008). As an eco-city with innovative sustainable transport, the streets as previously discussed in Masdar are narrow and shaded to provide a comfortable walking environment that encourages human interaction (Masdar Initiative, 2008). Pedestrian networks in the city are also supplemented by two electric transportation systems designed to efficiently convey people further distances (McGrath, 2008). The first system is a light rail which will connect Masdar to Abu Dhabi City, the adjacent international airport as well as other surrounding communities (Masdar Initiative, 2008). The second transport system developed for use in Masdar is an underground personal rapid transit system (PRT) which relies on compact pod cars to shuttle people around the city (Biello, 2008). These podcars will run on a series of magnetic tracks using electricity and will be fully automated, directly shuttling riders to a multitude of stations throughout the city (Biello, 2008).

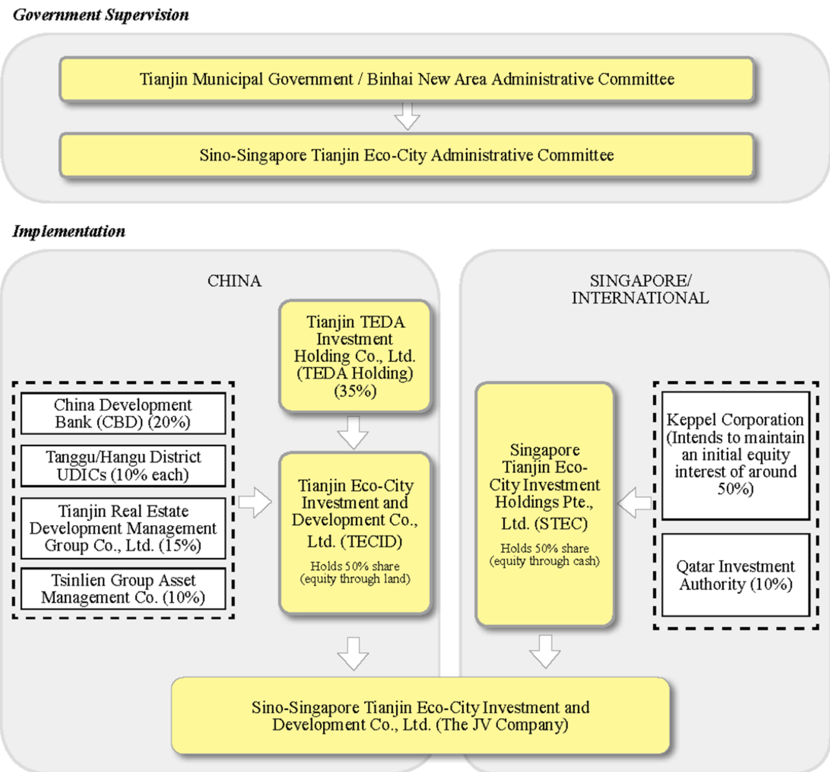
SINO-SINGAPORE TIANJIN ECO-CITY PROJECT

Source: http://www.tianjinecocity.gov.sg/images/Location/location_1.gif_accessed_10-10-10

7.3.3 Sino-Singapore Tianjin Eco-city Project

As China is experiencing the largest scale of urbanization at an unprecedented pace in history, there are frantic efforts by the Chinese Government and its experts to act quickly to salvage the resultant repercussion. Over the past three decades, the share of China's population living in cities more than doubled, reaching 44.9 percent in 2007. Urbanization is projected to rise to about 64 percent by 2025, which would translates to slightly over 350 million more people living in urban areas. (The World Bank, 2009, p.i). Consequently the Sino-Singapore Tianjin Eco-City (SSTEC) Project which follows earlier cooperation between China and Singapore on the Suzhou Industrial Park in China, in November 2007 is a collaborative effort initiated to demonstrate the commitment being put into efforts towards sustainable living in China (The World Bank, 2009, p.ii). According to Guo Changdong in his article[65] in china daily online, the Tianjin Eco-City is a landmark bilateral project between China and Singapore with private-sector investment and development.

Figure 7-23:The Institutional Overview of the SSTEC Project



Source: The World Bank, 2009, p.iii

Located in the Tianjin Binhai New Area (40 km away from Tianjin city centre), the 30-sq km Tianjin Eco-City is envisioned to create a harmonious and sustainable community that meets the needs of an

[65] (http://www.chinadaily.com.cn/m/tianjin/e/2009-07/02/content_8348621.htm_ 2009-11-11)

urbanising China and will be a modern township where 350,000 residents can live, work and play.When completed, the 4-sq km Start Up Area will be home to 26,500 households, with the first batch of residents expected to move in around 2011 .The tight timeframe leading up to the groundbreaking ceremony in July 2008 demonstrated the commitment of both countries to the speedy and successful implementation of the project, as well as the confidence of both countries that this target can be met. The early completion of the Eco-city will also help to maximize its demonstrative value.

A. Project Local Context

- **Geo-Physical Environment**

The Eco-city site is located 40 km from Tianjin city centre and 150 km from Beijing. The site is 10 km from the core district of the Tianjin Binhai New Area (TBNA), with the southern tip of the site only a 5 to 10 minute drive from the TEDA, the current driving force behind Tianjin's economic growth.

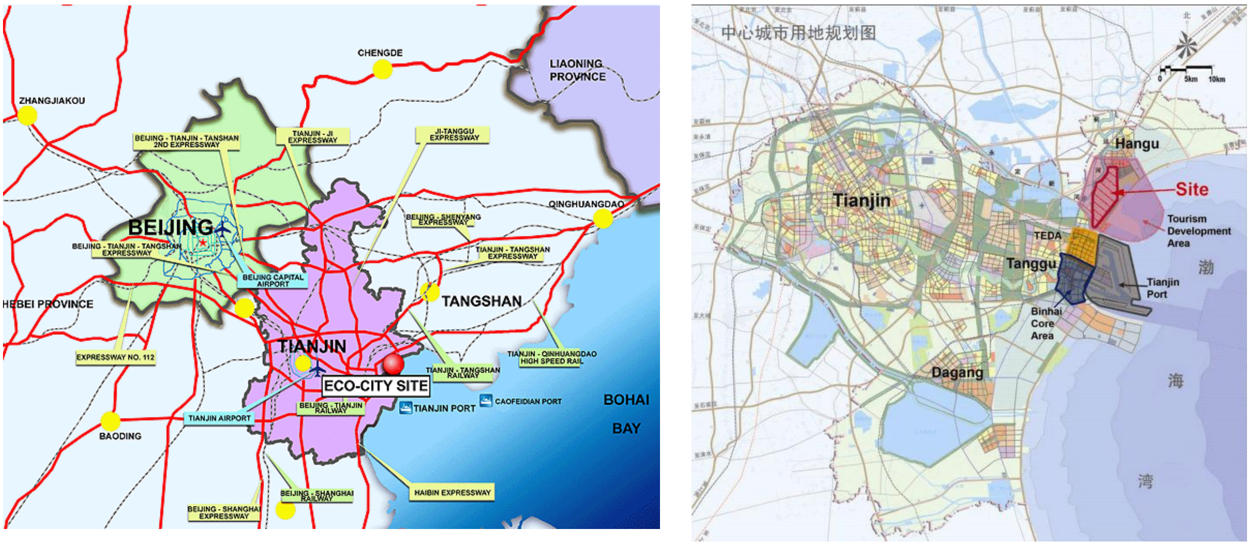
As a dual-core city, Tianjin is divided into the old city and the Binhai New Area. Binhai New Area is a new growth pole in China, and it maintains an annual growth rate of nearly 30% of the GDP. As of the end of 2010, 285 Fortune Global 500 companies have established branch offices in Binhai. It is a base of China's advanced industry, financial reform, and innovation.

Land conditions in SSTEC are relatively poor: one-third of its land is saline, one-third is wasteland, and one-third is water area. By selecting for development 34.2 km^2 of non-arable land, deserted salt pans, and polluted water bodies, the project contributes substantially to the efficient revitalization and use of scarce land and water resources. At the same time, the site selection will obviate urbanization development pressures on an equivalent 34.2km^2 of potentially agriculturally productive land, thereby contributing economic, social, and ecological benefits in a context where agricultural land is increasingly lost to urbanization (The World Bank, 2009, p.iv).

SSTEC is located in the northern part of the Tianjin Binhai New Area (TBNA), at the intersection of the Beijing-Tianjin urban development axis and the Bohai rim coastal industrial zone. The project is 45 km from the Tianjin city center, 150 km from Beijing, and 50 km from Tangshan. Under the extension of the new Beijing-Tianjin High Speed Rail to TBNA, and other planned.

SSTEC is located in one of the major growth poles in northern China. TBNA has been the powerhouse of Tianjin’s economic and demographic growth, producing 44 percent of Tianjin’s Gross Domestic Product (GDP) with only 10 percent of its population. Over recent years, TBNA has been experiencing one of the fastest growth rates among cities in China, with annual GDP growth of 20.6 percent from 1994 to 2005. (The World Bank, 2009, p.iv).

Figure 7-24:Location of the SSTEC Project Site



Source: http://www.tianjinecocity.gov.sg/images/Location/location_1.gif_accessed_10-10-10

In terms of urban population, it is the sixth-largest city of the People's Republic of China, and its urban land area (Binhai New Area is not included) ranks fifth in the nation after Beijing, Shanghai, Guangzhou, and Shenzhen. Tianjin's urban area is located along the Hai River, which connects to the Yellow and Yangtze Rivers via the Grand Canal in Tianjin.Tianjin was once home to foreign concessions in the late Qing Dynasty and early Kuomintang (KMT) era. The municipality incorporates the coastal region of Tanggu, home to the Binhai New Area and the Tianjin Economic-Technological Development Area (TEDA) (http://en.wikipedia.org/wiki/Tianjin#Geography_accessed_30-09-11).

- **City Structure and Form**

Spatial Pattern

A city's spatial development process establishes the location, concentration, distribution, and nature of demand for key urban services, including transport, energy, water, and waste services. It determines the physical and economic constraints and parameters within which infrastructure investments and capacities will need to be designed, and associated costs recovered.

At the same time, urbanization downstream from a large water storage facility would likely reduce the need to pump water and construct distribution mains that would be required for more dispersed urbanization upstream from a water facility. In many municipalities, water and wastewater pumping can amount to greater than 30 percent of a city's energy bills. 62

The SSTEC Master Plan envisages a population of 350,000 on the 34 km^2 site. The resulting overall density will be 10,294 people/km^2 . This is a little lower than the density of Tianjin's core city, which was 13,355 people/km^2 in 2000, and which is anticipated to drop to 12,668 people/km^2 by 2020. 63 SSTEC's density is planned to be almost twice the projected density in TBNA's core urban area, which is expected to have 6,684 people/km^2 by 2020. However, as 9 km^2 or 26 percent of SSTEC's land area will be open space, water, and greenbelt, a higher density of 14,000 people/km^2 is expected on the remaining 25 km^2 of land designated for construction. This proposed density places SSTEC ongChina's more densely populated cities. In 2005, for instance, Shanghai's population density was 13,761people/km^2, while Beijing's was 7,237 persons/km^2. 64China has some of the world's most densely populated cities, and while the typical trend is to disperse population, SSTEC plans to maintain high densities for good reason (The World Bank, 2009, p.16).

- **Ecology and Nature Conservation**

SSTEC is envisioned as an "economically sustainable, socially harmonious, environmentally friendly and resource-conserving" city which will become a "model ecological and low carbon city replicable by other cities in China". It aims to achieve this vision by taking an integrated approach to planning a new urban area in an environmentally sustainable manner. According to the master plan, SSTEC promotes integrating land use and urban transport and balancing employment and housing supply. SSTEC promotes the "use of clean/renewable energy and reuse/recycle of resources through innovative technologies and environmentally friendly policies and investments across various sectors", including water, energy, land, and transport, among others. Global climate change and social equity issues are also incorporated into the master plan by explicitly including GHG reduction and affordable housing targets (The World Bank, 2009, p.ii).

Integrated waste management will be implemented in the Eco-city, with particular emphasis on the "3Rs" of waste management - Reduce, Reuse and Recycle. The conservation of resources and reduction of waste generation will be encouraged through public education programmes. Where possible, non-organic waste will be recycled and reused, while organic waste will be used as biomass for energy.

Existing wetlands and biodiversity will be preserved. Extensive greenery will be a distinctive feature of the Eco-city, with lush green spaces and recreational spaces sensitively interspersed throughout the city. Water recycling and more efficient use of water resources will be one of the key features in the Eco-city. The Eco-city is located in an area of low rainfall. Water from rivers flowing through the region will not be able to meet the needs of the Eco-city. To overcome this constraint and to reduce its reliance on external water sources, the Eco-City will draw a significant part of its water supply from non-traditional sources such as desalinated water and recycled domestic and industrial wastewater. Apart from nature conservation there had been pragmatic efforts by the planners and developers to conserve the Heritage Tianjin. The development of the Eco-city will respect local heritage. The profile of the Ji Canal, a canal with 1,000 years of history, will be retained. Two existing villages within the Eco-city site, Qingtuozi and Wuqi, will be conserved through adaptive reuse or partial rebuilding.

- **Historical Development**

According to the SSTEC project website[66] set up by the Singapore Government, Premier Wen Jiabao readily agreed to jointly develop an Eco-city in the PRC with Singapore In April 2007, after the Senior Minister Goh Chok Tong broached the proposal for the PRC. However in Oct 2007 the PRC proposed four candidate sites for the Eco-city - Tianjin, Tangshan, Baotou and Urumqi for a competitive suitability analysis. One month later, Singapore and China jointly decided to select Tianjin as the location for the Eco-city. Consequently the Prime Minister Lee Hsien Loong and Premier Wen Jiabao signed a Framework Agreement on the development of the Eco-city on 18 Nov 2007. At the end of January 2008, the 1st Joint Working Committee meeting was held in Tianjin and co-chaired by Minister Mah Bow Tan and PRC Minister for Construction Wang Guangtao which sought to endorse in-principle a set of Key Performance Indicators (KPIs) for the Eco-city. Four Month later in April 2008, the 2nd Joint Working Committee meeting, which was held in Singapore, endorsed the draft Master Plan, which was then released by the Tianjin Municipal Government for public consultation. T The 3rd Joint Working Committee meeting in July2008 actually reviewed the detailed plans for the start-up area which led to the Groundbreaking Ceremony of the Eco-city in September 2008. Subsequently, in June 2009 the 4th Joint Working Committee met to review urban design schemes and the 5th Joint Working Committee meeting to review analysis of the KPI framework was held in May 10. As of the end of 2010, much of the targeted milestones in the implementation plan had been accomplished and in July 2011 the 4th Joint Steering Council Meeting was held to ascertain the progress of works.

Since the master plan for SSTEC was completed and approved in 2008, and the corresponding control plans are being finalized. The development work of Phase I of the project has begun and is expected to be completed between 2011 and 2013. (The World Bank, 2009, p.ii)

Figure 7-25: Completed Road as of December 2010

[66] http://www.tianjinecocity.gov.sg/

Source: (Boon, 2010, p.31)

Figure 7-26: Completed Dual Carriage Pedestrain Road

Source: (Boon, 2010,p.31)

B. Project Urban Context

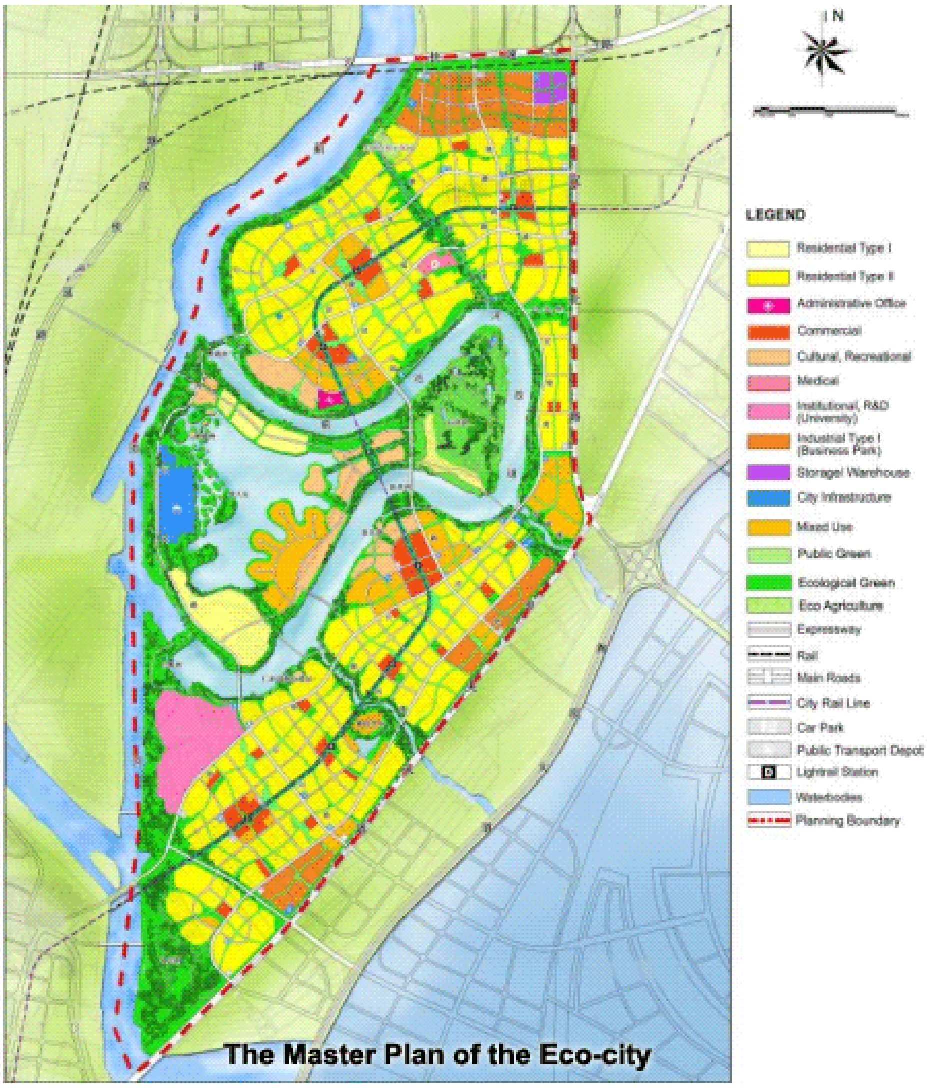
Although the annual average growth rate for the urban districts is likely to be only 0.2 percent over the next decade, the annual average growth rate for the TBNA where SSTEC is located is projected to be 5.5 percent. While the city center will absorb 197,000 people between 2000 and 2020, TBNA will absorb 1.65 million people in just 15 years (between 2005 and 2020) (The World Bank, 2009, p.iv).

Effective urban design can reinforce the public transport system and encourage pedestrian and bicycle use. It is advisable to maintain higher densities and spatial concentration along public transport corridors.

At the same time, good urban design can complement high aggregate density with increased commercial street frontage that provides a continuous array of ground-level commerce in neighbourhoods: restaurants, cleaners, grocery stores, hardware stores, cafes, and shops (etc.). Smaller block sizes linked to appropriate road networks can increase the exposed street frontage, reinforcing such commerce (The WorldBank, 2009, p.18).

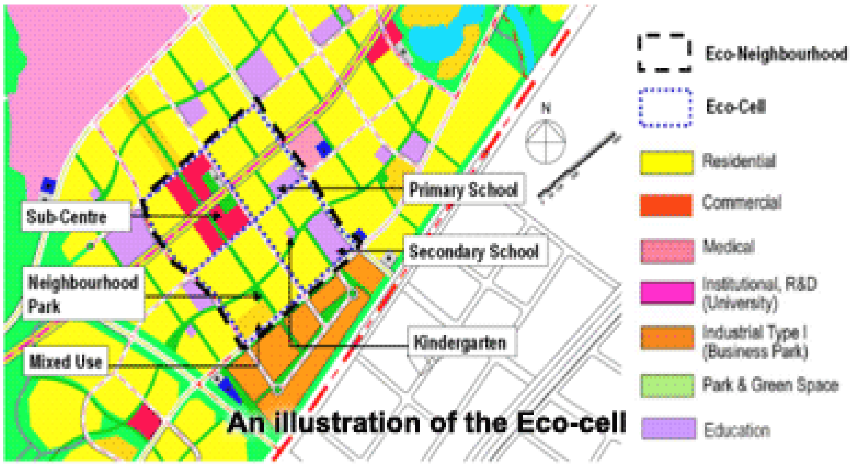
The SSTEC's Urban Design is framed by a spatial structure of "one spine, three centres, four districts" and "one island, three waters and six corridors", SSTEC's basic urban design constitutes the following: As is common in much new urban development in China, SSTEC supports a 400 by 400 m city block, called an eco-cell, which accommodates 8,000 residents. Roads will line the perimeter of these cells, though each cell will have four quadrants with pedestrian and bicycle only lanes. Each eco-cell will have a 'grassroots community centre' with a service radius of 200-300 m. Four of these eco cells will aggregate to form an eco-community of about 30,000 residents. The eco-community will have a residential community centre providing a higher level of activities. This residential community centre will have a service radius of 400- 500 m. Four to five of these eco-communities form an eco-district, and four of these eco-districts form (The WorldBank, 2009, p.18).

Figure 7-27: Master Plan of SSTEC



Source: http://www.tianjineco-city.com/en/eco_city/eco_vision/903.aspx_accessed_10-10-2011

Though the spatial structure of SSTEC makes good sense from the point of view of transit-oriented development, the decision to follow the existing Chinese approach of adopting a 400 by 400 m minimum block size poses risks to realizing the vibrant and walk-able community envisioned by the project. It is recommended that some of the 400m blocks be divided into smaller units. On this point, traditional block sizes in the vibrant older neighbourhoods of Chinese cities can offer good benchmarks for such urban design. In addition to adding variety to the existing scheme, experimenting with alternate block sizes during SSTEC's first phase would provide examples that could be evaluated and incorporated into designs considered for phase II and III (The World Bank, 2009, p.25).



Source: http://www.tianjineco-city.com/en/eco_city/eco_vision/903.aspx_accessed_10-10-2011

Another highlight of the Master Plan is an "Eco-Valley" running through the Eco-city as a north-south connector. It serves as the main ecological green spine and incorporates water-sensitive urban design elements, such as eco-swales and dry streams. The Eco-Valley will connect the major transit nodes, residential areas, community facilities and commercial centres. It will be a key public open space and focal point of the Eco-city.

C. Project Eco-City Context

Eco-City[67] according to SSTEC developers is not just about being greenbut also creating a vibrant economy, building a home for its residents and our desires for a better life. It is more than just cutting edge technologies or sexy, iconic buildings. It is about practical and well tested solutions. It is about the city' s spirit, civic values and community development, creating a sustainable lifestyle without compromising the residents' daily needs. More so sustainable development integrates six dimensions: intelligent city, clean water, ecology, clean environment, clean energy and green building. The Twenty six key performance indicators will be applied to ensure the city' s eco-development.

These 26 Key Performance Indicators (KPIs) were selected for the Sino-Singapore Tianjin Eco-city to guide its planning and development into a model city for sustainable development. In formulating these KPIs, reference was made to national standards in China and Singapore, and the higher of the

[67] (http://www.tianjineco-city.com/en/eco_city/eco_vision/903.aspx_accessed_10-10-2011)

two standards is adopted wherever feasible. Due consideration was also given to international practices as well as local conditions in Tianjin. Out of the 26 KPIs there are 22 quantitative and 4 qualitative KPIs. Quantitative indicators are categorized into three broad areas: ecological and healthy environment; social harmony and progress; and dynamic and efficient economy. Qualitative indicators focus mainly on regional coordination and economic integration (The World Bank, 2009, p.iv).The start-up area and the entire Eco-city development are targeted for completion by 2013 and 2020 respectively, and so reference is made to these years in the KPIs.

These qualitative KPIs included:

i. Maintain a safe and healthy ecology through green consumption and low-carbon operations.
ii. Adopt innovative policies that will promote regional collaboration and improve the environment of the surrounding regions.
iii. Give prominence to the river estuarine culture to preserve history and cultural heritage, and manifest its uniqueness.
iv. Complement the development of recycling industries and promote the orderly development of the surrounding regions.

However the quantitative KPIs which were group into four main objective categories comprise; Good Natural Environment, Healthy Balance in the Man-made Environment, Good Lifestyle Habits as well as Developing a Dynamic and Efficient Economy. These objective categories were further expatiated into the quantitative KPIs. For instance;

(1) **Good Natural Environment** had six(6) KPIs as the measurable indicators and the consisted of;
   - Ambient Air Quality: The air quality in the Eco-city should meet at least China's National Ambient Air Quality Grade II Standard for at least 310 days. The SO_2 and NO_X content in the ambient air should not exceed the limits stipulated for China's National Ambient Air Quality Grade 1 standard for at least 155 days.
   - Quality of water bodies within the Eco-city: Water bodies in the Eco-city should meet Grade IV of China's latest national standards by 2020.
   - Quality of Water from Taps: Water from all taps should be potable.
   - Noise Pollution Levels: Noise levels must fully comply with China's standards for environmental noise in urban areas.
   - Carbon Emission Per Unit GDP: The carbon emission per unit GDP in the Eco-city should not exceed 150 tonne-C per US$1 million.
   - Net Loss of Natural Wetlands: There should be no net loss of natural wetlands in the Eco-city.

(2) **Healthy Balance in the Man-made Environment** on the other hand had three(3) measurable indicators which are;

- <u>Proportion of Green Buildings </u>: All buildings in the Eco-city should meet green building standards.
- <u>Native Vegetation Index</u>: At least 70% of the plant varieties in the Eco-city should be native plants/vegetation.
- <u>Per Capita Public Green Space</u>: The public green space should be at least 12 square metres per person by 2013.

(3) **Good Lifestyle Habits** which permeate all sectors of live had ten (10) measurable indicators as well. These include;

- <u>Per Capita Daily Water Consumption</u>: The daily water consumption per day each person should not exceed 120 litres by 2013.
- <u>Per Capita Daily Domestic Waste Generation </u>: The amount of domestic waste generated by each person should not exceed 0.8 kg by 2013
- <u>Proportion of Green Trips</u>: At least 90% of trips within the Eco-city should be in the form of green trips by 2020. Green trips refer to non-motorised transport, i.e. cycling and walking, as well as trips on public transport.
- <u>Overall Recycling Rate</u>: At least 60% of total waste should be recycled by 2013.
- <u>Access to Free Recreational and Sports Amenities </u>: All residential areas in the Eco-city should have access to free recreational and sports amenities within a walking distance of 500m by 2013.
- <u>Waste Treatment</u>: All hazardous and domestic waste in the Eco-city should be rendered non-toxic through treatment.
- <u>Barrier-Free Accessibility</u>: The Eco-city should have 100% barrier-free access.
- <u>Services Network Coverage</u>: The entire Eco-city will have access to key infrastructure services, such as recycled water, gas, broadband, electricity and heating by 2013.
- <u>Proportion of Affordable Public Housing</u>: At least 20% of housing in the Eco-city will be in the form of subsidised public housing by 2013.

(3) **Developing a Dynamic and Efficient Economy** to support the unconventional sustainable development had four (4) measurable indicators as well. These were;

- <u>Usage of Renewable Energy </u>: The proportion of energy utilized in the Eco-city which will be in the form of renewable energy, such as solar and geothermal energy, should be at least 20% by 2020.

- <u>Usage of Water from Non-Traditional Sources</u>: At least 50% of the Eco-city's water supply will be from non-traditional sources such as desalination and recycled water by 2020.
- <u>Proportion of R&D Scientists and Engineers in the Eco-city Workforce</u>: There should be at least 50 R&D scientists and engineers per 10,000 workforce in the Eco-city by 2020.
- <u>Employment-Housing Equilibrium Index</u>: At least 50% of the employable residents in the Eco-city should be employed in the Eco-city by 2013.

The SSTEC is envisaged on completion to demonstrate Innovation, non-conventional and provide multiplier effect. Through the implementation of these KPIs in the development process, the Sino-Singapore Tianjin Eco-city has applied the planning concept of eco-economy, eco-residence, eco-culture, harmonious community and scientific management. By integrating advanced ecological, environmental protection, and energy-saving techniques, it will create a natural, harmonious and liveable human residence, and thus commit itself to constructing an eco-city that is economically vibrant, environmentally friendly, resource-efficient and socially harmonious.

An eco-culture with regional features will be formed to promote a green and healthy style of life and consumption. Focusing on coordination with the neighbouring regions in terms of environment, socio-culture, economy and policy will help to realize regional integration. The SSTEC promises to play a catalyzing or demonstrating effect in other provinces in China.

7.4 LESSONS AND DISCUSSION

There are quite varied lessons that can be gleaned from the enumerated realised and the on-going or planned projects that may be essential to consider whilst proceeding seeking for strategies to implement in TSSA.

Though the Curitiba example seems to have been implemented at an era when the socio-economic and political situation was quite different from the current internet age, it still has quite some timeless lessons that can be learnt from it. The implementation strategy amidst the opposition and tenacity of the planning authorities may be in contradiction to the current status-quo for eco-city development where consensus building prior to the project development is vital. However, the acceptance of the project and the support it generated among the inhabitants support the fact that in a society of less exposure dictatorship with patriotism may be the best alternative to democracy or consensus building. Another issue is the scale of the scale of the development which was more on the regional basis since Curitiba has been recognised as a metropolis.

Some of the good lessons include how they used the development of urban green infrastructure network development to protect the rivers and water bodies by converting the land use from housing to parks along banks of these water bodies. More so, the innovative program that gave incentives to the poor to engage in the cause for eco-city development like the Garbage purchase program. Many planners have contended, for example, that cities with over a million people must have a subway system to avoid traffic congestion. Prevailing dogma also claim that cities that generate more than 1000 tons of solid waste a day need expensive mechanical garbage-separation plants. Yet Curitiba has neither as citizens recycle paper equivalent to nearly 1,200 trees each day. The 'Garbage That Is Not Garbage Initiative' has drawn more than 70 percent of households to sort recyclable materials for collection (Rabinovitch, et al., 2009, p. 326). Also in order for the development control and its enforcement to work, access to information on development related issues was free flowing and to curtailed land speculation and the idea of development before planning. Most importantly, the introduction of the effective transportation system and network and policies enhance mobility within the region with cost within the budget of the local government. In a nut-shell, strong political leadership and continuity backed by an efficient institutionalised planning system played a key role in the success of making Curitiba and Eco-City. Kronsberg on the other hand is an example of how a small quarter of a city can be eco-city planned and monitored to lift the living standard of the entire community. The treatment of the landscape and it water system using basic and inexpensive principles are very important to be highlighted.

According to CHRISTINA LARSON in her report on Yale's Environment 360[68] the planning of Dongtan Project on the other hand was done with little awareness of how local people lived, and the much-touted projects have largely been scrapped. Today, almost nothing has been built and the project has been abrogated after the mayor of the city was indicted on corruption charges. Some residents have been moved off the island, many of them becoming cab drivers in bustling Shanghai. Meanwhile local environmentalists and academics have recently spoken out against the project in the Chinese press, noting that the planned construction site happened to be located on the last extent wetlands outside Shanghai, home to rare migratory birds. Dongtan and other highly touted eco-cities across China were meant to be models of sustainable design for the future. With the discovery of oil in many of the TSSA countries, there is a tendency for international planning firms to strategically prepare visual stimulating and impressive economic analysis like Dongtan for new eco-cities for them. More often than not, these vaunted eco-cities have been designed by big-name foreign architectural and engineering firms who plunged into the projects with little understanding of Chinese politics, culture, and economics — and with little feel for the needs of local residents whom the utopian communities were designed to serve. Instead they usually become models of bold visions that mostly stayed on the drawing boards or collapsed from shoddy implementation. Without extensive consultation with local people, it's a challenge for foreign planners, even with the best of intentions, to understand what is required to transplant a farmer who grew up plowing fields into a city.

In the case of the Masdar project, the city's $22 billion budget served as a catalyst for additional innovation, which could also be considered as benefit to the economy (Todonova 2008). The large sums of money that were allocated to the project's course really could serve as an economic incentive for all major stakeholders to be part of it. According to Rosenthal (2008), Aluminium companies responded to the incentive by developing a more competitive product with significantly reduced carbon emissions to prevent their product from being excluded from the project.

The Reduce, Reuse and Recycle as well as composting and waste-to energy strategy can be researched and implemented with appropriate technology that is suitable for the Ghanaian economy. This would also call for the central Government policy and budget support as new recycling plant and waster trucks and companies would have to be supported with subsidies. Re-usage of the waste water system can also be explored and decentralized photovoltaic power also encouraged with the proper policy backing it. Through a combination of careful control of materials brought onto the site and intensive recycling and waste-to-energy technologies, Masdar City would aim for net

[68] http://e360.yale.edu/content/print.msp?id=2138_retrieved on 29_09_2009

zero waste. Physical waste would be managed through an integrated, user-friendly and odorless system and biodegradable materials would be composted (Nader/ Energy Procedia, 2009, p.3954).

Though a zero car city may be difficult, if a pragmatic green infrastructure network is planned and implemented with the necessary support, it would be pleasant for people to ride from the origin to their destinations without suffering from the scotching sun. The Bus Rapid Transit system may also be introduced as well as the Light Rail System in the Long-term. Masdar City was developed on a solid vision and objective backed by the requisite policy and political will to propel its execution into reality. Research into the new Technologies, Systems and Policies at Graduate level is relevant to help maintain any new system that would be introduced into Ghanaian education system.

After the oil, what will Masdar use to sustain its bloated population desert metropolis? TSSA cities ought to be planned in tandem with the other adjoining cities to curtail the temptation of creating a haven and expensive city for only the rich. Looking at the policing system in the country, a case like Masdar in Ghana would just increase the high-tech robbery and artificial lifestyle which would only support the rich, thus causing social segregation which was fought against during independence of Ghana. No one knows whether Masdar would be a success or not as it's just an experimental project yet to be sent through the rigorous test of time in a developing economy. Masdar development was not planned with the people but was planned for the people with the hope that it would satisfy the aspirations of the future inhabitants.

To develop an Eco-City afresh, one need to get the support of the decision makers of the country to buy into the vision or align its development agenda to it. According to Best (2011)[69] unlike Tianjin which financially and politically are backed by two nations, Masdar is almost entirely backed solely by the Abu Dhabi government. Masdar is an initiative of the government, is owned by a government-controlled company (Mubadala), and has been financed majority of the funds from the Abu Dhabi government. However Dongtan was backed by a single political figure on the Chinese side, the level of the official was much lower than that of in Masdar. In Masdar, the backing is coming from the highest levels of the Abu Dhabi government, not a city or district level official. SSTEC had both the Singapore Government and Chinese Government on board right from the project initiation. Thus one can infer that for an eco-city project to be successful the political will or backing needs to be from the topmost or the hierarchy in the government since the implication of its implementation has a lot of national implications.

[69] http://robswatsonadventure.blogspot.com/2011/03/masdar-city.html_accessed_10.20.2011

This may not be the case for existing cities that needs transformation into the eco-city development. What is necessary in that contest is the citizenry support which can be co-opted when basic needs are provided for through innovative strategies with the Eco-city development agenda like the case of Curitiba in Brazil.

PART - 3

Analysis of Focal Case Study

8 BASELINE PROFILE OF NEW JUABEN MUNICIPAL AREA (NJMA)

8.1 DEVELOPMENT HISTORY

The history of the New Juaben State originated from a people who had to migrate from their traditional home in Ashanti in 1870s and sought refuge in the then British Protectorate of Akyem Abuakwa (El Alawa, 2008). Their choice of Akyem Abuakwa as a destination was by design rather than an accident. This was because, in the 1830s, the Juaben under the great leader King Kwasi Boateng had sojourned at Kyebi in self-imposed exile and savoured the lavish hospitality of the Akyem people (El Alawa, 2008). Due to his excellent education, his rich working experience and high position he had held in the public service, Daasebre Prof. Emeritus Oti Boateng, the Omanehene (paramount chief) of the New Juaben Traditional area has already made a noticeable and impressive impact on the socio-cultural conditions of the place. However, the economic fortunes of the municipalities (for that matter Urban NJMA) remain least to be desired due to functional complexity and linkages relating to distribution of services and infrastructure (El Alawa, 2008). The spread of settlements including Old Settlement such as Oyoko, Suhyen, Asokore, Affidwase and parts of Adweso has been associated with non-compliance to planning schemes and a high spate of unauthorized development whilst other rural settlements do not have base maps[70].

8.2 PHYSICAL AND NATURAL ENVIRONMENT

8.2.1 Location and size

New Juaben is one of the six municipalities in the twenty one districts of the Eastern Region of Ghana and it covers a land area of about 110 square kilometres (New Juaben Municipal Assembly, 2006, p.17). It shares boundaries on the northeast with Akyem Abuakwa district, on the South east with Akuapem North, Yilo Krobo on the East and Suhum Kraboa Coaltar on the west. The population in the municipality is about 155, 000 inhabitants with Koforidua the regional and municipal capital contributing about 65% of the municipal population.

8.2.2 Climate and vegetation

The municipality falls between semi-deciduous rain forest climatic zone with a bi-modal rainy season of between 1200mm and 1700mm reaching its maximum during the peak period of May/June and September/October. The dry period is relatively small experienced between November and February.

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[70] http://www.ghanaculture.gov.gh/index1.php?linkid=65&archiveid=1233&page=1&adate=20/11/2008; The Ghanaian Times page 9 Thursday, November 20, 2008

Humidity and temperatures are generally high ranging between 20°C and 32°C (New Juaben Municipal Assembly, 2006,p.17). The mild temperature has a significant bearing in making the municipality a major tourist destination. The vegetation is characterized by tall trees with evergreen undergrowth and economic trees including chlorohora excelsa (odum) ceiba pentandra (onyina) Antaris Africana (kyenkyen) and troplochinton scleroxylon (Wawa) in the presence of scattered patches of secondary or broken forest. Lumbering, farming and building activities have however contributed to the degradation of the original vegetation [71](New Juaben Municipal Assembly, 2006, p.17).

8.2.3 Topography and Drainage

The underlying rock formation of the topography is mainly metamorphic which is known as the Akwapim/Toga rocks. This is part of the Akwapim ranges that stretch across the north eastern portion of the municipality. The rock formation has significantly contributed to the growth of the quarry industry serving as a great potential for the production of chippings for road construction. The land is gently undulating with heights ranging between 152m and 198m above mean sea level. The highest area is the mountain belt along the eastern boundary of the municipality locally called Obuotabiri. The Municipality is largely drained by the Densu River and its tributaries (Bampon, Obopakko and Efena) which serves as the main source of drinking water for the municipal. The river is dammed near Koforidua from where treated water is distributed to Koforidua and its suburbs. Few waterfalls are found at different sections of the Densu River[72]. The destruction of the surrounding environment of the river basin is however impacting negatively on the sustainability of this natural resource and causing perennial water shortage particularly during the dry season (New Juaben Municipal Assembly, 2006).

8.2.4 Soil

The three predominant soil types found in the municipality are the Nenkese-Koforidua/Nta-Ofin compound, Fete-Bediase complex and Adawso-Bawjiasi/Nta-Ofin compound association. These soil types are well suited for perennial tree crops and adopted annual and semi- perennial food crops of the area. They support the growth of cash crops such as cocoa, coffee, oil palm and citrus. The Ofin series is particularly suitable for the cultivation of dry season vegetables crops as vegetables sweet potatoes, sugar cane and rice. The Adawso-Bawjiasi/Nta-Ofin compound association, which forms

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[71] (Culled from New Juaben Municipal Assembly, 2006, p.17-64)

[72] (http://www.ghanadistricts.com/districts/?r=4&_=146&rlv=topology_accessed May 30th, 2011)

the smallest group of soils, is characterized by grey-brown loamy humans' horizons which are most economically utilized for the production of annual and semi-perennial food crops such as plantain, coco-yam and bananas[73].

8.2.5 Land Tenure

As per the history of NJMA and for that matter Koforidua, the land occupied was bought and paid for by the government from the Akyem Abuakwa to settle the Ashanti refugees who were running due to the war with the Ashanti King. The lands in Urban NJMA or Koforidua are therefore vested lands. Vested Lands- is a unique situation brought about by statutory intervention where the landowner retains the customary land ownership but the management of the land is taken over by the state in trust for the owners. The management responsibilities cover legal (e.g. prosecution), financial (e.g. rent assessment, collection, disbursement) and estate management (e.g. physical planning and its enforcement and administration of the property). Vested lands are administered under the Administration of Stool Lands Act, 1962 (Act 123) and the Lands Commission Act, 2008 (Act 767) (Water Aid Ghana[74], 2009, p. 13).

As per the records of the Lands Commission of Ghana, the total land affected in Koforidua as vested lands is about 19.47km2 by the Executive Instrument 195 enacted in 1961 (Nikoi, et al., 2006, p.27). The rights expropriated from the affected stools include the right to possess, use, manage, alienate security of tenure, bequeath and mortgage. In its current form, the policy gives the government direct control over all incomes from the affected Stool lands as well as non-affected Stool lands in the country. To this extent Stools in the country have legal rights to only 22.5% of all revenue from Stool land transaction. That is to say 77.5% of gross stool land revenue (capital and or rental) is deducted at source almost as tax (Nikoi, et al., 2006, p.27). However, lands which have already been registered by private persons retain all its rights as per law. This put Koforidua or urban NJMA into a unique position to implement urban policies and programs that can affect its fortunes in future as compared to other urban centres in Ghana where most of the lands are stool lands and saddled with land litigations.

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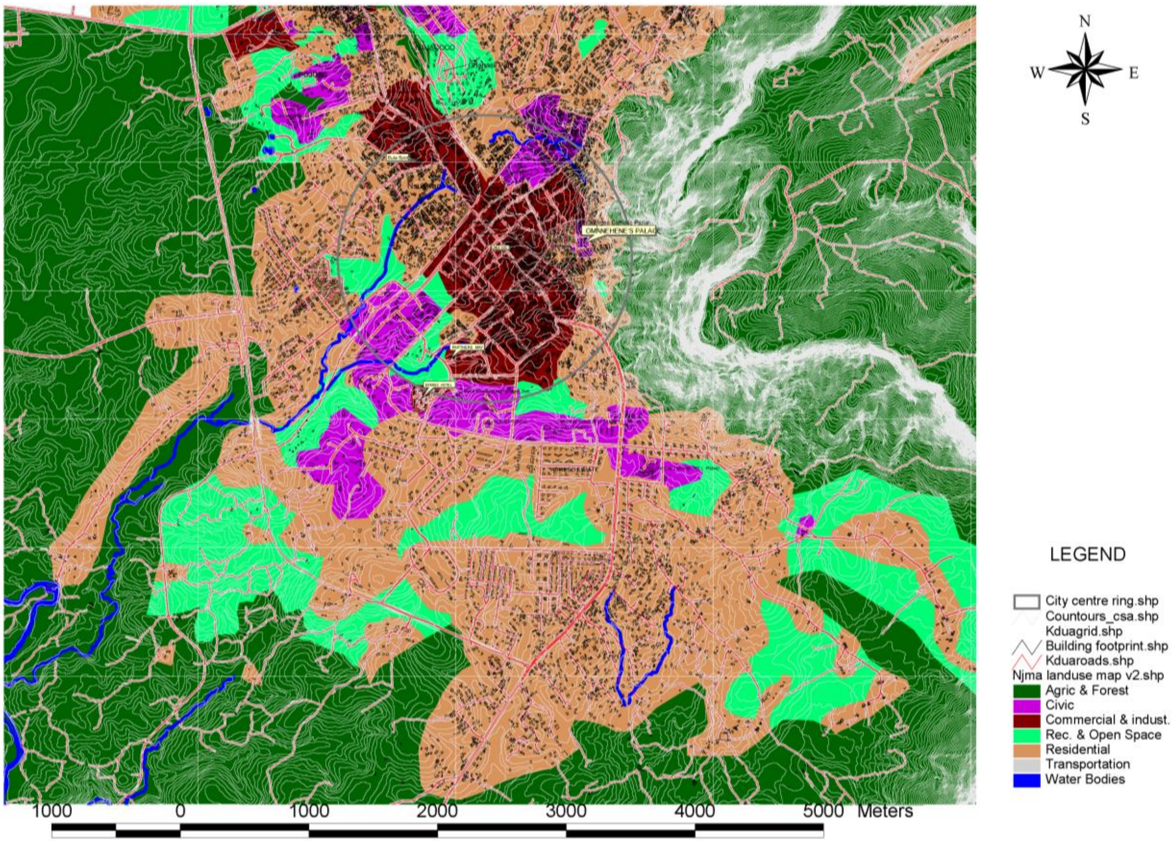
[73] (Culled from New Juaben Municipal Assembly, 2006, p17-64)

[74] (http://www.wateraid.org/documents/plugin_documents/land_tenure_study_report.pdf)

8.2.6 Land Use

As mentioned in the section 1.3.1 the sector covers an area of approximately 220 hectares. Out of this about 50% (i.e. 118,37hactares) is developed. The main Land Use categories are Agric and Forest, Civic/Public, Commercial and Industrial, Residential, Transportation (Roads and Pathways) and Water Bodies. Residential and civic and cultural uses pre-dominant generally residential and civic and cultural and open space uses dominate in the north-east, south- west respectively.

Figure 8-1: Existing Land Use Map of Urban NJMA



Source: Author

The existing land use demonstrates how human settlements can be destructive to the natural environment if it is not controlled. However, the natural limitation posed by the Obuotabiri hill to the eastern portion of NJMA has prevented sprawling of the city in all four directions and future destruction of agriculture and forest cover. The fragmented urban Green Infrastructure indicates the absence of any existing land use policy guiding the development in NJMA. Despite the presence of many circulation and access ways, the presence of vehicular-pedestrian conflict on the roads tends to favour automobile usage. The city centre as indicated by the circular ring shows that there is virtually no Green Infrastructure at the core of the city fabric and hence the existing recreational and open spaces tend to be threatened with some human developments in the near future. The orientation as indicated by most of the foot prints of the developments shows that there is no adherence to the solar orientation in the design and planning of the structures let alone the neighbourhoods.

8.3 HOUSING AND TRANSPORTATION SYSTEM

8.3.1 Housing

Housing facilities are mostly available in the peri-urban communities but limited in supply in the municipal capital (Koforidua). Majority of modern housing units are however found in Koforidua and areas such as Nyamekrom, Korle Nkwanta and Densuano. There is a very high occupancy rate and a number of them lack basic amenities like Toilets. The Housing delivery is dominated by the private sector and the popular house type is the compound house with courtyards. These are mostly found in Effiduase, Asokore, Oyoko and Jumapo. The few public housing facilities include those provided by SSNIT and government accommodation for public service staff (New Juaben Municipal Assembly, 2006, p.64). This also provides a good surface accessibility to services such as health, banking, post services, education, agriculture extension production and marketing centres, commodity flow and linkage with the districts.

8.3.2 Transportation and Mobility System

The access routes and circulation networks which enhance mobility within and around the Koforidua city contribute also to its form and structure as indicated in the land use map (figure 7-1). Almost all the existing roads in the municipality are reached by improved conditions of tarred reads and feeder roads and the district has a road network totalling up to 72 kilometres. The municipality compact size of 110 km^2 gives it a road density of 0.6 km^2 which is relatively adequate and suitable for efficient movement of people goods and services.

The main mode of transport for intra-community movement is walking. However well defined lanes and walkway are non-existent making walking very inconvenient thus adequate lanes and walkways are required. Apart from the trunk dual carriage road which has the potential of revealing the great natural landscape of the city, most of the routes really ignore to take advantage of the natural vistas.

A very high number of journeys occur between the peri-urban communities and CBD daily. Journeys to work and shop at the CBD are the predominant type. The two main modes of transport for these journeys are the *trotros* (private own Vans for Commuters) and the second is taxi. There is however a new introduction of inter-city Mass Transport system in place that serves the Koforidua city and its peri-urban settlements like Affidwase, Asokore, Oyoko, Akwadum, Densuano, etc. The absence of organised trotros and taxis terminal eventually make the vehicles load on and off load passengers and goods on the carriageway. The only form of rail transport is currently not in use. This was previously however being used to transport farmers and their foodstuffs from the villages to Koforidua and back during the market days. There is also no provision of Light Rail Transport just like every other city in Ghana. Proper parking facilities for both trotros and taxis are required.

Though there is a lot of intra-communities pedestrianisation and within sectors of the CBD, there is little or virtually no pedestrian infrastructure in place. There is also no infrastructure for the physically challenged along any of the routes whilst the roadsides and road shoulders are overtaken by advertising signs and street hawkers. Street furnishing and furniture is required to embellish and improve the streetscape. Due to vehicular pedestrian conflict compounded with high indiscipline on the roads, pedestrians are forced to wait for and compete even at pedestrian crossings with motorist. Koforidua is also noted for high Car Ownership Rate (COR)(Vehicles/1000Population). According to Faah (2008, p.73), the city's COR was about 137 vehicles per 1000 inhabitants as of 2008 and he projected it to be 178 vehicle/1000inh and 273 vehicles/1000 inhabitants in 2013 and 2023 respectively. As compared to Accra, the capital city of Ghana, Faah (2008, p.73), indicated that the COR was 105 vehicle/1000 inhabitants in 2008 and projected it to 150 vehicles/1000 inhabitants and 248 vehicles/1000 inhabitants respectively. This really indicates Koforidua potential for high transport energy consumption and eventual high emission of $CO_{2.}$

8.4 PUBLIC UTILITIES AND COMMUNITY SERVICES

The uniform and coordinated spatial distribution of basic infrastructures and services namely water, electricity, internet, telecommunication, educational institutions, banking and postal services, police, health facilities, markets and allied utilities are available in the municipality. The average water coverage is 49% as indicated by the New Juaben Municipal Assembly (2006) medium term development plan. Water delivery for domestic and industrial purposes is supplemented by rain harvesting, rivers, streams and dug-out wells.Rainwater harvesting is however carried out at the household level and in few institutions despite the high rainfall pattern in the area.

About 90% of solid waste generated in the municipality are disposed off in a landfill site located at 5km on the Akwadum road. The remaining 10% of the estimated 150 tons of waste generated daily are disposed off by open incineration at unauthorised dumping sites. There are 113 pre-school facilities with an enrolment of about 8100 and a pupil to teacher ratio of 1:27. More so there are 127 primary schools and 72 Junior Secondary Schools. There are 6 Senior Secondary Schools, 5 technical/ Vocational Institutions, 1 Polytechnic, 1 Teacher Training College and 1 University. A considerable volume of civic activities are carried out in the municipality and include the provision of postal services, Police, broadcasting and prison services and the facilities used for the provision of services are post office, police station, broadcasting station, and prison yard. There is one stadium though every community also has a Town hall which serves as a community centre. There are two major culture parks but poorly landscaped, which are the Jackson Park and Jubilee Park. Apart from that every other open space and basic school playing field also serves as a funeral ground for the week-ends and monthly social and funeral gatherings.

8.5 SOCIO-ECONOMIC SITUATION

8.5.1 Demographic characteristics

The 2000 population census puts the population of the municipality at 136,768 with growth rates of 2.5% which is lower than the national average of 3.1 the projection for 2005 is 154531 with female population constituting 51.5% and 48.5% for the male. The population density is 684 persons per square kilometre. Koforidua the regional and municipal capital harbours over 65% of the entire population of the district. The 52 settlements have small population sizes which do not normally measured up to the population thresholds required for the provision of essential socio-economic services. The municipality has a dependency ratio of 64.7% which implies that there are about 65 persons in the dependent age for every 100 persons in the working age group this is compared with the regional dependence figure of 90.7.

8.5.2 Age and sex composition

The age structure of the district shows relatively large proportion of children and a small proportion of older persons i.e. 65+ years. The age and sex distribution of the municipal assembly is shown in the table below

Figure 8-2: Age Composition Of The Population of New Juaben Municipal Area

AGE (Years)	**UNDER 15**		**15-64**		**65+**	
SEX	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
POPULATION (%)	35.4	34.0	60.6	60.8	4.0	5.2

Source: Statistical Service, 2006

The portion of the urban population in the municipality is 88.4%. The rural-urban split however is 15.7% rural and 84.3% urban.

8.5.3 Household Size and Characteristics

The municipality has an average household size of 10.9 persons which is the highest in the region. Table three depicts the comparison of the stock of houses and households in the municipality and the region.

Figure 8-3: Household Characteristics of New Juaben Municipal Area

DISTRICT	POPPPULATION	NO. OF HOUSES	NO. OF HOUSEHOLDS	HOUSEHOLDS PER HOUSE	AVERAGE H/HOLD SIZE
ALL DISTRICTS	2,106,696	283,461	453,663	1.6	4.6
NEW JUABEN	136,768	12,571	34,295	2.7	4.0

Source: Statistical Service, 2006

New Juaben municipality also has the highest number of households living in rooms in compound houses, i.e. 67.1%which is higher than the regional average of 43.1%. The district however has 11.3%of households living in separate houses which are the least common in the region. The ratio of male to female heads is 2:1.

8.5.4 Employment status

The municipality has got a high proportion of self-employed businesses without employees. The percentage of workers in the employee category is 27.9% which is the highest in the region. A huge proportion of the employed population is engaged in the public service, industrial, education sectors. About 29.3% of the workers are engaged in commerce while 28.6% are in production transport and equipment operations. Koforidua as the municipal capital and the centre of most administrative, commercial and political activities has also become the destination of immigrant youth from the surrounding villages although the indigenes are also migrating to Accra in search of non-existent jobs. In this regard, most people in the rural set up in the municipality as well as other districts migrate to Koforidua to seek jobs. On the other hand, the proximity of the district to the national capital Accra also attracts a good number of people from the municipality especially the youth to the national capital in search of jobs, which are mostly non-existent.

8.5.5 Culture and Tourism

New Juaben municipality is endowed with an enviable potential that predisposes the area to tourism development. The potential of the municipality includes the physical, historical and cultural variant that could be developed for conventional tourism. The scenic landscape, multiple ethnic characters which manifests itself in the exotic cultures as well as the sub-urban characteristics of the many of the settlements make the area a favourable destination for adventure seeking and exploratory tourists The celebration of the annual festival of the people, Akwantukese, has always attracted people from within and outside the shores of the country. It has developed over the year into a huge cultural celebration and greatly enhances tourism in the municipality. Other existing attractions are the waterfalls, peaks, historic places, cultural heritage and supporting facilities such as hotels and parks. Notable among these are the Kentenkiren waterfalls, Akwadum-Mpaem forest Akyekyeso crocodile sanctuary, Obuotabiri Mountains and bird view at Srodai and the Koforidua perk. Some of These tourists potential require farther development to enhance patronage. In addition these are over 18 high standard hotels and restaurants in the municipality. A couple of these hotels also provide conference facilities.

Two main cultural activities are prominent in the sector and these are funeral and burials which take place on the death of the member of the community. Incidental open spaces and streets are used for funerals. This is because well defined areas for the activity are not available. There is a cemetery in the sector and all the burials are carried out there. This cemetery serves the other sectors as well. It's getting congested and therefore its capacity requires expansion.

8.5.6 Ethnicity and Religion

The municipality is homogeneous in terms of ethnicity with a high dominance of Akans and ga-Adangba, Ewes and the other northern tribes also constitute a large part of the population. There is a fair mix of the Ashantis, Kwahus and Akyems with a sizable number of the Akwapim. The municipality on the other hand is predominantly Christian constituting of 82.8%, Muslims 6.1% and the traditional believers 2.4%. These religious inclinations have got a major influence on the dissemination of the information and constitute a significant force in mobilizing people towards developmental activities[75].

8.6 GOVERNANCE

The New Juaben Municipal Assembly was established under the local Government Act 462 of 1988 and granted its present status by Legislative Instrument (LI) 1426 of 1988. It is composed of 48

[75] (Culled from New Juaben Municipal Assembly, 2006, p.17-64)

electoral Areas and further divided into 13 Zonal councils and 86 Unit Committees (New Juaben Municipal Assembly, 2006, p.40). The Municipal Chief Executive is the political and administrative head of the Assembly and the Municipal Co-ordianting Director is the head of the bureaucracy and providesguidance and direction for all 11 decentralised departments of the Municipality. Nine out of eleven of these decentralised departments that are required by law are established and are in operation(New Juaben Municipal Assembly, 2006, p.43). The Department of Trade and Industry and Natural resource conservation are the two yet to be formed. That also explains why Environmental and Cultural conservation as well as Employment Opportunities are endemic problems of the municipal area.

8.7 UNDERSTANDING NJMA URBAN FORM AND STRUCTURE

8.7.1 Urban Pattern, Structure and Form

Urban pattern, structure and form have been used interchangeably and differently by many scholars and professionals of the built environment and their meanings have no longer clear in contextual usage. Hence a focus definition that can direct any discussion or future interventions was used to meet the objectives of this research. Hence according to Marshall (2005), when it comes to urban patterns:

- a historian or morphologist may be most interested in the sequence of formation of the urban structure;
- the transport planner might be more concerned with the relative distribution of 'trip ends';
- The town planner might be interested in the distribution of neighbourhoods, their facilities, and green spaces.

He went on to explain that there can be no single correct or definitive way of classifying patterns or identifying pattern types, since a diversity of overlapping types and themes are both appropriate and inevitable (Marshall 2005, p. 12). Urban structure on the other hand can also refer to the urban spatial structure, which concerns the arrangement of public and private space in cities and the degree of connectivity and accessibility (Wikipedia 2011). Marshall (2005) opines that urban structure is sometimes used to describe a variety of patterns and spatial distributions. Urban structure may best be equated with the two-dimensional organization of the ground plan of an urban area, such as the street pattern or the structure of land parcels. In this sense, it can be regarded as a specialised aspect of urban form; however, urban structure can also have socio-economic interpretations which have no direct associations with physical form. In its physical manifestation, urban structure is perhaps best reserved for application to forms that are or relate to contiguous structures, such as transport networks, or the structure of public spaces plus private parcels of land. This interpretation would exclude non-contiguous scatters (constellations) of buildings or land parcels (Marshall 2005, p. 14).

Urban spatial structure can also be defined as a combination of land use formation, its densities and the spatial design of infrastructure such as transportation and communication (Anderson et al., 1996). It can alternatively be characterised by three elements: the urban form, the human interaction in the city and the organising principles that define the relationship between the two (Bourne, 1982). Either way, the urban spatial structure of a city seems to have a significant influence on the transportation flows within its area; yet, it does not determine them entirely (Carty, J., Ahern A.; 2009, p.2). Urban form is perhaps the most all-encompassing of these terms that can imply either design or emergence of form, in two or three dimensions, from the scale of courtyards to conurbations. Although urban form includes all three dimensions in principle, at the widest scale, an urban area approximates to a two-dimensional surface, akin to an image on a map. From this point of view, urban form may refer to the overall size or shape of the urban area (e.g., a linear or star-shaped form), or its degree of articulation into discrete settlement units (Marshall 2005:p. 15).

8.7.2 NJMA Urban Form and Growth

The spread of settlements including old settlements such as Oyoko, Suhyen, Asokore, Effiduase and parts of Adweso have been associated with non-compliance to planning schemes and high spate of unauthorized developments. This has led to the increasing problem of accessibility and provision of infrastructures. The rural settlements including Akwadum, Mpaem, Suhyen, and parts of Jumapo and Oyoko do not have planning schemes. Base maps covering the unplanned area are now being developed for the preparation of planning schemes to curb haphazard development (New Juaben Municipal Assembly, 2006).

a. Spatial analysis

The functional hierarchy of settlements in the district positions Koforidua the regional and municipal capital, as the highest ranked settlement in the 52 communities. This is in terms of functional complexity and linkages related to distribution of services and infrastructures. Majority if facilities and economic infrastructures are found in the municipal capital. This situation has got a major impact on the scope and direction of economic and spatial development of the district.

The municipal capital has been a hub of commercial and industrial activities attracting a huge number of migrants in the search of employment and other opportunities. The disparity in the provision of infrastructures and services has led to the relative congestion of business activities in the urban and peri-urban areas and negatively affected the growth of other communities especially in the quest to attain the threshold population to support the provision of certain functions. Among these settlements classified under the second order category are the Akwadum, Suhyen, Oyoko and Jumapo

b. Urbanisation and Growth

The pace of urbanisation in Ghana has been quite rapid. In 1948, the ratio of the urban population to the total population was 13%. This increased to 31% in 1984 and 44% in 2000. In 1960, about 40% of Ghana's population lived in the three largest cities - Accra, Kumasi and Sekondi-Takoradi) and a further 9% lived in the next four (4) agglomerations – Cape Coast, Tamale, **Koforidua** and Winneba. Indeed, Accra alone accounts for over 40% of the total urban population (Tackie, 2008). Thus, despite the large increase in the number of urban localities from 39 in 1948 to 364 in 2000, approximately half of the country's population lived in the seven (7) largest urban areas (Water Aid Ghana, 2009, p.24).

c. Non-Physical Aspects:

The Urban Precinct or District Capital has a folklore which has been paraphrased into "Koforidua Frawase[76]" – "Koforidua Flowers"(From the Expression: "Koforidua Nhwiren, Dea Mede Wo Reye!" Literally Translated as: *Koforidua Flowers, What Use Do I Have Of You!*). The ideograph stems from the conspicuous consumption by some rich people during the rapid urbanization of Koforidua following the success of the cocoa industry, and later the diamond mining industry in the Eastern Region of Ghana at the turn of the nineteenth century. Sadly, due to lack of culturally conservation and preservation of oral history, the meaning have not been harnessed to identify how it can be used to assist inhabitants to associate with the urban fabric in which they dwell. The "Koforidua Flowers" symbolizes **Urbanization, Economic Prosperity, and Conspicuous Consumption** which is deep rooted in the mind set of the people.

The second element is the local Akwantukese festival which is celebrated annually to mark the Great Exodus or Journey of the Juaben from the former home in the Ashanti Kingdom to their current place

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[76] http://www.africawithin.com/akan/akan_economic.htm accessed_on_30th_May_2011

of abode. The spirit and ethos that surrounds this festival is that of nostalgia and passion which needs to be harnessed as an urban design and planning asset. These non-physical aspects could be tapped into as an asset for the implementation of an extensive Green Infrastructure Program.

d. Edges and threats to the Urban Structure:

The various neighbourhoods and enclaves in Koforidua lack any neatly visual compartmentalisation but rather its edges neatly dissipate visually and become very difficult to distinguish one neighbourhood from the other. This uniformity also exhibits some sense of dullness without any unifying architectural and landscape elements. One major threat of the urban fabric is the potential eternal lost of any cultural uniqueness due to lack of formal conservation of old building and sites with historic values. The Old palaces are being renovated without any documentation of the original state for the benefit of history and guide for emerging architectural styles. The contemporary architectural forms and styles also lacks visual cohesiveness and respect for any environmental and energy efficient requirements .The existing creeks, streams and rivers (e.g. Nsukwao, Okumi, Densu, Nyanyano) are all under threat from brisk and unrelenting urban and human developments along its banks. The highly under-capacitated Town and Country Department in the municipality also lacks the requisite tools and capacity to conserve the any architectural or urban elements with historic values and also regulate the emergence of new ones. They rather unofficially equate oldness with decay and newness with amenity.

e. Landmarks and Nodes:

As a city there are only few landmarks and nodes that help in the orientation and enhance of the environmental psychology within the urban space. The Ghana Commercial Bank and the SSNIT Buildings at the heart of City provides a unique landmark and node for orienting oneself and know exactly where to move or go within the CBD. The Wesley Methodist Church building is another landmark that welcomes you on entry into the city from the south which Accra-Aburi road. The St Georges Catholic Church is also prominently situated at the eastern side of the city at the foot of the Obuotabiri hills whilst Jackson Park also support the magnetic pull of commercial visitors to the city. A major boost to the urban fabric would be strategically enhancing and enriching the vistas and major natural sceneries as well as community funeral grounds. These grounds can also be incorporated into the comprehensive GI network for its preservation.

f. Pattern, Grain and Texture:

From the structural map of the City it appears the density is concentrated at the city centre and sparse at the peripherals. The building footprint may be dense but due to the dormitory nature of the peri-urban communities, everybody works within Koforidua and goes back to sleep in the evening at the peri-urban communities. More so, due to its uniformity of height (i.e. 4-16 metres- 1-3 storeys), with few 4-5 storeys, the texture of Koforidua can be described as irregular formed by network of branching routes. The entire community appears more of an extensive and uniformly grained area which does not reflect the undulating nature of the adjoining natural landscape. Its shape is more of an articulated sheet with elements of fractal geometry due to the natural settlement pattern of the compound houses. Communities like Nsukwao, Affidwase and Densuano shows some level of fractal settlement patterns.

g. Urban Visual Landscape and Routes:

The Urban Visual landscape is one of an eye-sore due to the littering of the routes indiscriminately with competing advertising signage and billboards. Compound the problem of many uncoordinated advertising signage is the crawling problem of street hawing and the perpetual absence of relevant road signs making access routes not only confusing for the motorist but the pedestrians and other users.

h. Direction of Growth:

The current direction of growth is towards the peri-urban settlement with very few infillings of the CBD. The development of the outer ring-road and the commencement of the national Affordable housing outskirts of Affidwase-Akwadum road have spark up very prominent and modern developments along those area. These as usual do not follow any development strategy or growth management pattern but typical sprawling of the communities.

9 GREEN ASSESSMENT OF URBAN NEW JUABEN MUNICIPAL AREA-GHANA

9.1 ECO-NERGY EFFICIENCYASSESSMENT

9.1.1 Relationship between Urban Form and Eco-Nergy Efficiency

'Eco-nergy[77] efficiency' is a term which for the purpose of this research have been coined out of **Eco**logical Responsive and E**nergy** Efficiency. Eco-responsive urban community is that community with its urban pattern and development positivey responsive to the Air and Atmosphere;Land Cover and Land Use;Land Conversion;Changes in Land Productivity;Land Degradation; Desertification;Biodiversity;Water as well as Bio-capacity. This consequently utilises the eco-city concept in its form and urban system conceptualisation and key to this is the develipment of a comprehensive green infrastructure network.

In the case of Energy Efficiency, it deals with the Total Final (Energy) Consumption (TFC)[78] which is the sum of consumption by the different end-use sectors. TFC does not include the energy used by the transformation industries and the energy losses in converting primary energy into a useable form for the final consuming sectors (IEA, 2005, p. 3). Non-energy use of such oil products as white spirit, lubricants, bitumen, and paraffin waxes is included in TFC. The sectors considered in the TFC are: Industry; Transportation (Road transport and All other Transport)[79]; Agriculture; Commercial and Public Services; Residential;Non Energy Uses and "other". Petrochemical feedstock and backflows from the petrochemical industry are not included. The total amount of primary energy refers to the energy consumed from all sources including fossil, nuclear, hydroelectric, modern renewable, traditional renewable and all renewable fuels and waste (IEA, 2005, p. 3).

For the purpose of this study, Road Transport Energy and Residential Energy efficiency would be considered. This is because within the SSA as indicated by the figure below as off 2001 these two sectors contributed more than 66% of the TFC for the sub-region. The case for Ghana is even more elaborate as these two sectors contributed more than 78% of the TFC for the country. Any attempt to efficiently deal with these sectors would automatically impart on the entire TFC for the Case Study area and the Country as a whole. The Energy supply sector in Ghana includes;

- Biomass in the form of Firewood and charcoal

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[77] Ecological Responsive and Energy Efficiency

[78] (The IEA measures the heat content of all energy commodities in metric tons of oil equivalent (toe). One toe is equal to 10 Exp. 7 kilocalories, 41.868 gigajoules, or 11,628 gigawatt-hours (GWh). A toe measures theenergy contained in a metric ton (1000 kg) of crude oil.)

[79] Road Transport includes all fuels used in road vehicles, including military, as well as agricultural and industrial highway use. The sector excludes motor gasoline used in stationary engines and diesel oil used in tractors. All Other Transport refers to all fuel used for non-road transport except fuel used for international marine bunkers and ocean, coastal, and inland fishing. It includes transport in the industry sector and covers railway, air, internal navigation (including small craft and coastal shipping not included under marine bunkers), fuels used for transport of materials by pipeline and non specified transport(IEA, 2005, p. 3).

- Petroleum in the form of gasoline, diesel, kerosene, LPG, residual fuel oil, etc.
- Power/ Electricity from hydropower, oil and natural gas.
- Solar & others in the form of off-grid PV , Solar Dryers, Biogas Plants and Wind Energy

(Energy Commission, Ghana, 2006, p.128) where as the demand side as captured in figure 8-1 below includes;

- **Residential** -Urban, Rural
- **Commercial and Services**-Tourism, Health, Defence, Education, ICT, Offices, Stores, Informal (vendor cooking, etc), Others
- **Agricultural and Fisheries** - Irrigation, Land Preparation and Harvest, Spraying and Logging, Post Harvest Processing, Livestock, Fisheries.
- **Transport** -Road, Rail, Maritime, Air
- **Industries**-Manufacturing, Mining, Utilities, Construction, VALCO

Though there are a mature institutions of research on the energy efficiency strategies and greenhouse gas contributions of individual energy-using devices such as buildings, automobiles and other structures there is a much less complete picture of the larger systems in which they operate, particularly urban systems and fabric (Mehaffy, et al., 2009). There is a lack of data on systemic indicators that are more difficult to measure or quantify, such as the cause of different trips people make (whether they are induced or mitigated by urban infrastructure), and energy flux effects as a result of urban morphology and density (Mehaffy, et al., 2009). Other factors include our poor understanding of qualitative factors, reasons for the choices made about housing and mobility, and people's expectations towards comfort and mobility (Mehaffy, et al., 2009).

According to Mehaffy et al., (2009) we do not even have a comprehensive model at this point that fully accounts for the key drivers of urban systemic energy use and their interactions, or a taxonomy of main determinants of urban energy use – as opposed to the much more clearly understood technological efficiencies of energy-using devices. It is important to recognise that cities, and other settlement types, can be treated as energy-using systems in their own right, with their own varying levels of efficiency.

Moreover, we know that the urban form can produce or mitigate heat island effects, affecting cooling demands, and can correlate with more or less efficient building morphologies. More difficult to assess, the form can affect the behaviour and consumption patterns of individual energy users, as they make decisions about a range of possible activities that affect energy consumption and emissions (Mehaffy, et al., 2009).

Figure 9-1: Energy Consumption(as a percentage of total final consumption)

	Energy Consumption(as a percentage of total final consumption by Sector)															
	Total Final Consumption (1000 metric toe)		Industry		Road Transport		All other Transport		Agriculture		Commercial & Public Services		Residential		Non-Energy Uses & "Other"	
	1990	2001	1990	2001	1990	2001	1990	2001	1990	2001	1990	2001	1990	2001	1990	2001
SUB-SAHARAN AFRICA	81.031	259.478	41,0	19,4	24,1	10,5	4,5	2,0	2,5	1,6	4,0	2,2	21,4	56,2	2,4	8,0
Angola	107	1.753	41,5	12,8	20,0	6,0	20,6	7,9	0,5	0,0	7,6	3,8	7,2	66,5	2,5	2,9
Ghana	4.367	6.337	15,7	14,4	11,8	14,5	1,7	2,4	0,9	2,7	0,3	1,2	67,8	63,8	1,8	1,0
Nigeria	8.184	85.491	19,3	10,8	47,7	9,2	4,8	0,6	0,0	0,0	1,9	0,3	21,1	78,3	5,3	0,7
NORTH AMERICA	1.468.100	1.725.599	27,2	27,2	29,0	31,1	8,2	7,2	1,2	1,1	12,3	12,5	16,3	16,5	5,8	4,3
United States	1.306.779	1.540.623	26,1	26,2	30,0	32,3	8,4	7,3	1,1	1,0	12,2	12,2	16,1	16,6	6,1	4,5
EUROPE	1.198.340	1.858.697	34,9	32,2	20,7	18,9	4,2	6,1	2,7	2,7	8,8	8,7	23,8	27,5	4,8	3,9
Germany	247.275	246.022	33,6	29,8	20,8	22,9	3,5	3,9	1,2	1,1	11,5	9,8	25,6	28,6	3,7	3,8
United Kingdom	145.374	161.418	26,8	24,6	25,5	24,4	6,5	8,0	0,9	0,7	8,9	10,8	25,7	27,7	5,8	3,8

Source: (Adapted from IEA, 2005, p.1-3)

Some authors argue that certain land use variables, for example density, have a strong correlation with energy consumption in travel (e.g. Newman and Kenworthy, 1989; Frank and Pivo, 1994; Cervero, 1996). Some are more cautious and suggest that land use factors are, at most, only a small part of the overall picture, and that other factors, such as socio economic factors, are more important in influencing the variation in travel (e.g. Gordon et al, 1997; Boarnet and Crane, 2001). Other researchers contend that there seems to be no significant basis to suggest that in light of current transport technology and costs households will desire to return to higher densities and that using land use planning as a policy measure to change transport energy consumption is not an obvious method. There is certainly little consensus within the body of previous research as to the relationships between land use and travel, and less still as to how land use can be structured to reduce transport energy consumption (Carty, J., Ahern A.; 2009, p.3).

There are divergent views as to which optimum urban form or structure enhances reduction in car travels and more so it's still not yet empirically proven whether increasing densities impacts positively or negatively on modal choice, travel distance and energy consumption(Banister et al, 2007). Whereas Newman and Kenworthy (1989) stipulates that increasing densities reduces energy consumption by transport, Gordon et al (1989), postulate that there is no clear relationship between the proportion of car trips and population density in the USA. This variation in opinion over the topic of urban planning strategies' effect on transport energy consumption is deepened by Jenks et al, (1996) thinks decentralised concentration' is the most efficient urban form in reducing car travel. Compact cities according to Breheny (1995); Gordon & Richardson (1996) and Banister et al, (2007) may not necessarily be the answer to reducing energy consumption, due to effects of congestion; also decentralisation may reduce trip length. By Banister et al, (1997) estimation, density is the most important physical variable in determining transport energy consumption but Owens, (1998) thinks that higher densities may provide a necessary, but not sufficient condition for less travel. Having more people close to their jobs will reduce vehicle miles travelled, freeway traffic and tailpipe emissions (Cervero, 1996). Communities with approximate job-housing balance see a majority of residents working in their home community (Cervero, 1989).

Nevertheless, diversity of services and facilities in close proximity reduces distance travelled, alters modal split and people are prepared to travel further for higher order services and facilities(Banister,1996; Banister,2007, p.5) However, Owen(2005) opines that mixing of uses is not as important as density in influencing travel demand. Williams (2005), also adds that much research advocates 'contained', compact, urban layouts with a mix of uses in close proximity, i.e. a move away from functional land use zoning. The search for the ultimate sustainable urban form perhaps now needs to be re-orientated to the search for a number of sustainable urban forms which respond to a variety of existing settlement pattern and contexts (Jenks et al, 1996) Location is an important determinant of energy consumption and car dependency (Banister, 1997), hence development close to existing urban areas reduces self containments and access to non-car owners (Headicar, 1997).

On the other hand, according it Schwanen ET all, (2001), de-concentration of urban land use to suburban locations and new towns almost promotes the use of public transport as well as cycling and walking. Distance to work however does not necessarily increase. In another analogy, Hanson,(1982)deducted that the trip frequency increases with household size, income and car ownership whereas Naess,(1996) postulated that travel distance, proportion of the car journeys and transport energy consumption increases with trip distances. Within all these controversies of opinion and research findings, there are basic fundamentals which delineate the points of departure held by these academics and professionals with regards to this topic. Bannister et al (2007) attribute one of these to problems with definition of the "out variable" where the impact of urban planning on transport energy consumption is a measure by various different parameters which are not comparable and hence make it difficult to draw conclusion. For instance travel is measured in terms of journey to work(most commonly) or of all trips; and mode choice(most commonly), trip frequency(increasingly), trip length(rarely), and composite measures (rarely) such as vehicle miles travelled and energy consumption.

Another problem is that of location where different geographical areas of research also give varying results of the findings. Even the time and the period of the year when the research was survey was conducted may also affect the traffic situation. Many of these effects take place over a considerable period of time, thus making it difficult to establish causality, and there is a potential for "contamination" from the effects of external factors that are not controlled for in the analysis (Bannister et al, 2007)

The evolution of transportation and land use has been symbiotic: urban form has a large impact on transportation network performance and vice versa (Kelly, 1994, p. 137; Kanaroglou, et al., 2001, p.23). In the 1800s, cities were characterised by high densities and mixed landuses. Evidence of this is provided by Lewis who, in a study of residential and employment locations in Montreal between 1861 and 1901, found that workers, constrained to woalking as predominant mode of travel, were inclined to live close to their place of employment(Lewis, 1991, p.144-146; Kanaroglou, et al., 2001, p.23).With the private automobile being a highly flexible and fast mode of travel, the need for a close spatial asociation between complementary land uses decline.

Thus in search of quiet neighbourhoods, larger homes and and lots, several negative repercussions are attracted by the sprawl and it includes;

- Increase in length and number of automobile trips
- Congestion, noise pollution,automobile energy energy consumption
- Permanent transformation of natural and farmland to urban use (Carley, 1992, p.207; Wegener, 1995, p.1; Kanaroglou, et al., 2001, p.24)

Kanaroglou, et al.(2001, p.24) is of the opinion that improvements in technologies must be supported by changes in human behaviour(i.e. reduced use of private autos) and Government policy initiative (development of efficient public transportation, fuel taxes, land use planning) that facilitate this behavorial change. Although it is clear that a relationship exist between the urban form and the transportation energy use and emissions, it is not clear which urban form is the most environmnetally benign and energy efficient (Kanaroglou, et al., 2001, p.24)

9.1.2 Factors Affecting the Urban Structure and Eco-Nergy Efficiency Relationship in NJMA

The intricate and complex relationship that exists between Urban Structure and 'Eco-Nergy' Efficiency in Koforidua brings out some issues that ought to be highlighted. Issues and factors which have urban planning implications for the Case Study area includes;

- **Proximity of daily needs and activity centres**: A good mix and distribution of workplaces, retail, offices and other daily destinations results in significantly shorter trips per day on average (Kenworthy, et al., 1999). Within the NJMA Urban Structure bringing location of activities and convenient shops or retail outlets close to the inhabitants would have a significant reduction in transport energy demand.Thus,for Koforidua what is needed is an integrated rather than fragmented urban network results in shorter trips on average, and proportionately lower energy use per trip. It also promotes walking, as average walking trips are also shorter (Pushkar et al., 2000, Dill, 2004).

- **Availability of effective, safe and convenient public transport:** An average single-occupancy passenger sedan consumes 4,200 kilojoules per passenger-kilometre, while a 40% occupied subway consumes 280 kilojoules per passenger-kilometre (just 6.7%). A 50% occupied diesel bus consumes 800 kilojoules per passenger-kilometre. *(Energy Information Administration, 2005).* It underlines the importance of mobility management with biasness towards public transport and high occupying vehicles whilst reducing the COR which possess a great potential for transport energy reduction
- **Walkability and Bikability:** Walking which is a very low-energy form of transportation - even when taking into account the food required to fuel it is not popular with the people of Koforidua due to unavailability of pedestrian infrastructure and attitude of people towards walking and biking. Assuming the fuel is cereal, walking consumes approx. 150 kilojoules per passenger-kilometre (*Summarised in Hydro-Québec, 2005.)* It's usually considered as a symbol of low prestige to bike and walk to places of interest for the indigenes. Moreover, the beginning or end segment of a public transport trip is almost always a walking segment. Hence due to the absence of pedestrian infrastructure in the city, obstruction of walkability (through lack of sidewalks, dangerous streets and so on) is also impeding transit use as well. Biking is also a low-energy form of transport, just 60 kilojoules per passenger-kilometre when fuelled by cereals (Various, summarised in Hydro-Québec, 2005.).
- **Loss of ecosystem services:** A low-density urban form consumes more land and destroys areas that may be contributing valuable "ecosystem services", such as water filtration, aquifer recharge and more. The loss of these services translates into yet more energy demand for pumping, water purification and the like. *[Knapp G., et al., 2005].* The success of these neighbourhoods and in promoting lower-energy habits

while attracting and retaining residents over time depends on attractive architecture, durable high-quality construction, and access to parks and natural areas *(Holtzclaw, 2001).* More so the ability of urban trees to improve the thermal comfort and hence improve the Eco-Nergy efficiency in the surroundings is a function of the seasons, background climate, size of the green area, type of surface over which the trees are planted, and the amount of leaf cover (Emmanuel, 2005, p.41).

- **Urban building type, exposure and orientation:** In addition, building orientation as it is shaped by urban structure can strongly affect passive solar characteristics, including excessive solar gain and loss of heat. *(Cited in Allen et al., 2004.)*

Table 3: Microclimatic effects of City Parameters

Phenomenon	Possible Effect
Population Size	Urban-Rural temperature difference is proportionate to population size. The effect is pronounced as population increases beyond one million. However, the relationship is much more complicated in tropical cities
Topography	Air drainage caused by elevation differences and secondary wind patterns created by topography tend to reduce the Heat-Island Effect
Rivers and Water bodies	UHI dissipates at or near water bodies, even if the water body is in the middle of a heat island
Wind Speed	UHI intensity is inversely proportional to macro-level wind speeds. However, urban wind flows are usually weak at macro-level
Anthropogenic Heat	The presence of large numbers of heating equipment and air-conditioners can aggravate the heat-island effect, though the effect pales in comparison to solar energy trapped by buildings
Water Runoff	UHI effect is more pronounced if more rainwater is allowed to drain away quickly from cities. Availability of water helps partition more heat by evaporation
Vegetative Cover	The presence of sufficient vegetative cover not only ensures more evaporation but also less radiation received at the earth's surface (due to photosynthesis)

Source: Chandler (1976); Landsberg (1981); Oke (1982); Emmanuel, 2005, p.26.

In relation to NJMA, since the population is under 1 million threshold, it does not exhibit much effect on the micro-climate but nevertheless, during the peak seasons like Christmas and Easter, some considerable effects is realised. Due to the presence and effects of the Obuotabiri Hills in NJMA, the ambient temperature is somehow modulated by the topography. The effect of the wind speed and

water run-off is relatively low except in the rural fringes where the sand had been weaned for construction purposes.
Nevertheless, the temperature difference between the urban core where vegetation is minimal and the fringes are significant can be attributed to the vegetative cover.

9.2 ASSESSMENT TOOL AND SOFTWARE

9.2.1 PLACE^{3}S

PLACE^{3}S, an acronym for **PLA**nning for **C**ommunity **E**nergy, **E**conomic and **E**nvironmental **S**ustainability, is a land use and urban design method created specifically to help communities understand how their growth and development decisions can contribute to improved sustainability. It is the name of a method of planning developed cooperatively by the state energy offices in California, Oregon and Washington and consultants Criterion, Inc. and McKeever/Morris, Inc., both of Portland, Oregon. The PLACE^{3}S method is based upon the findings of a large group of talented researchers. Their refinement of the understanding of the relationship of energy to the environment and to the economy has made it possible to construct analytical methods like PLACE^{3}S (U.S. Department of Energy, 1996,p.2).

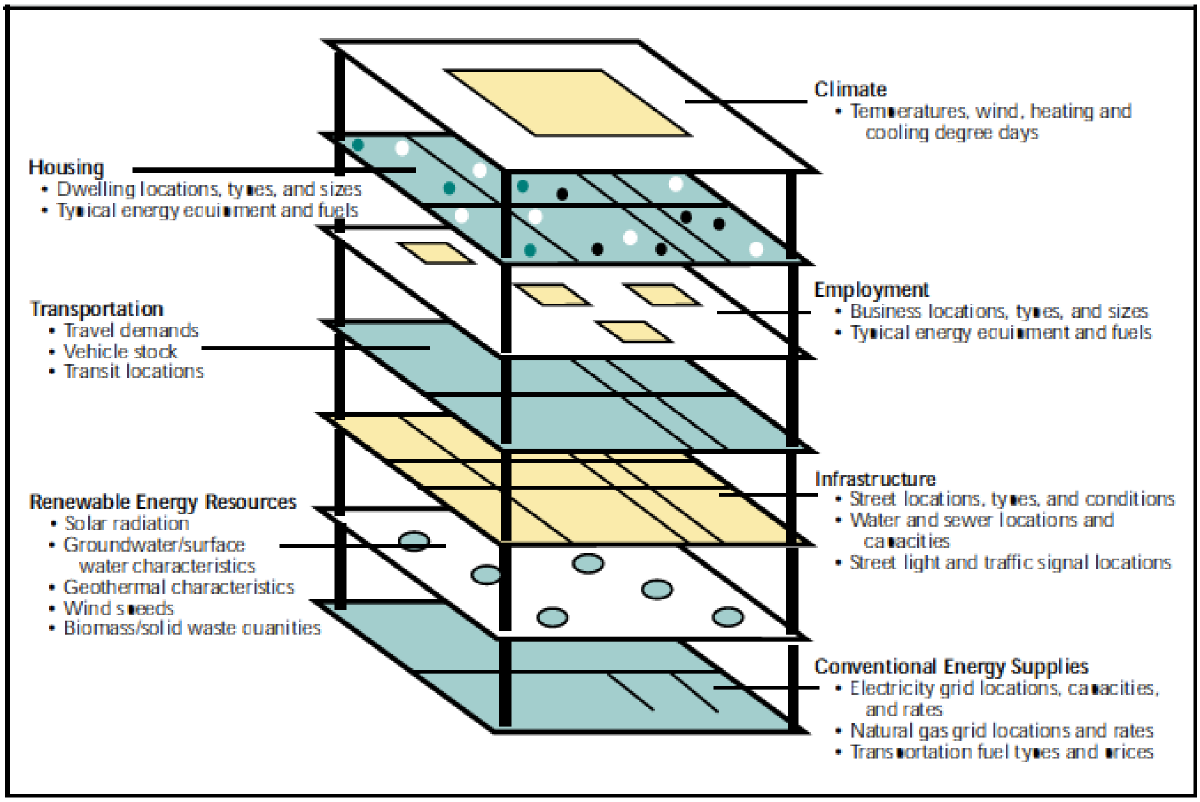
PLACE^{3}S can help communities assemble the data and perform the analysis needed to find and to maintain the complex balance that will lead to sustainability. In essence PLACE^{3}S enables communities to use energy as yardstick to measure the sustainability of their urban design and growth management plans. As per the Department of Energy (DOE)(1996) the PLACE^{3}S approach to urban planning uses energy accounting to evaluate the efficiency with which we use our land, design our neighbourhoods to provide housing and jobs, manage our transportation systems, operate our buildings and public infrastructures, site energy facilities, and use other resources. It goes on to explain that PLACE^{3}S uses energy accounting as a uniform language to bring together a diverse set of stakeholders. It provides maps and focused data to educate the public and decision makers about the effects of their choices on their community. The outcome is a well-informed inclusionary public process , the DOE(1996) expatiates, that balances community values and integrates environmental, economic and social goals. The premise of PLACE^{3}S is that urban planning and design can shape communities for efficient energy production, distribution and use. By intentionally conserving all forms of energy and promoting reliance on renewable resources in planning and design choices, cities can simultaneously improve their economies, environments, and quality of life.

Common community planning issues today are population growth, competition for business, limited infrastructure, and declining quality of life. How a community responds to these issues will determine if it becomes more or less sustainable in the future. Adapting a community planning process to employ the PLACE^{3}S method will provide information about the long-term energy, environmental, and economic implications of plans to help communities discover ways to increase sustainability (U.S. Department of Energy, 1996,p.3).

Creating energy efficient community plans requires measuring energy demands and supplies for housing, employment, transportation, and infrastructure. These measurements are similar to other calculations that tabulate dwellings, residents, workers, traffic, and other variables in city planning. The PLACE^{3}S method simply adds an "energy column" to these measurements. The energy sectors that PLACE^{3}S measures include:

- **Transportation**. How much gasoline, diesel, and alternative fuels do cars, trucks, and transit vehicles use? Transportation energy is usually the largest end-use sector in a community, often accounting for 40 to 50 percent of total energy use annually.
- **Residential/Commercial/Industrial.** How much electricity, natural gas, and other fuels do heating and cooling, lighting, and appliances and equipment in buildings use? PLACE^{3}S also tabulates the energy embodied in the manufacturing and transport of construction materials. The residential sector is normally 20 to 30 percent of total community energy use, with the commercial and industrial sectors often accounting for another 20 to 25 percent.
- **Infrastructure**. How much electricity do streets lights, traffic signals, and water and sewer systems use? PLACE^{3}S also measures energy embodied in the construction of streets and utility systems. Community infrastructure normally amounts to 5 to 10 percent of total community energy use.
- **Energy production**. In contrast to the consumption measurements described above, this category measures energy output for local renewable energy resources such as solar, wind, and geothermal and for high-efficiency technologies such as cogeneration and district heating and cooling. These types of production resources can make communities more self-sufficient and can extend the life and efficiency of existing electric and natural gas distribution grids. (U.S. Department of Energy, 1996, p.10)

Figure 9-2: Information needed for PLACE3S Study and Analysis



Source: (U.S. Department of Energy, 1996, p.16)

In order to make the PLACE^{3}S method applicable for the NJMA Area the following land-use and travel data was necessary to perform a meaningful analysis:

a. Dwelling units (DU) by type. At a minimum, distinguish dwelling types between single-family and multi-family. Use additional housing types if they are available in the regional database, since they can support greater accuracy in energy consumption estimates.

b. Employment by standard industrial classification (SIC). Employment is usually expressed by number of employees in a subarea. These data generally are organized by SIC type. Alternatively, some databases contain square footage of employment facilities, which can also be used to support energy consumption estimates.

c. Vehicle miles travelled (VMT) per year. This includes all motorized vehicle types, except transit. It includes all trips produced by, and attracted to, each subarea.

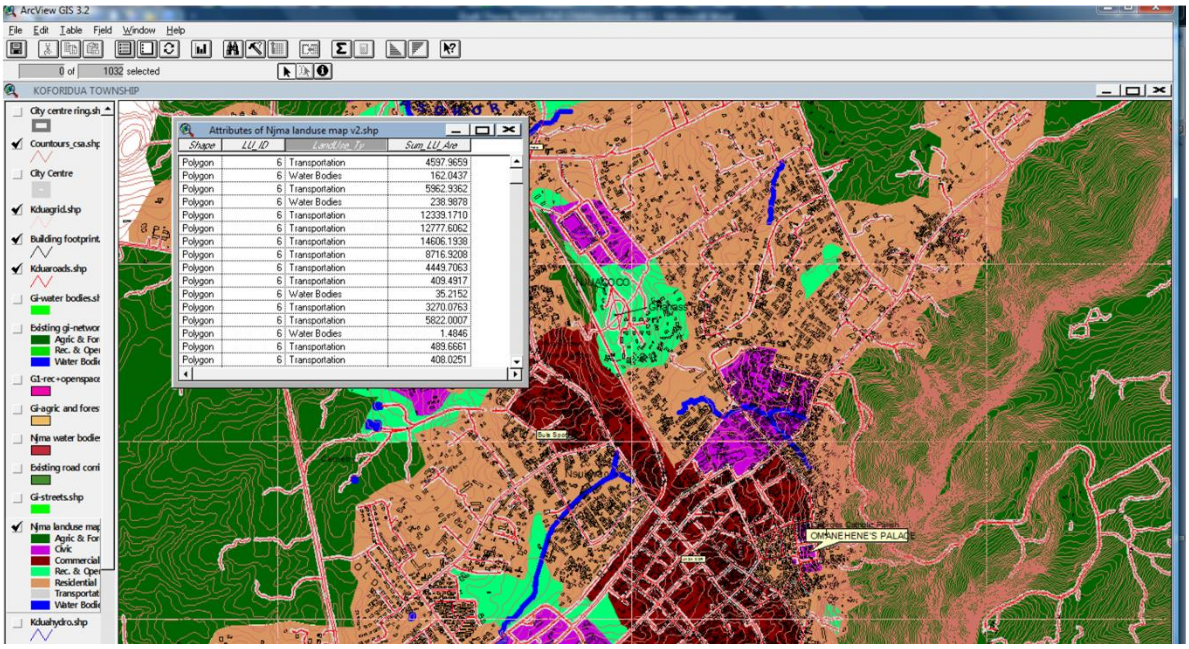
d. Transit passenger miles travelled (TPMT) per year. This includes all transit trips produced by, and attracted to, each subarea(U.S. Department of Energy, 1996, p.45)

An attempt was made to utilise this to assess the energy efficiency of urban NJMA but due to lack or reliable data and inconsistency of the available ones a different method was adopted which is a hybrid of other methods was used.

9.2.2 ArcView GIS Desktop

Geographic Information System (GIS) has the capabilities in handling all numerous data simultaneously as one desire and it is easy to find alternatives. GIS handles a number of spatial attributes, their properties, and their interrelationships to each other. This would enable the user to store, process and visualize current and old information, update and manage the data desirably. The stored digital map information of the GIS database can be plotted in the required format to produce a map, retrieval, manipulation and display of all the data through set of GIS tools. For example the allocation of particular location for certain green type to meet certain aesthetic quality can be accomplished easily through multiple criteria and multilevel queries of the spatial and attribute data. GIS might also contain information for management and monitoring, such as soil moisture content of the soil, green types and conditions, including climatic requirements, risks and management (care) needs. Similarly the post implementation role of GIS may include the changes in the urban greeneries, changes in the ecosystems and the economic impact of urban greening (Owusu, 2005, p.52). Thus as an intermediary software, ArcView GIS 3.2 was uses with its Spatial Analyst Extension capabilities to analyse the Maps and generate new ones.

Figure 9-3: ArcView GIS 3.2 Screenshot during the Landuse Map analysis



Source: Author

9.2.3 LEED for Neighbourhood Development

According Welch, et al.(2011) LEED for Neighbourhood Development (LEED-ND) promotes best practices in location, design and development at the neighbourhood scale. It is the first LEED rating system to focus beyond the building level and evaluate whole neighbourhoods—or multi-building projects that contribute to neighbourhoods—and prioritize criteria such as site location, urban design, transportation, housing affordability, walkability, socio-economics, and neighbourhood-wide green infrastructure, in addition to green buildings(Welch, et al., 2011, p.37). The most sustainable neighbourhoods tend to exhibit high levels of walkability, a sense of place, social cohesion and stability, and neighbourhood resiliency amidst changing economic and socio-political conditions (Welch, et al., 2011, p.4). The LEED-ND is used for projects may constitute whole neighbourhoods, portions of neighbourhoods, or multiple neighbourhoods. According the United States Green Building Council (USGBC) (2009),there is no minimum or maximum size for a LEED-ND project, but the core committee's research has determined that a reasonable minimum size is at least two habitable buildings and that the maximum area that can appropriately be considered a neighbourhood is 320 acres, or half a square mile. A project larger than 320 acres is eligible but may find documenting certain credits difficult and may want to consider dividing the area into separate LEED-ND projects, each smaller than 320 acres. Although projects may contain only a single use, typically a mix of uses will provide the most amenities to residents and workers and enable people to drive less and safely (USGBC, 2009, p.xv).

The LEED 2009 for Neighbourhood Development Rating System is a set of performance standards for certifying the planning and development of neighbourhoods. The intent is to promote healthful, durable, affordable, and environmentally sound practices in building design and construction.
Prerequisites and credits in the rating system address five topics:

- Smart Location and Linkage (SLL)
- Neighbourhood Pattern and Design (NPD)
- Green Infrastructure and Buildings (GIB)
- Innovation and Design Process (IDP)
- Regional Priority Credit (RPC) (USGBC, 2009, p.xiv)

This rating system is designed primarily for the planning and development of new green neighbourhoods, whether infill sites or new developments proximate to diverse uses or adjacent to connected and previously developed land. Existing neighbourhoods can also use the rating system, and its application in this context could be especially beneficial in urban areas and historic districts. It is, however, important to point out that the owner or owners applying for certification should already own, have title to, or have significant control over a majority of the project site (USGBC, 2009, p.xvi). More so, the Smart Location and Linkage (SLL) of the topics in the rating system try to assess and evaluate **where to build,** whilst Neighbourhood Pattern and Design (NPD) tackles **what to build** and the Green Infrastructure and Buildings (GIB), **how to manage environmental impacts** (Welch, et al., 2011,p.4). Projects seeking certification must meet all prerequisites and earn at least 40 points by achieving various credits. Beyond basic certification, projects may achieve Silver (50 points), Gold (60 points), or Platinum (80+ points) certification for increasingly high performance (Welch, et al., 2011, p.36). The detailed checklist these three main categories are as indicated in Appendix 3.

LEED for Neighbourhood Development as explained by the copyright owners USGBC, emphasizes the creation of compact, walk-able, vibrant, mixed-use neighbourhoods with good connections to nearby communities. In addition to neighbourhood morphology, pedestrian scale, and mix of uses, the rating system also emphasizes the location of the neighbourhood and the performance of the infrastructure and buildings within it. The sustainable benefits of a neighbourhood increase when it offers proximity to transit and when residents and workers can safely travel by foot or bicycle to jobs, amenities, and services. This can create a neighbourhood with a high quality of life and healthy inhabitants. Together, well-located and well-designed green neighbourhood developments will play an integral role in reducing greenhouse gas emissions and improving quality of life.(USGBC, 2009,p.xix). The content a have several similarities to the goal of an Afro-Green Community development nevertheless the strategy and focus of the LEED-ND maybe suitable for the USA scenario, but a lot more of it may have to be adjusted for it to suit the TSSA context. More so considering the fact that, what goes into an Eco-Efficient and Environmental Responsive Community in TSSA may require other Geo-Anthropological considerations which maybe meaningful in the African context but nonsense in the American. The idea that there is not a Yes or No answer to the question for a Green Neighbourhood but a neighbourhood can have a level of ‘Greenness’ that is Certificate, Silver, Gold or Platinum seems interesting to apply it in the TSSA context. It is therefore paramount that an assessment tool which is more suitable to the TSSA context be prepared with the knowledge gleaned from the PLACE^{3}S, GIS Desktop and the LEED-ND.

9.3 GREEN INFRASTRUCTURE ASSESSMENT AND ANALYSIS

There are **three** key dimensions to the assessment of green spaces and green infrastructure which should inform judgements about ***conservation, enhancement, linkages, creation and development initiatives, opportunities and proposals*** (Davies, et al., 2006, p.26) for urban NJMA***:***

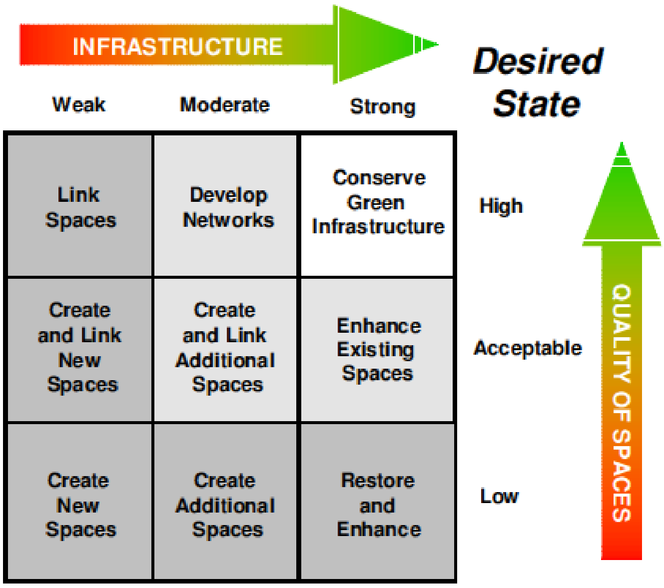
9.3.1 Context

In strategically planning for the GI of urban NJMA, the needs, wants, aspirations and problems of communities, groups and individuals who are actual or potential users of GI must be considered in making judgements about conservation, change or development (Davies, et al., 2006,p.26). This is effectively a demand side issue and relates not just to the total population, but also aspects of demography, deprivation and disadvantage. In short, certain areas may have a higher priority need for GI developments by virtue of their characteristics (Davies, et al., 2006, p.26).In this study, a desk analysis of the Medium term Development plan of NJMA(New Juaben Municipal Assembly, 2006) where detailed problem and vulnerability analysis have been done thrugh multi-stakeholder consultations. Key issues gleaned form this report for the GI planning includesecurity at night due to lack of adequate street lighting,absence of pedestrian street furnishings and furniture which poses as a threat to children and the physically challenged in the community.

9.3.2 Quality

Although quality is to a degree an absolute concept, the quality of green spaces and links is also determined by the concepts of sufficiency and suitability (Davies, et al., 2006,p.26).In the case of this study, It is entirely appropriate to conclude that an area has GI that is both sufficient (relative to defined and meaningful standards) and suitable (relative to a careful analysis of the needs of the surrounding area), although this conclusion is based on the available evidence, the authors insight of the area and the objectives as set out in the vision for the GI planning.

Figure 9-4: Quality of Spaces, Green Infrastructure and the 'Direction of Travel`



Source: (Davies, et al., 2006, p.26)

9.3.3 Interaction

GI has multiple functions and many of these functions derive from connections between elements. For example, non-car transportation will be enhanced when relatively high density residential areas are connected to centres of employment, and wildlife corridors are more likely to be effective when they link together relevant nature reserves and other habitats. Thus, linking green spaces to make networks and integrating networks to form an infrastructure realises synergies and can meet demand with supply. However, it is often the case that the links which may have real impact are non-obvious, or are not considered by planners in making decisions which could potentially have ramifications, either negative or positive, for the attainment of these outcomes (Davies, et al., 2006, p.26).

Thus using the above matrix in figure 48 above and the GIS software, a qualitative assessment was performed on the existing GI and Water bodies Map of NJMA. The description in the matrix were assigned as attributes of the various polygons representing the layers of the GI Network and the following questions used to critically analysed the existing GI situation and the way forward. The questions were;

- ***a.*** ***What green infrastructure elements must be protected?***
- ***b.*** ***What elements should be changed in character or enhanced?***
- ***c.*** ***Where there is a need to create new elements and what type should they be?***

d. ***Where the development of grey infrastructure should be integrated with GI?***
e. ***Which elements should be linked together?***
f. ***Which elements are possibly tradable to achieve net environmental gains in both an infrastructure and qualitative sense?***

The polygons were assigned attributes to indicate whether they were weak, moderate or strong as per infrastructural value and as per quality of space assigned-low, acceptable and high. The following connotations were used in the assignment;

- I_W represents: Weak Infrastructure value
- I_M represents: Moderate Infrastructure value
- I_S represents: Strong infrastructure value
- Q_L represents: Low Quality of Space
- Q_A represents: Acceptable Quality of Space
- Q_H represents: High Quality of Space

Thus for example, on aggregating the layers, polygons with;

$I_W + Q_L$ = Create New Space (CrtNewSpcs- as indicated in the GIS attribute table)

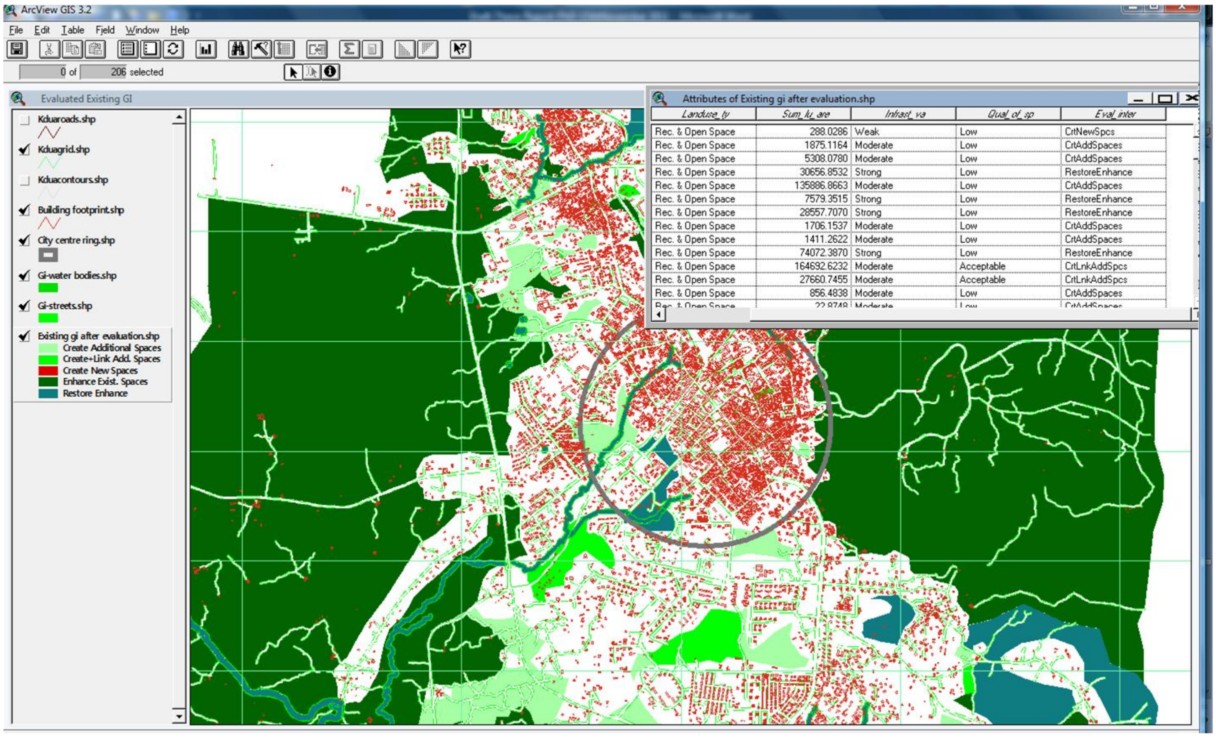
$I_W + Q_A$ = Create Link and New space (CrtlnkNewSpcs)

$I_M + Q_H$ = Develop Networks

$I_S + Q_H$ = Conserve Green infrastructure

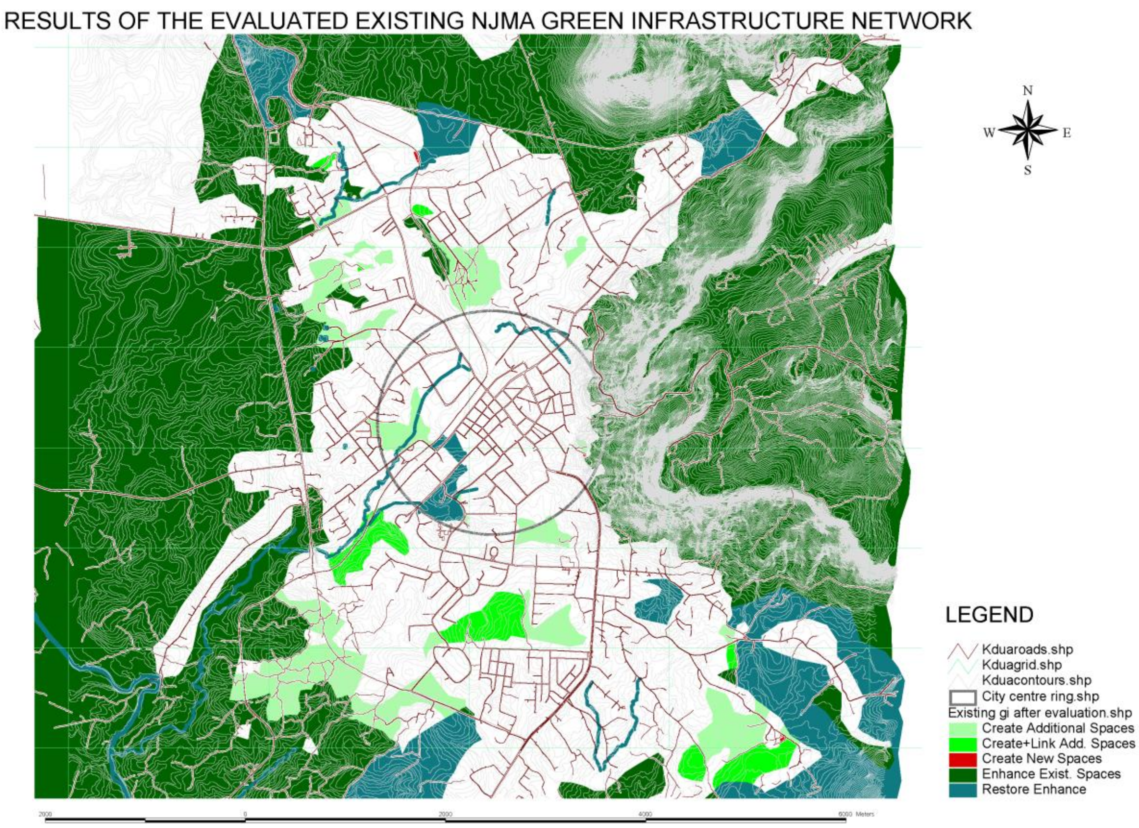
Consequently the resulting Map for NJMA using the above qualitative assessment strategy on the existing GI map is shown below in figure 8-5 and 6 below

Figure 9-5:Snapshot of the GIS Evaluation Process



Source: Author

Figure 9-6: Intermediate GI MAP After Evaluation



Source: Author

Thus using the above map as a baseline input, key decision as what constitute a Critical Green Infrastructure was determined. The concept of Critical National Infrastructure is well established: ***it defines the power, transportation and communications networks, food and water supply systems and other infrastructure components without which basic economic, welfare and social systems cannot effectively function.*** In applying the same principle the same principles in attempting to identify what comprises the Critical Green Infrastructure. The question is 'what can you not afford to lose' (Davies, et al., 2006, p.30)? This question must be answered with regard to ;

a. *context (e.g. what else is there nearby?),*
b. *quality (e.g. is this one of the most significant and valued sites in the area) and;*
c. *interaction (e.g. is this the only green link between a community and a nature reserve or between two large areas of green space?).*

According to Davies, et al., (2006, p.30), the answer does not have to be yes to all three to conclude that this is critical GI, and it may be that restoration or enhancement is required, but the critical issue is to identify those elements where loss or further degradation cannot be permitted.

9.3.4 Compatibility of the GI Eco-System Services on a Given Land

After delineation of the given spaces and areas for a comprehensive GI development, it also essential to identify the compatibility of the eco-system services that are being provided by the various aspects of the GI network demarcated. For the NJMA area the eco-system services considered are as adapted from Community Forest Northwest (2011, p.7) report for Northwest Climate Change Partnership;

1. **Managing surface water –** green infrastructure can help to manage surface water and sewer flooding by reducing the rate and volume of water runoff; it intercepts water, allows it to infiltrate into the ground, and provides permanent or temporary storage areas.
2. **Managing high temperatures** – particularly in urban areas, where evaporative cooling and shading provided by green infrastructure can ensure that towns and cities continue to be attractive and comfortable places to live, work, visit and invest.
3. **Carbon storage and sequestration** – storing carbon in soils and vegetation.
4. **Managing riverine flooding** – green infrastructure can provide water storage and retention areas, reducing and slowing down peak flows, and thereby helping to alleviate river flooding.
5. **Food production –** providing environmentally sustainable food production that delivers food security.

6. **Material substitution** – replacing materials such as concrete and steel (which involve high fossil fuel consumption in their production) with sustainably managed wood and other natural materials.
7. **Providing low carbon fuels** – replacing fossil fuels with lower carbon alternatives, including bio-energy, wind and hydro.
8. **Reducing the need to travel by car** – providing local recreation areas and green travel routes to encourage walking and cycling.
9. **Helping other species adapt** – providing a more vegetated and permeable landscape through which species can move northwards to new 'climate spaces'.
10. **Managing visitor pressure** – providing a recreation and visitor resource for a more outdoors lifestyle, and helping to divert pressure from landscapes which are sensitive to climate change.
11. **Reducing soil erosion** – using vegetation to stabilise soils that many be vulnerable to increasing erosion.
12. **Managing water resources** – green infrastructure can provide places to store water for re-use, allows water to infiltrate into the ground sustaining aquifers and river flows, and can catch sediment and remove pollutants from the water, thereby ensuring that water quantity and quality is maintained.
13. **Managing coastal flooding**[80] – green infrastructure can provide water storage and retention areas, reducing and slowing tidal surges, and thereby helping to alleviate coastal flooding

[80] To be utilised for cases with coastal line

Figure 9-7: Compatibility Matrix to climate change adaptation for GI Eco-system Services in NJMA

1. Carbon storage & sequestration	2. Fossil fuel substitution	3. Material substitution	4. Food production	5. Reducing the need to travel by car	6. Managing high temperatures	7. Managing water supply	8. Managing riverine flooding	9. Managing coastal flooding	10. Managing surface water	11. Reducing soil erosion	12. Helping other species to adapt	13. Managing visitor pressure	
	+	++	o	++	++	+	++	++	+	++	++	o	1. Carbon storage & sequestration
		o	--	o	o	-	o	o	o	o	o	o	2. Fossil fuel substitution
			--	o	o	-	o	o	o	o	o	o	3. Material substitution
				+	+	-	-	-	-	-	o	o	4. Food production
					++	+	++	+	+	-	+	++	5. Reducing the need to travel by car
						++	++	+	++	++	+	++	6. Managing high temperatures
							++	+	+	+	o	+	7. Managing water supply
								++	++	+	+	++	8. Managing riverine flooding
									++	+	+	++	9.Managing coastal flooding
										++	++	++	10. Managing surface water
											++	-	11. Reducing soil erosion
												-	12. Helping other species to adapt
													13. Managing visitor pressure

++	Generally compatible
+	
o	
-	
--	Generally incompatible

Source: (Adapted from NCCAPC), 2010, p. 53)

Managing coastal flooding was included because although NJMA have no coastal line, the study would be adapted for other TSSA country that may or may not have coastal lines. There are quite a number of TSSA countries in which their cities are battling with coastal flooding and reclamation of lands. For example Ghana in 2000 spent more than 84 million US Dollars[81] in the Keta Sea Defence project.

[81] Culled from http://www.modernghana.com/news/36169/1/body-to-manage-keta-sea-defence-project.html_accessed 2nd June, 2011

9.4 ENERGY EFFICIENCY ASSESSMENT AND ANALYSIS

In the urban environment, however, radiant temperatures vary according to shade, urban canyon geometry, vegetation availability and the seasons. The need for evaporative heat losses which lead to lower ambient air temperature and also reduce the potential for heating the urban canopy layer (UCL) is very critical for the urban thermal comfort. In the tropics it's important not only to use radiative and convective heat has losses to increase urban thermal comfort but also protect people from driving rains as well (Emmanuel, 2005, p. 87).

In terms of urban design strategies, the approach to tropical urban comfort may be summarized as follows (Givoni, 1989; p.7-6):

- Street Layout and system of network
- Density of built-up area
- Average and relative height of buildings
- Proper choice of building types (thick, thin, doughnut, etc.)
- Design details of green spaces

Table 4: Optimal Urban Parameters suggested for mitigating the negative impact of Urban Heat Island (UHI)

Urban Parameters	**Optimal Values**
Canyon Geometry	Height: width ration of 0.4-0.6 is suggested by Oke(1988b) for minimal heat trapping in summer and enhanced trapping in winter, without infringing too much upon air quality standards
Thermal Properties	An albedo increase of 0.15 in Sacramento, California was shown(Sailor, 1995) to have reduced the UHI by 2.7°F
Moisture Availability	The average moisture availability in North American cities in 15% of that in rural areas (Monteith, 1973). Its doubling was found to reduce the UHI by 20% in a simulation study (Oke et al., 1991)
Anthropogenic heat	Sailor (1995) suggested better building insulation and compact urban planning for a 50% reduction in building and urban heat wastes.
Vegetative Cover	Average North American cities are about 30% tree covered (Moll et al., 1989). Sailor (1995) found that a doubling of this amount could reduce the UHI by about 2°F.

Source: (Emmanuel, 2005; p.39)

Though there is no current statistical information on the effect of the urban parameters of NJMA or nay tropical developing country, the above listed in Table 3 indicates a marginal gain when applied to the cities. Hence an effort to increase the energy efficiency of a community through urban design strategies is still viable. A composite assessment was done after the key performance indicators had been developed and the ratings compiled for both the energy efficiency and ecological responsiveness.

PART - 4

Proposals , Recommendations and Conclusions

10 PROPOSALS FOR IMPLEMENTING ENERGY EFFICIENT AND ECO-RESPONSIVE STRATEGIES IN NJMA

10.1 SCOPE OF THE PROPOSALS

Due to the broad nature of the definition of what an eco-nergy efficient African City or an Afro-Green city would comprise of, a combination of diverse characteristics due to the different anthropo-geographic characteristics need to be factored in without promulgating a rigid prescriptive solution instead of guidelines that would enhance a generic development. The energy efficiency aspect of the proposal of the study focuses on transport and residential and policy instruments to reduce energy consumption, associated global emissions, and tailpipe emissions from transport and residential sectors which are the major contributors to the deteriorating environment and energy consumption in TSSA cities. The eco-efficiency aspect, on the other hand, deals with green urban infrastructure planning and strategies which enhances the environmental responsiveness and eco-system functions of the entire community.

Urban form develops slowly, and for this reason it often escapes the attention of those looking for rapid energy reductions. The structure of NJMA is primarily influenced by its circulation networks and the location of activity centres. Making all parts of the community and resources accessible therefore becomes fundamental to the development and growth of the place. Yet the corollary is that urban form is a persistent energy user, and therefore any changes made now are likely to have a large and compounding effect over time. This is particularly important in the TSSA (for that matter Ghana), where urban growth is often dramatic and chaotic, and its impacts are set to shape global energy and carbon patterns for many decades to come. Transport energy efficiency strategies according to Kwon, et al.,(2006,p.12) should;

a. shorten the total number of kilometres travelled by the vehicle,
b. minimize the vehicle’s fuel consumption per kilometre, and
c. Reduce local or tailpipe emissions per unit of fuel.

However some of the available strategies that can be implemented to achieve the above include (i) vehicle technology change; (ii) fuel quality improvement; (iii) alternative fuels; (iv) transport management, including traffic restraint measures; (v) public transport; (vi) road-use pricing; and (vii) other fiscal and administrative measures (Kwon, et al., 2006, p.12).Consequently, in the case of NJMA, the strategic action that is proposed to achieve purse the envisaged transport energy efficiency (TEE) are Mobility Management and updating of the Municipal Land Use plans which seeks to produce more compact, transit-served, walk-able urban form.

As indicated in box 4-7, the barriers to REE are in 2 main groups

a. Structural barriers: conditions that are beyond the control of the individual end-user
b. Behavioural barriers: problems that characterize the end-user's decision making

Thus any solution to tackle the problem in NJMA ought to be channelled in creating a paradigm shift in both individual attitudes and generate enough political will to back it up with pragmatic policies. Hence the strategic proposal for NJMA includes the Certification systems and a mixture of Catalyst projects and incentives for REE .The current land use composition of NJMA depicts that the municipality is almost a dormitory urban centre despite it serving as the commercial nerve centre for the Eastern region. Thus a REE system would be a major break-through for the entire community and make it attractive.

On the other hand, as indicated in chapter 5.3.1, the main barrier to eco-responsive planning are **Technical, Economical, Political, Informational** as well as **Social**. Hence a proposal to ameliorate the ecological decay and neglect in the area need to be something which is pragmatic, less expensive but help to change attitudes of the people to the environment whilst creating some sense of ownership. Thus within the Urban Green Infrastructure Networks strategy, what may be needed most for now is:

- Development Controls Enactment and Enforcement; and
- Ecological Aesthetics and Connectivity

Suffice it to say, it’s important to note that these proposals are being made with the assumption that the democratization and good governance practice in the Ghana is going to be deepened not derailed which would consequently trickle down to NJMA. More so, the decentralisation system in Ghana is assumed to also deepened and backed by adequate political will for municipalities and metropolitan areas to embark on initiatives that can serve as best examples for the sustainable development of the countries urban centres.

10.2 URBAN TRANSPORT ENERGY EFFICIENCY STRATEGY

10.2.1 Mobility Management

In other to enhance the efficiency of the UTE in NJMA or Koforidua, Mobility Management (MM) is proposed as one of the strategies which ought to be adopted religiously. The most comprehensive TEE approach evaluates transportation is in terms of accessibility, the ability to reach desired goods, services and activities (Litman, 2002, p.3). The transport sector in Ghana accounted for about 85% and 99.7% of diesel and gasoline consumption in the economy respectively. With the increasing world crude oil prices, such an efficiency strategy will have positive impact on future demand (Energy Commission, Ghana, 2006, p.38).

Conventional approaches often assume that transportation means motor vehicle traffic, measured in terms of per capita vehicle ownership and vehicle-kilometres, average traffic speed, roadway level of service, etc. From this perspective, anything that increases motor vehicle traffic speed and volume is considered desirable, and anything that reduces motor vehicle traffic speed and volume is considered harmful. A more comprehensive approach assumes that transportation means personal mobility, measured in terms of person-trips and person kilometres. From this perspective, strategies such as better transit services and rideshare programs may improve transportation without increasing total vehicle-kilometres. However, this approach still assumes that movement is an end in itself, rather than a means to an end, and increased personal movement is desirable (Marful, et al., 2010).

Mobility Management is defined as a primarily demand-oriented approach to passenger and freight transport involving new partnerships and a set of tools to support and encourage a change of attitude and behaviour towards sustainable modes of transport (Litman, 2002; p. 2). Mobility management however does emphasize on the movement of people and goods, not just motor vehicles and so gives priority to public transit, ridesharing and non-motorized modes, particularly under congested urban conditions (Litman, 2002; p. 1) with Fractal settlement pattern. Mobility management strategies use a variety of mechanisms to change travel patterns, including facility design, improved transport options, pricing, and land use changes. These affect travel behaviour in various ways, including changes in trip scheduling, route, destination, and frequency, plus traffic speed, mode choice and land use patterns (Litman, 2002, p.6).

Due to its low cost and multiple benefits, Sustainable Mobility Management is apparently the fulcrum of the connectivity and transportation objective of any evolving Afro-Green Community from NJMA. It is therefore ideal for urban communities in TSSA like NJMA which has limited resources to devote to Transportation Infrastructure (see table 4 below which lists some of the reasons to implement Mobility Management in developing countries like Ghana) to adopt mobility management as a strategy. Most urban centres in Ghana like NJMA which have narrow and crowded streets, limited space for parking and a diverse mix of road users, leading to conflicts over space and risk of crashes (Litman, 2002; p.1). Almost all the countries within the TSSA region cannot afford to build the highways and parking facilities that would be needed if the economies improve and the automobile ownership becomes common. As a major portion of the population in Koforidua cannot afford to own private motor vehicles, investments and policies that favour automobiles over other travel modes may be inequitable and unsatisfactory for solving most residents' travel needs (Litman, 2002; p. 1).

Thus as indicated in table 5 below, a mixture of mobility management strategies comprising; Improved transport options, Incentives to reduce driving, parking and Land use Management as well as program and policy reforms is proposed for implementation within the municipality to ensure TEE. There are many potential mobility management strategies with a variety of impacts. Some improve transportation diversity (the travel options available to users) whilst others provide incentives for users to change the frequency, mode, destination, route or timing of their travel. Some reduce the need for physical travel through mobility substitutes or more efficient land use and others involve policy reforms to correct current distortions in transportation planning practices (Litman, 2002, p.1).

Faah (2008, p.140), revealed in his research that Greenhouse gas emissions and fuel consumptions from road transport in Ghana could be reduced, if a proportion of daily trips made by passengers could be shifted from the use of private cars to the use of public transport such as buses. Thus, for a 10% and a 20% of daily passenger trips shift that were considered for the first and second scenario, the outcome was a 0.24 $MtCO_2e$, and 0.46 $MtCO_2e$ yearly emission reductions respectively.

Table 5: Factors That Justifies Mobility Mangement In Developing Countries

Infrastructure supply	Urban roads, parking, sidewalks and paths are often congested and crowded. Streets and sidewalks serve many functions and users (walking, talking, retail businesses, sleeping, begging, etc.) Streets not well designed for heavy motor vehicle traffic.
Vehicle supply	Low automobile ownership among general population. Medium to high automobile ownership among middle-income households. High automobile ownership growth rate among wealthy households. High bicycle ownership in some regions. Medium to high supply of public transit and taxi vehicles.
Personal mobility	Large variation in mobility between different income groups: low mobility among the general population and high mobility among wealthier groups.
Transportation diversity	Considerable diversity (walking, cycling, animal carts, public transit, private automobile). Conditions of alternative modes, such as walking, cycling, public transit, are often inferior (slow, uncomfortable, unsafe, unconnected, etc.).
Institutional capacity	Some developing countries have poor civil institutions to plan, implement and enforce traffic improvements. Sometimes poor cooperation between different levels of government. Most decision-makers are relatively wealthy and so tend to personally favour automobile-oriented improvements.
Government costs	Limited funding for transportation infrastructure and services.
Consumer costs	Many households spend a large portion of income on transport.
Traffic safety	High traffic casualties per motor vehicle. High risk to vulnerable road users (pedestrians, cyclists, animals, etc.)
Comfort	Low comfort levels for non-motorised travel (walking, cycling, animal carts, etc.) Low comfort levels for most public transit.
Environment	High pollution concentration in urban areas. Pavement of greenspace (farmlands and wildlife habitat) a problem in some areas.
Land Use	Medium to high accessibility in urban areas (many destinations can be reached by walking, cycling and public transit). Poor and declining accessibility in most suburbs and new communities. In some regions, limited land available for new transportation infrastructure.
Economic development	High dependence on imported transportation goods (vehicles, parts and fuel). Economic development harmed by dependency on imported goods.

Source: (Litman, 2002; p. 2; Marful, et al., 2010)

Table 6: Examples Of Mobility Management Strategies

Improve Transport Options	Incentives to Reduce Driving	Parking and Land Use Management	Programs and Policy Reforms
Alternative Work Schedules Bicycle Improvements Bike/Transit Integration Carsharing Flextime Guaranteed Ride Home Individual Actions for Efficient Transport Park & Ride Pedestrian Improvements Ridesharing Shuttle Services Small Wheeled Transport Taxi Service Improvements Telework Traffic Calming Transit Improvements Universal Design	Walking And Cycling Encouragement Commuter Financial Incentives Congestion Pricing Distance-Based Pricing Fuel Taxes HOV (High Occupant Vehicle) Priority Parking Pricing Pay-As-You-Drive Vehicle Insurance Road Pricing Speed Reductions Street Reclaiming Vehicle Use Restrictions	Bicycle Parking Car-Free Districts and Pedestrianised Streets Clustered Land Use Location Efficient Development New Urbanism Parking Management Parking Solutions Parking Evaluation Shared Parking Smart Growth Smart Growth Planning and Policy Reforms Transit Oriented Development (TOD)	Access Management Carfree Planning Commute Trip Reduction Programs Market Reforms Context Sensitive Design Freight Transport Management Institutional Reforms Least Cost Planning Regulatory Reform School Transport Management Special Event Management TDM Marketing Tourist Transport Management Transport Management Associations

Source: Litman, 2002; p. 4; Marful, et al., 2010

As shown in table 6 above, a lot of the elements of the identified proposed strategies of mobility management in NJMA affects shift mode, reduced vehicular trips and reduced vehicular ownership which inadvertently affects transportation energy demand and consumption.

Table 7: Benefits of travel impacts due to mobility management strategy implemented

(Blank means no impact, or mixed positive and negative impact)

Objectives	Reduced Traffic Speeds	Shift Trip Time	Shorter Trips	Shift Mode	Reduced Veh. Trips	Reduced Veh. Ownership
Congestion Reduction		X	X	X	X	X
Road Savings			X	X	X	X
Parking Savings				X	X	X
Consumer Savings				X	X	X
Transport Choice				X	X	X
Road Safety	X		X	X	X	X
Environment Protection				X	X	X
Efficient Land Use			X		X	X
Livability	X				X	X

Source: Litman, 2002; p. 9

10.2.2 Preparation and Updating of the Municipal Land use plans

Previous research findings in 1975 by Council for Environmental Quality indicated that urban form can reduce Transportation Energy by 54% and Total Energy by 47% as shown in figure 4-6 above. Carrol (1977), also reports in a later research finding that urban form can reduce transport energy by 52% whilst Naess (1995) also indicate 60% (Anderson, 1993; Naess, 1995; U.S. Department of Energy, 1996,p. 42) as shown in previous chapters. It can therefore be deduced that land use planning and urban design affect about 70% of that or 56% of the United State's total energy use (Anderson, 1993; U.S. Department of Energy, 1996, p. 1) and thus the situation of NJMA may not be different despite the unavailability of empirical data to confirm that. Transportation demands are affected both by the degree of clustering and community planning and by density. "Planning" alone can save nearly 14 percent of total energy consumed, but "planning" combined with increased density can save up to 44 percent (Real Estate Research Corporation, 1974,p.5). Shapes and sizes of Land use designations directly affect travel requirements (especially trip length and frequency) and consequently cause a Variation of up to 150% as indicated in figure 4-6.

In the context of a vast varying culture, geography and economy, the urban areas of TSSA cannot have a one-fit-all solution to make their urban communities' energy efficient through land use planning. Thus instead of proposing specific designs which fits all situations, guidelines and policy framework can specify a process by which those designs and planning should be developed and approved . Consequently, in other to serve major development areas in NJMA and its adjoining towns well by public Transport the urban authorities responsible for transportation planning and traffic management would have to introduce dedicated public transport corridors (especially bus lanes) which would reduce the travel time one needs when using the public transport hence justifying why people would favour public transport in the case of modal shift.

The type of Network design and traffic management strategy put in place would ensure that the new thorough traffic does not negatively affect the housing areas and interfere with the usability of NMVs (Petersen, 2002,p.29). Orientation of mobility and parking to favour NMVs, pedestrians, and public transport to reduce private auto dependence needs to be pursued. Minimising transportation energy use by integrating services, shops, industrial parks and community facilities(as opposed to the existing dormitory community character of NJMA)(Smith, 1981,p. 401).

Enforcement of the law through the previous suggested mobility management strategies need to be intensified for the successful realisation of any objectives of an integrated Land use and transportation planning initiative. Some major interventions that ought to be considered in the updating or preparing the new landuse plan of NJMA can be categorised into 3 main interventions guidelines;

a. New Development and Urban Development Guidelines

More so, in the municipal land use plan, new developments ought to be located near existing local high capacity transit routes, terminals and interchanges.

- As indicated in the example of figure 9-2 below, new urban development like shopping Malls, industrial Park, Cultural museum, etc., have been located at places with existing amenities and developed infrastructure and services and to take advantage of it congruent functions. In this instance balance use of public transport route in both directions is guaranteed.
- Care have also been taken to locate convenient shops, sport facilities crèche, pharmacies and leisure facilities are decentralised as much as possible and also accessible with 500-600m. This is to ensure that these facilities are accessible on foot, bike and from residential areas. Concentrations of social amenities and work places which in use travelling to city centre and eventually causing traffic jam and increase transport energy consumption have been minimised.
- Infill development ought to be encouraged through the Municipal Development policy and other strategic development plans for NJMA. A mixture of utilisation on a reasonable level of scale within blocks has to be ensured to prevent the one-directional flow of traffic during rush hours. The city life through cultural and entertainment programmes need to be enhanced and also night life have to be boosted to resuscitate the city during the evenings.

b. Public Transport and NMT guidelines

Improving the quality and numbers of public transport vehicles to encourage modal shift from private to public transport and NMVs usage;

Access Roads and streets leading to ;

- Schools and Universities like the All Nations University, New Juaben Secondary School,etc. ;
- Poular market and shopping centres like the Accra-Tema Station, Kumasi Station Agatha Market etc.;

- Factories and other employers of large number of workers like the Offices of the Regional Adminsitration and Ministries , Intavenous Infusions, etc.; and
- Churches and Mosques with large congregations

Ought to be connected by a walking distance to a public transport station and NMV routes and lanes. The design standards for the new roads in NJMA needs to ensure they are safe and efficient for NMVs use and also retrofit existing roadways to facilitate safe and efficient NMVs use. These standards are proposed to work in tandem with clear functional road hierachy and corresponding speed limits. Thus appropriate and adequte traffic infrastructure like road signs and street lights ought to be inplace whilst the traffic enforcement agents also play their role without corruption and partiality. The updated NJMA Land Use Plan ought to prioritise the NMT through by the introduction of adequate NMT Infrastructure and planning for the usage of NMVs within the urban precinct. Dedicated lanes for the NMVs are recommended since it gives the cyclist a sense of security and entitlement of the road. In planning for the NMVs for NJMA, it is proposed that Non-Physically Separated Lanes (NPSL) are utilised because;

a. It's Cheaper
b. Its less likely to be occupied by street vendors and pedestrians;
c. Its less likely to become obstructed by refuse, debris or wide-three wheeled NMVs
d. It's easier to clean, maintain and remove debris and garbage
e. If it becomes obstructed, it's easier for the cyclist to get around the obstruction. (Hook, et al., 2002, p.27)

Nonetheless, it can be argued that these NPSLs may be frequently obstructed by double parked cars or illegal use by motorist. This can be resolved by the on-the-spot fine which would be handed out to offenders by the traffic control agents. Also the issue of NMV users veering suddenly into the lanes of motor vehicles obstructing them and causing accidents can also be resolved through the massive road safety campaign and fines for offenders. However, Municipal Road Safety Campaign and education would have to be intensified to ensure that the public become aware of the rights of pedestrians and cyclist as a road user.

c. Motorised Private Traffic and Freight Transport guidelines

As part of ensuring an effective public transport system that promotes TEE, the under listed proposed guidelines would have to be considered in the overall comprehensive transport policy and land use integration plan;

- Policies and enforcement regulation to curtail hindrances to flowing traffic especially Pedestrainisation, NMV mobility as well as public transport need be incorporated.
- Public transport stops to be located strategically close to housing and parking areas. Conflict between moving and parked vehicles are to be prevented by ensuring the location of entrances and exit of parking areas away from areas where tail back from intercession is possible. (Petersen, 2002, p.38-39)
- Suitable areas ought to be reserved as bulk breaking points and centres which can receive and load commercial goods and trucks during the Thursday market days;
- Towing Task force and 24/7 auto maintenance and emergency service providers like that of the ADAC in Germany would help curtail the rampant abandonment of broken-down vehicles in existing narrow and dilapidated roads during the raining seasons.

d. THE UP-DATED LAND USE MAP OF NJMA:

Under the updated Land Use Map, the following interventions and strategies were carried out to allocate the uses for the 6 main categories as it existed before.

1. Residential Land Use - where people live (houses, apartment buildings)

Growth and development of residential areas of NJMA shall be areas that are safe, healthy and comfortable to those living there. Residential areas need to be convenient to educational, commercial, industrial and public facilities with a street system that prevents the disruption of privacy, cleanliness, safety and attractiveness for a proper living environment. The following guidelines would inform the consolidation and allocation of the residential land use in NJMA;

- Promotion of urban identity by implementing homogeneous rational typologies and by improving public spaces.
- Encourage the development of neighbourhoods that offer quality housing, recreation, and retail services in close proximity.
- Restriction of building heights, as a function of slope, altitude, seismic zone and centrality, and not of the price of land.
- Avoidance of fragmentation, by filling up empty spaces in the urban fabric.
- Avoidance of very high or very low densities, seeking a balance.
- Encourage mixed land uses, integrating housing, working places, social infrastructure and commerce.
- Upgrade older neighbourhoods by improving streets, drainage, and community facilities while supporting private remodelling and rebuilding

2. **Civic Land Use - government related (schools, town hall, and police station)**

These include facilities for all governmental services on behalf of the public. The Facilities necessary for public health, safety and welfare but are more supportive in nature are all part of the Civic use of the land. For example, Police, fire services, general governmental buildings, elementary and secondary schools. Hospitals, clinics, libraries and art centres which contribute to the cultural or the mental health are also included. The siting of these facilities ought to be close to their target group not centralised at one location which cause unnecessary traffic jam as the public commute to seek for services.

3. **Recreational & Open/ Vacant Space Land Use - for fun, entertainment purposes (parks, public green, empty land etc)**

- Creation of public open spaces to promote social interaction between the inhabitants.
- Improvement of design qualities of the surrounding spaces of the high-rise buildings by organizing parking spaces, pedestrian paths, playgrounds and green spaces.
- Creation of a green pedestrian network that links the entire NJMA CSA.
- Provision of open public spaces with urban furniture.

4. **Commercial and Industrial Land Use – activities for money (stores, banks), industry (factories)**

Growth and development of commercial areas of the NJMA must be accessible, convenient and at attractive locations. Commercial areas shall be located to provide for economical operation of a business that protects the investments of existing and future commercial concentrations.

- Encourage a variety of commercial activities to meet the needs of its residents, businesses and visitors.
- Encourage new business development opportunities, by protecting critical areas of economic enterprise and promoting a variety of locations for economic activity.
- Encourage planned, integrated commercial areas by discouraging spot commercial development in residential neighbourhoods.

Growth and development of industrial areas of the NJMA should be encouraged to locate in specific areas. Industrial areas shall be suitably located so that industrial growth can continue, convenient to traffic arteries and utility lines with the least possible adverse effect on other land uses.

- Encourage the development of industries that further diversify and stabilize the NJMA's economic base that are compatible to the labour force, raw materials and industrial climate and provide space for new and expanding high technology industries with low environmental impact.
- Insulate industrial sites from other activities by providing sufficient buffers to reduce nuisance and hazard exposure to surrounding non-industrial areas.

5. **Agricultural and Forest Land Use - land used to grow food etc. (farmland)**

Though there are still adequate farmlands in the NJMA area, the tenure has been lost from the indigenes to private investors through land grabbing phenomena and it's worsened by the fact that all the NJMA stool lands are vested lands. This means the lands were paid for by the colonial masters and hence belongs to the government and the traditional rulers are just caretakers. This has caused a lot of fertile lands to be lost for real estate firms who directly negotiate with the central government in Accra who have not performed any suitability analysis to do the allocation. Nonetheless the remaining Agric and Farm lands provides a variety of environmental services such as aesthetically pleasing landscapes, open spaces, wildlife habitat, water recharge and air filtering qualities apart from reducing UHI. This Agric and Farmland use as already indicated is vulnerable to price completion from large-scale urban and sub-urban expansion and urban sprawl. Thus an Urban Growth Boundary is advisable to be implemented to help promote compact and contiguous development patterns that can be effectively served by public services and (2) to preserve open space, agricultural land, and environmentally sensitive areas that are not currently suitable for urban development;" (Nelson and Duncan in Urban Containment in the US)[82]. Urban Growth Boundary can help communities:

- Manage leapfrog or sprawling development;
- Support densities needed for public transportation systems;
- Protect natural resources;
- Protect farmland so that it is viable for modern agriculture operations;
- Manage expenditures for urban services including road maintenance, water and sewer service provision, and police and fire protection.

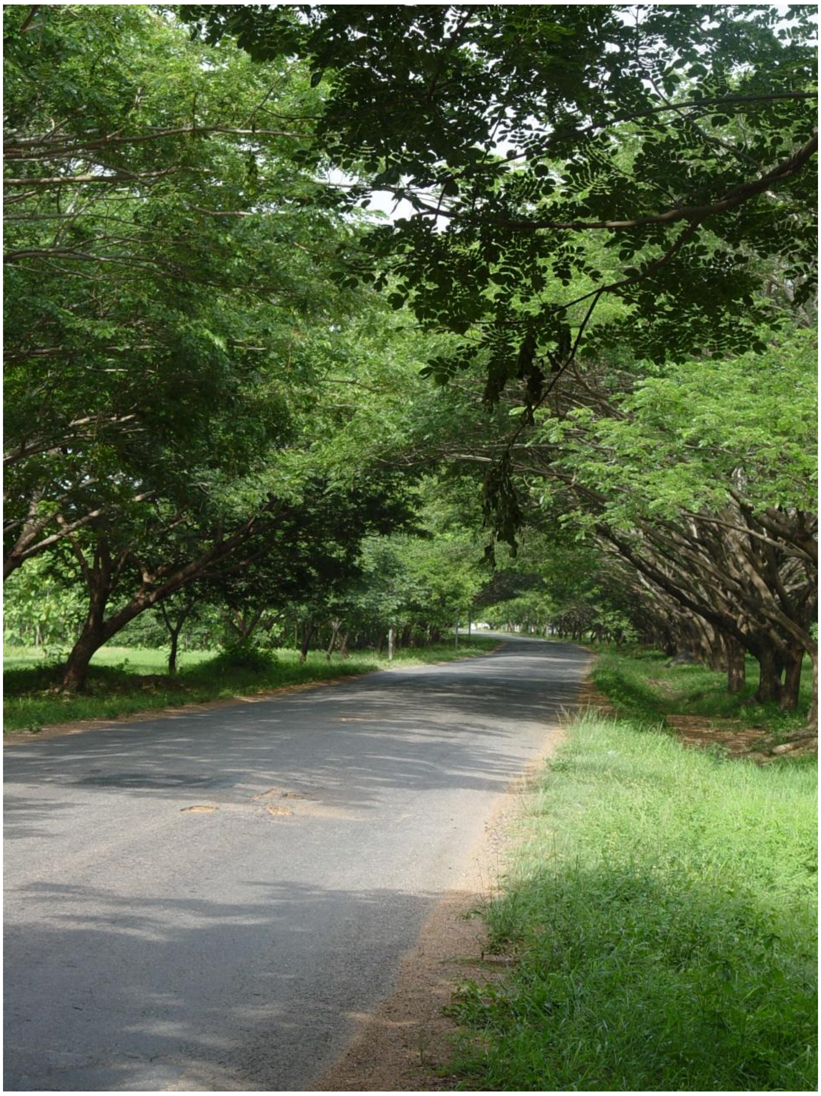
[82] "Urban Containment in the United States: History, Models, and Techniques for Regional and Metropolitan Growth Management;" Nelson, Arthur and Casey Dawkins; American Planning Association PAS Report 520.

6. Water Bodies

The water Bodies in the NJMA area have their banks encroached upon by farmers and other human activities including settlements. The few which are still flowing are almost full of silt and almost lifeless. There is a need for de-silting of the water courses and greening along the banks to project the fishes from dying.

Since population, employment and other socio-economic analysis and projections are beyond the scope of this study, a detailed proposed land use map has been left out from this report because the basic information for that is missing.

Figure 10-1: An Example of an attempt to use Trees to provide shade in Eastern Region (Akuse)



Source: Author

10.3 RESIDENTIAL ENERGY EFFICIENCY STRATEGY

10.3.1 General Influential Conditions and Certification Systems

a. General Influential Conditions

There are quite a number of general conditions that influence the demand and supply of Residential Energy in TSSA but since the supply side remains marginally constant in the case of NJMA, emphasis shall be made on the demand side. The residential energy demand is predominantly affected by the building systems and its elements which also depend on some general conditions in the macro-urban environment. These general influential conditions include the geo-physical aspect of the urban fabric coupled with the orientation of some major infrastructural networks. It also involves to some extent the level of community advocacy for energy efficiency supported by the various government agencies. Thus in NJMA, streets should be so aligned to reap the maximum benefit from macro-level wind directions which implies aligning the streets along the major monsoonal wind directions. In the weak wind regime of the tropics, another possibility is to induce wind flow by the thermal differences that arise at the edges of water bodies. Differences in the thermal properties of land and water in NJMA generate river/land breezes at day/night respectively. These wind flow patterns in NJMA could be harnessed effectively by pragmatic urban planning measures that promote deep wind penetration into the city. More so, enhancing ventilation in tropical urban structures like NJMA could be done by;

- Density of the Area
- Orientation and with of Streets
- Heights and Relative heights of buildings

Although a street layout parallel to the major wind directions will be beneficial at urban scale, it might cause wind flow problems at building scale (Givoni,1994, p. 1048; Emmanuel, 2005,p.118). Givoni opine sthat the tropical street layout be at a oblique angle(between 30° to 60°) to the prevailing winds(Givoni,1994,p.1050; Emmanuel, 2005, p.118). Built densities and heights are other important variables in promoting ventilation in the urban tropics. Usually high-density zones are prone ventilation regimes, and long walls of building fabric prevent deeper penetration wind.Givoni(1994,p.1050; Emmanuel, 2005, p.118) suggest that an urban- profile of variable building height, where buildings of different heights are placed next to each other, and when the long facades of buildings are oblique to the wind , it enhances urban ventilation.

Supportive regulatory oversight, flexible E.E program strategies, aggressive state and local policies, appropriate energy rates, price and usage information, evaluation, measurement and verification of energy demand, supply and consumption, time of sale energy rating disclosure of residential properties and E.E training and education. More so needed for these to work efficiently, the follow general conditions ought to be in place;

- Attractive incentives and financing(as explained below);
- An effective management structure;
- A large scale trained, equipped and certified work force, able to both conduct audits and perform quality renovations;
- A robust quality assurance mechanism;
- A thorough understanding of the markets, players and motivations;
- Extensive social marketing;
- Performance guarantees;
- Effective community initiatives;
- Time-of-sale policy initiatives that drive customers into programs; and
- An involved, engaged and profitable private sector.

There are many strategies that can be adopted to enhance the REE which ranges from age-old strategies (urban codes and regulations) to innovative strategies like incentives and certification systems) (Mehaffy, et al., 2009).

b. Certification Systems

"Certification systems seek to ensure that products meet a set of agreed-upon standards. These programmes can be designed to encourage compliance with national and international environmental laws, or to go "beyond compliance" and to protect the environment more than the law requires. Many certification programmes are voluntary, market-driven mechanisms that use independent third-party verifiers to ensure that the certified goods adhere to the certification criteria. [These independent verifiers are usually accredited institutions or individuals who are not employed or otherwise affiliated with the producers.] Not all certification systems rely on third-party verifiers, but such independent verifiers can lend credibility to a certification system"[83]. These innovative certification systems generally provide a scoring matrix that gives points for factors discussed herein, such as density, mixed use, walkability, access to transit, and building type. The certification is a standard that developers and municipalities can use as a promotional tool. In some

[83] http://www.unep.org/dec/onlinemanual/Enforcement/InstitutionalFrameworks/CertificationSystems/tabid/89/Default.aspx?page=3

cases governments will use such systems to select preferred projects or to expedite approval – or in some cases, will apply them as outright regulatory codes.

Hence in the case of NJMA's transformation to an ECO-NERGY efficient Community, a certification system for Afro-Green Communities and Building can be set up to assist in the uniformity of the assessment and transition. This may be similar to the LEED for Neighbourhood Development (LEED-ND) certification system for green communities is currently being piloted by the U.S. and Canada Green Building Councils (CaGBC) or the BREEAM system is prominent in Europe. This system for NJMA however would factor in its auditing the concept of an Afro-Green Building and communities as described in chapter 2.2 above. An Afro-Green Community and Buildings Certification system for Ghana would be a smaller scale of national certification systems and allow itself to be tailored more specifically to domestic conditions. This is because some national systems are endorsed or operated by government agencies while others are operated by trade associations or other entities and in this case the stakeholders in the Building Industry can form the Ghana Green Building Council(already at the preliminary stage) which can oversee this certification system.

Most certification systems are either (1) process-oriented or (2) end-product oriented. Process-oriented systems verify that products or materials are being produced according to a set of standards. End-product systems certify that the product itself has a certain quality. The standards in process-oriented certification programmes are often designed to ensure the sustainability of the process. End-product certification systems deal with specific qualities of the product. End-product certification systems are often referred to as "eco-labelling" programmes. However, eco-labels are not always the product of certification systems.

This Afro-Green Community and Building Certification system would however be a composite integration of both end-product and process oriented system. The process of planning and design of the community's needs to follow a certified process as well as the end product which is the community itself with its systems. In order for this certification system to succeed, it is important that it gives participating stakeholders and users an advantage that compensates them economically for these costs. This economic advantage often takes the form of increased sales and consumer preference for certified products (in this case buildings and communities) over uncertified products. This advantage only exists, however, when consumers and retailers discriminate between certified and non-certified products. This discrimination can be effective with adequate government policies and incentives. Developments and facilities for instance, which are most likely to thrive in future, will address the following sustainable objectives:

a. Be located in already-developed areas;
b. Balance residential, commercial and industrial uses to reduce transportation needs and support public transit and NMVs;
c. Reduce solid waste, and encourage recycling during construction and use;
d. Improve storm water quality and peak flows;
e. Conserve potable water;
f. Design and operate to minimize energy demand;
g. Include renewable energy supplies;
h. Connect to efficient district energy systems; and
i. Provide third-party certification that communicates environmental benefits to the market and regulators;
j. Consider small-scale land forms, landscape, existing buildings and pavement, solar orientation, and other issues that affect microclimate when subdividing parcels

10.3.2 Catalyst Projects and Incentives

As part of the proposed strategies identified that may be utilised in NJMA to achieve REE is initiation or identifying residential catalyst projects that can trigger interest in Afro-Green Buildings. Catalyst projects are projects deliberately created to trigger associated growth by others. Often these are public projects, or public-private projects. Examples are transit-oriented developments, model communities such as the UK's "Eco-towns", and government development projects in preferred locations. These catalyst projects in NJMA would seek to maximise the use of on-site renewable energy resources and high-efficiency technologies to rely less upon imported energy and reduce demands for grid-delivered electricity and natural gas, thereby prolonging the existing energy infrastructure's ability to deliver adequate supplies. More so some of the characteristics that would have to be associated with these types of residential facilities are;

- High performance enclosure with reduced thermal bridging and high R-Value insulation
- High performance hot water system and Solar hot water systems (if needed)
- High performance space conditioning system strategies and technologies while maintaining occupant comfort, health and building durability
- Automated Home-energy management systems

Residential facilities offer a tremendous potential and opportunity for energy savings in NJMA and achieving success will require a host of strategies, and the flexibility to adapt to dynamic market conditions. Therefore, for residences in hot and humid climates, like NJMA, a trade off is required for building shapes that could minimize exposure to the summer sun while encouraging air movement, if natural ventilation is one of the design strategies. Aiming for this objective, Givoni (1998) suggested a changeable configuration for a residential building plan, in which the inward recessed porches of the building were equipped with operable insulated shutters. The open configuration of the building, with windows in the rooms overlooking shaded porches, allows natural ventilation and restricts direct solar gain in hot and humid summers; whereas a closed configuration, with insulated panels closed, creates a compact building and reduces heat loss in the winter (Malhotra, 2005, p.6).

The Building systems in these Catalyst Projects which may significantly affect REE use in NJMA include:

- **Building Envelope**

The building envelope can contribute up to 73% of the total heat gain/loss in a residence (DOE 2004; Malhotra, 2005, p.5). Building envelope characteristics such as building geometry and orientation, properties of materials, type and quality of construction, and its interaction with the outdoor conditions, impact the heat gain and loss through the envelope (Malhotra, 2005, p.5).

  - **Building Configuration**

There are quite a number of strategies for the organization, shape, orientation and location of building groups and building spaces, and the building envelope components, to obtain space heating, cooling and day lighting benefits from the sun and wind(Brown et al, 2001; Malhotra, 2005, p.5) which the catalyst project can adopt. For these projects there are even control strategies for promoting/restricting heat gain and loss through the envelope by means of wind breaks, plants and water, indoor/outdoor rooms, earth sheltering, solar walls and windows, thermal envelope, shading and natural ventilation(Watson et al, 1983; Malhotra, 2005, p.5)which can also be utilized effectively. The effects of building design features such as the layout, window orientation, shading and ventilation, on the indoor environment and energy use (Givoni 1998; Malhotra, 2005, p.5) cannot be overstated for a community like NJMA. As indicated in figure 4-7 in the previous chapter, there are some effective Energy efficient siting strategies by climatic zone (American Institute of Architects, 1991; U.S. Department of Energy, 1996 p. 71). This was reiterated by some design guidelines for improving comfort and energy conservation in different climates by Givoni (1998)(Malhotra, 2005, p.5).Thus as part of the REE strategies that can utilized, the building configuration indicated in chapter four can be analyzed and utilized for these catalyst projects in NJMA.

- **Compact Designs**

Attached or clustered buildings and earth sheltering can protect residential structures in NJMA from extreme temperatures as well as from undesired winds. Orienting the building along the east-west axis, maximizing cooler seasons exposure to the south, southeast and southwest sides, providing a clear solar access, sunspaces on the south, buffer spaces along the north, and temperature zoning inside the building can maximize solar gain and minimize heat loss in the cooler seasons for some parts of TSSA. However for NJMA building envelope shading should be utilized effectively without destroying the character and aesthetics of the façades to minimize heat gain in the warm humid climatic conditions. On the other hand, for natural ventilation, orienting and planning the building for maximum contact to outdoors to capture the prevailing winds, open indoor plan, high ceiling, two story spaces, open stairwells and elevated living spaces are recommended for maximizing air-flow indoors (Malhotra, 2005,p.6) of residential buildings in NJMA.

- **Thermal Properties of Opaque Elements**

The properties of opaque building envelope elements of the residential buildings in NJMA that can determine the thermal performance of these buildings include: insulating value, thermal mass of the construction material, the location/sequence of different layers of the assembly, and the absorbance and emissivity of the exterior surface of the finish materials (Malhotra, 2005, p.7). Thermal insulation retards conductive, convective and/or radiative heat transfer (ASHRAE 2001a) providing adequate insulation in the building envelope is critical for energy-efficiency. Also the thermal mass provides significant benefit in shifting peak load conditions and reducing overall heat gain or loss, provided that average outside temperature is moderate. This allows reduced HVAC system size that could result in energy and cost savings. However, these benefits would depend on the configuration of the wall assembly of these buildings in NJMA (i.e., insulation inside or outside thermal mass relative to the building interior) and the climatic conditions. Another important aspect of the building envelope which is normally neglected in Ghana when it comes to energy savings is the fenestrations. Windows are typically the weakest link in a building's thermal barrier. For the catalyst projects to be naturally ventilated (which is very crucial for warm humid climates), size and placement of windows relative to wind movement is also critical. However, this should not compromise unwanted heat gain/loss but the energy impacts of the fenestration can be optimized by using: (1) day lighting, (2) glazing with special transmission properties, and (3) insulated glazing with low air leakage. Heat flow through fenestration can be controlled by various single or multiple (insulating) glazing, interior and exterior shading, and spectrally-selective coatings and tinted glass (ASHRAE 2001a)(Malhotra, 2005, p.13).

These though can usually be cost prohibitive for the project to be marketable in a competitive real estate market.

❖ Space Cooling Systems

Space heating and cooling in residences consumed 32% and 12% of the U.S. residential energy use in the year 2002, respectively (DOE 2004) but comparatively to the TSSA cities, there would not be a need for heating due to the temperatures but cooling is inevitable. The annual heating or cooling requirements of a house depend on the climate, size and type of the house, insulation level, air-tightness, solar gains, internal heat generation, thermostat setting, and other operational factors. Using energy-efficient strategies for these factors reduces a building's thermal load and allows reduced HVAC system size. Furthermore, properly sized and energy-efficient systems and equipment, achieve the longest run time cycle possible that optimizes the system performance and reduces energy use for cooling. Properly sized air-conditioners also perform better in terms of moisture removal ability, noise and comfort (Proctor et al. 1995 and Proctor and Albright 1996; (Malhotra, 2005, p.16), which is an important comfort issue in hot and humid climates. considerable distribution losses are associated with such devices and are responsible for much higher source energy consumption. In the instance where space cooling system is unavoidable in NJMA, it's important to engage qualified AC specialist to size the ACs to make them run efficiently. Where natural ventilation could be adopted, it's important that the building is oriented to allow the building envelope harness the prevailing wind to cooling the interiors.

❖ Domestic Hot Water Systems

Domestic water heating is an important end-use in residences that includes heating water primarily for clothes washing, dishwashing and personal hygiene. Though this is not very popular in TSSA, energy required for water heating accounted for 13% of the U.S. residential energy use in 2002, making it the second largest end-use after space heating and cooling in an average home (DOE 2004). As Ghana enters into the league of middle income countries and with the influx of the oil economy, more Ghanaians would be using DHWs. Therefore, energy-efficiency in a domestic hot water (DHW) system is an important energy-saving strategy. A number of resources have analyzed DHW consumption in residences and have investigated ways to reduce energy for domestic water heating. The first step towards energy-efficiency in a DHW system begins with a reasonable estimation of hot water demand and proper sizing of the storage tank. Stein and Reynolds (1992) gave hot water consumption by use and the supply water temperatures at the point of use for different domestic purposes. Based on these values, it is estimated that a family of four in NJMA would require 35 gallons of hot water daily. However, actual hot water demand depends on the characteristics and operation of the appliances that use hot water, and on the schedule and preferences of the occupants. Solar water heaters are good substitutes for electricity or gas water heaters for NJMA which happens to have adequate solar exposure year-round.

- **Lighting**

Lighting affects building energy use in two ways: the energy required for lighting and the energy associated with removing or replacing the internal heat gain from lighting. Lighting accounted for 12% of the U.S. residential energy use in 2002 (DOE 2004) and though the exact figure for NJMA is not available it can be assumed that it's also quite significant. Not all home in NJMA uses electricity for lighting but others uses petroleum products like Kerosene and liquefied Petroleum Gas (LPG) as well. By integrating day lighting with energy-efficient electric lighting and controls, and following energy conserving practices, lighting energy use as well as the internal heat gain from electric lighting can be reduced significantly (Malhotra, 2005, p.18) in the catalyst projects proposed for NJMA.

According to Malhotra, (2005, p.20), the average daily use per light in kitchens is about 3.8 hours, followed by living rooms (3.4 hours), and family rooms (3.3 hours). Rooms where lights are used less intensively are bedrooms (1.6 hours) and bathrooms (1.8 hours). The IESNA (2000) gives recommended illuminance values for different activities in residences. They recommended a lighting level of 30 lux (3 fc) for general lighting, 50 lux (5 fc) for dining, 300 lux (30 fc) for non-critical kitchen activities, normal reading and grooming and 500 lux (50 fc) for activities with critical seeing. Stein and Reynolds (1992; Malhotra, 2005, p.23) provided a relation between lighting levels and lighting loads for different light sources. A compact fluorescent lamp (CFL) offers the energy economy of a fluorescent lamp yet lasts 10-12 times longer than an incandescent lamp. Electronic ballasts eliminate 60 Hertz flicker and reduce power consumption by 25-40% compared to electromagnetic ballasts. Halogen lamps are less efficient than the CFL, but are still about 20% more efficient than incandescent lamps, and they last longer. Halogen Infrared Reflecting (I-11R) lamps are 50% more efficient than standard incandescent lamps and also, last longer than incandescent lamps Improved incandescent lamps, which are preferred for applications with limited use and/or frequent on/off cycles, consume about 10% less electricity than standard incandescent lamps (MI 1994).

Thus replacement of incandescent lamps in NJMA with CFLs has one of the highest (35%) energy savings potential for lighting (DOE 1996; Malhotra, 2005, p.23). Dimming incandescent lights by 10% to 75% saves 5% to 50% of lighting electricity (RMI 1994), motion detectors save lighting electricity by 40% in bathrooms, 30% in bedrooms and kitchens, and 20% in living rooms and kitchen/dining areas. An average of 26% annual operating cost savings were found with replacement with more efficient lamps, 45% with typical manual on/off controls with dimmers, timers, or sensors, 57% with an integrated system of efficient lamps, efficient luminaries and appropriate controls (Conway 1994). Thus a combination of strategies for the lighting system in the catalyst project of NJMA is recommended. Since these measures, integrated with day lighting, can save up to 90% of lighting electricity (RMI 1994; Malhotra, 2005, p.23).

Using CFLs to replace incandescent bulbs; 14-20W CFL replacing 60W incandescent onion bulb was introduced in Ghana by the Ministry of Energy as part of its energy efficiency and conservation drive. Penetration based on a cycle of average of 8 million CFLs to introduction every 4 years beginning with 6 million in 2007 was targeted. Liberating equivalent of about 2,000 GWh a year, 6 million 20W CFL replacing 60W incandescent onion liberates 240 MW demand equivalent to generating about 1,640 GWh (Energy Commission, Ghana, 2006, p.42-43).This demonstrate that its possible to incorporate this strategy in the overall REE since there is adequate political will which would support the initiative and policy.

❖ **Appliances**

Major appliances in residences include refrigerators, clothes washers, dishwashers, cooking equipment and home electronics. Together, they accounted for 29% of the U.S. residential energy use in 2002 (DOE 2004). As Ghana enters the league of middle income countries with the influx of the oil economy, the use of these appliances would not only be a means of convenience but a symbol of success. Hence the appliance quota of the residential energy is bound to escalate and without any shift of paradigm and behaviours it would contribute significantly to the residential energy demand in NJMA. It's therefore imperative that energy-efficient products and energy conserving practices used and followed religiously to have a great energy-saving potential. This section discusses appliance energy use and energy-saving options in four categories: refrigerators, wet cleaning equipment, cooking options and home electronics. Already as part of the energy conservation strategies there is discontinuation, through legislation, the local production, importation and use of inefficient electricity consuming equipment and appliances effective from 2012 (Ministry of Energy, GoG., 2010, p.38). Promotion and dissemination of improved cookstoves, kilns, setting up of institutional structures for education of the populace on the benefits for saving energy in the home is very key. A continuation of the already started Energy Efficiency Standard and Labelling ought to be extended to cover other appliances like electric fans, televisions, refrigerators and deep freezers. This is because according to the Energy Commission of Ghana, penetration of energy efficient fans in the residential sector is estimated at over 90 percent and they consume between 20 – 30 percent less electricity than average fans are available. Some television sets consume about 20 Watt power and some as low as 2 Watt at standby mode (Energy Commission, Ghana, 2006, p.40).

The residential or household sector of the Ghanaian economy which accounts for over 50 percent of the country's energy consumption have significant share of the nation's energy demand is due to the high usage of wood fuels comprising mainly firewood (almost 76 percent) and charcoal. The rise in residential share from about 50 percent in 2000 to almost 56 percent in 2004 was due to the significant increase in wood fuel consumption share in the energy supply mix (Energy Commission, Ghana, 2006, P.20). Also calls for attentions for innovative strategies since it's not only the conventional power that needs conservation but the source of the wood fuel as well.

These catalyst projects alone are not attractive enough without incentives that would be offered by the New Juaben Municipal Authority. These incentives include taxes, tolls, fees, surcharges, credits, deductions, offsets and the like. Initiation of these Catalyst projects in NJMA or identifying existing ones which would be evaluated by the Ghana Green Building Council and award them Gold, Silver or Bronze Stars for Afro-Green Community properties may be a very good incentive. This may include award schemes, grants (Gold -1million USD, Silver-500 thousand USD and Bronze-250 Thousand USD), education campaigns, policy reports and conclusions, research dissemination, and other non-pricing influences. Incentivize Energy Efficiency promising technologies to increase market awareness and penetration to bring down cost. The economics of urban development may be thought of as its "operating system", and evidence shows it is a system that is highly sensitive to cost differences. Development patterns will change when the structure of costs and fees changes. Energy efficiency will increase as the cost of energy increases, through market processes, but also through carbon taxes and the like.

10.4 URBAN GREEN INFRASTRUCTURE NETWORK STRATEGY

10.4.1 Development Controls Enactment and Enforcement

Development Controls enactment and enforcement is one aspect of the UGI network strategy proposed for adoption in NJMA to ensure ecologically responsive community development. Development Control is the element of the Town and Country Planning system through which local government regulates Land Uses and New Building. It should rely on the "Plan-led System" whereby Development Plans are formed and the public consulted for consensus building and input. Subsequent development requires planning permission, which will be granted or refused with reference to the Development Plan as a material consideration. As stated in Box 9-1 below, "settlements properly planned and managed", it implies that development control is a form of proper planning and management of settlements whether rural or urban . But its effects and benefits for urban settlements cannot be overstated. Nevertheless, any development control system without appropriate Legislative Instruments (LI) is like Power without Authority and may be an ineffective engine of growth. Another pre-requisite for effective application of development control is house numbers and national identification for the citizens and inhabitants of the various communities. This is critical for the enforcement of any LI introduce because offender need to be located and brought to book with extra effort by the law enforcement agencies. The basic role of the development control in NJMA shall include;

Box 10-1: The Essence of Development Controls

"Cities and Towns have been engines of growth and incubators of civilisation and have facilitated the evolution of knowledge, culture and tradition as well as industry and commerce. Urban settlements, properly planned and managed, hold the promise for human development and the protection of the world's natural resources through their ability to support large numbers of people while limiting their impact on the natural environment."

[Second United Nations Conference on Human Settlements (Habitat II); Paragraph 5 of the Habitat Agenda]

1. Anticipate the development needs of an area;
2. Identify relevant development issues;
3. Identify opportunities for and constraints to development;
4. Identify areas which are suitable/unsuitable for different types of development;
5. Make proposals for the way in which the area should develop over time; and

6. Establish policies and standards to guide development.

In regards to the NJMA, this development control would also help in Life Cycle Management of the urban landuse. That is by incorporating the ideas of development, decline and succession in the evolution of the urban fabric as suggested Richard B. Andrews neighbourhood life cycle stages could be identified and appropriate urban renewal intervention introduced;

i. Growth
ii. Maturity
iii. Decline
iv. Uncertainty
v. Late Decline
vi. New Growth

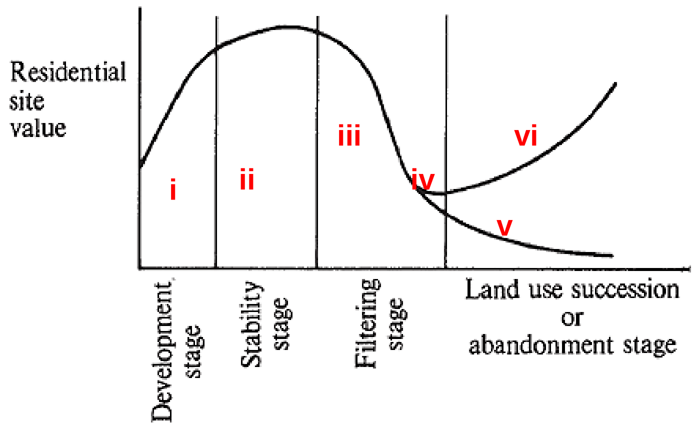
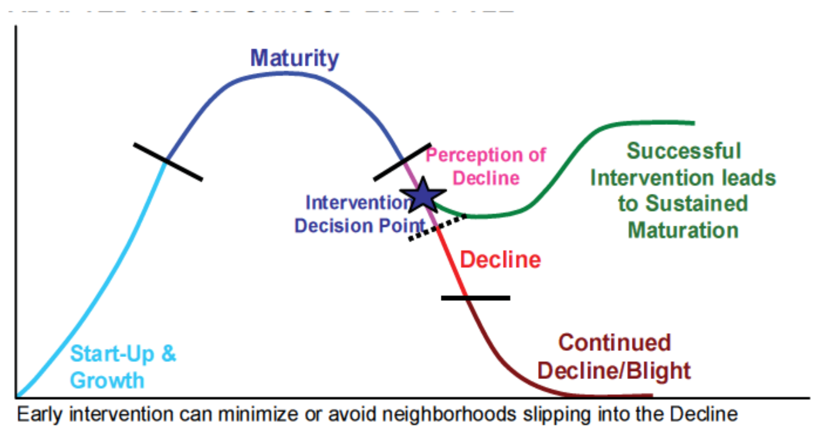


Figure 10-2: Richard Andrews' neighborhood life cycle[84]

An adapted or development controlled neighbourhood life cycle can be seen in figure 9-2 below as implemented by the Virginia Beach city community. The development control as an UGI strategic tool is thus envisaged to modulate the UGI aspect of the community as well though a similar cycle. This is because most UGIs are strongly interdependent on the communities when it comes to their eco-system functions.

Figure **10-3: Adapted Neighbourhood Life Cycle**



Source: (City of Virginia Beach, 2008)

[84] http://www.allbusiness.com/glossaries/neighborhood-life-cycle/4963971-1.html_accessed on August 8th, 2011

More so the development control as an UGI strategic tool would seek the promotion and protection of Green Infrastructure Development by providing guidelines for;

i. Landscape Linkages

ii. Conservation corridors

iii. Green Belts

iv. Reserves

v. Managed Nature Landscapes

vi. Ecological Sites

vii. Cultural/Historic/Recreational Sites

Development control as it is supposed to function needs to have some basic provisions which include;

a. General Provisions

b. Use Standards (identifies the land uses and restrictions or limitations to specific permitted use for each zoning district)

c. Intensity or Density Standard (Max. and Min. Density, Max Floor Area Ratio)

d. Dimensional Standards (Max. Building Height-present in the current Ghana Building Regulation)

e. General Development Standards (Parking and Loading Standards, Landscape Planting Standard)

f. Development Standards for Hazard areas or Sensitive Lands (Obuotabiri hills of Koforidua)

g. Non-Conformity Standards (regarding land use or structures that was legal when established but would not be allowed under current zoning law)

h. Development Review Procedures

i. Enforcement Provisions

j. Amendment Provisions

Though the development control is aimed as an UGI strategy, it has a broad function in enhancing the urban physical quality and efficiency of which UGI is a part. Emmanuel (2005, p.126), indicated that the development control has the potential of also promoting energy efficiency and transportation reduction which in the long run makes urban physical development an environmentally responsive (see table 7 below).

Table 8: Development Controls for Urban Physical Quality Enhancement and Efficiency

Development Control	Possible Form	Development Goal	Environmental Effects
Zoning Law	Sub-division size regulation, built density control, Built Density Control, Land-use Control, Street width and Type Control, Specifications for bicycle lanes and pedestrian paths, promenades and neighbourhood squares regulation, water front development controls	Energy Efficiency and Transportation reduction	Air Quality, climate quality improvements
Building Regulation	Building and Site Orientation Guidelines, building form guidelines, building envelope control, arcade development guidelines, building limit, shading requirements, energy audits	Energy Efficiency	Climatic Quality Improvements
Landscape Control	Type and Density of Green space Guidelines, Water impoundment requirement, Hence and fence controls, public green space guidelines	Energy Efficiency	Climatic Quality, Water Quality improvement

Source: Adapted from Emmanuel, 2005,p. 126

Some examples of laws and codes that may be required in Ghana to help the broad framework of implementing a successful UGI are;

- Standard State Zone Enabling Act which endeavours to provide, so far, as it's practicable to foresee, that proper zoning can be undertaken under it without injustice and without violating property rights.
- Standard City Planning Enabling Act which would serve as organization and power of the Planning Commission which has been directed to prepare and adopt 'Master plan' & Control private sub-division of land.

- Development and Regional Impacts Code which applies for Categories of developments those because of their magnitude, nature or the effect on the environment are likely to present issue of regional impact. (American Planning Association, 2006)[85]

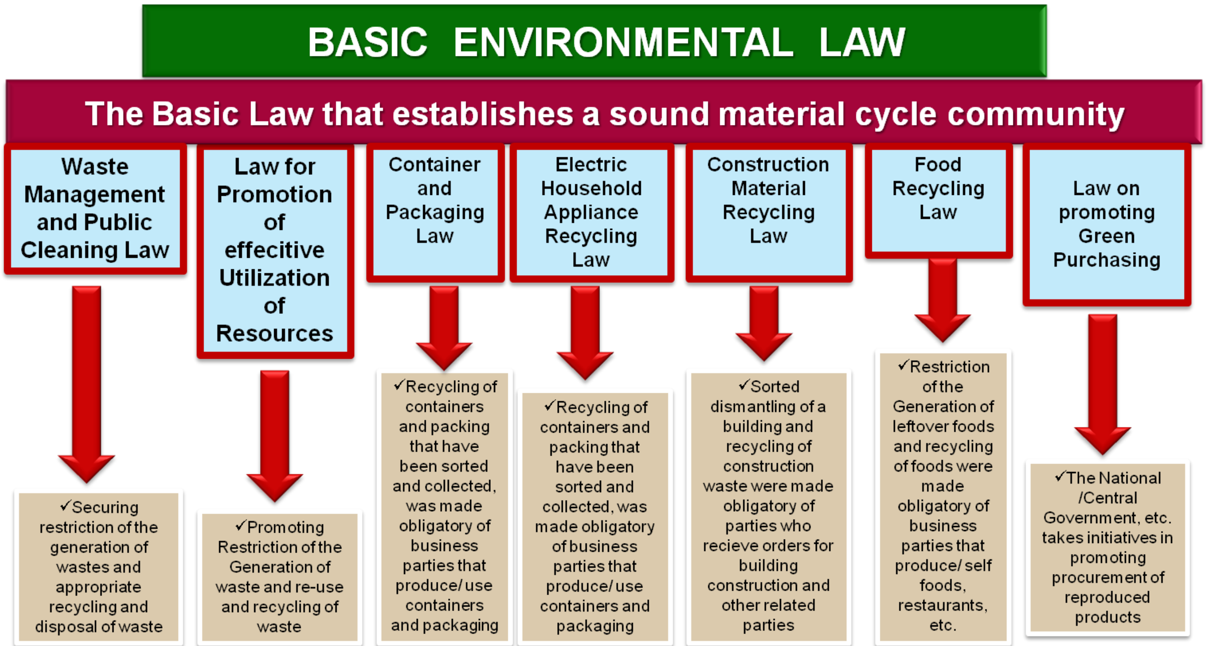
This however does not imply that there aren't any development controls in Ghana and for that matter NJMA. Though development controls exist, they have been so much saddled with barriers and limitations to the extent that they are almost dysfunctional. They are utilised more or less as a post-development inventory and adaptation control mechanism. Some of the **barriers** saddled with the development controls in Ghana include;

1. Inadequate Institutional, legal and regulatory framework
2. Dualistic Nature of Zoning and Spatial form- reflection of colonial settlement policy- clear separation between colonial quarters and indigenous villagers;
3. Urban Political Instability and interference in implementation of urban development plan proposal(DCEs and MCEs)
4. Weak enforcement mechanism of the few Legislative Instruments for Urban Development
5. Unsuitable Urban Physical Planning Methodology
6. Excessive Delays in Approving Physical development
7. Lack of adequate capacity and relevant capacity building initiative at various planning and development control institutions

In a country where water bodies, parks and wetlands are almost used or converted to refuse dumping sites, there is a need for adequate LI which can regulate and prevent the UGI from being destroyed due to bad attitude and behaviours. As adapted from the GEC in Japan, if the Ghanaian parliament as a matter of priority legislates into law some basic sound material cycle community laws (see figure 9-3), any UGI proposed would be spared of the onslaught of the community refuse in NJMA.

[85] Adapted from contributions by Staurt Meck, FAICP, American Planning Association, Chicago Illinois

Figure 10-4: Some Important Laws That Needs To Be Considered



Source: Adapted from Legislative Instruments supporting Environmental Responsiveness in Japan, GEC 2005

As part of the development controls proposal for the UGI network strategy for NJMA, a proposed standard and an ensuing guiding principles was adapted from English Nature Green Space Standard.

a. **General Standard for UGI Planning in NJMA**

This general standard which is referred to as Accessible Natural Green space Standard Plus(ANGST+) have the modified ANGST standard taking into account of stakeholder involvement, local decision making and connectivity and the the latter being a fundamental component of all infrastructure; green or grey.

These standards include the following as basic and may be modified depending on the local situation as approved by the local planning and environmental protection agency;

- *No permanent dwelling attracting the use of automobile should be constructed more than 300 m from their nearest area of natural green space of at least two (2) hectares in size;*
- *There is provision of at least two (2) hectares of natural green space per 2,000 populations;*
- *That there should be at least one accessible 20 ha site within two (2) km from home*
- *That there should be one accessible 100 ha site within five (5) km;*
- *That there should be one accessible 500 ha site within (10) km;*
- *That adjacent green spaces are interconnected; the priority and extent being determined by local decision making informed by stakeholder involvement.* (Davies, et al., 2006,p.10)

b. General Guiding UGI Planning Principles for NJMA

Due to the fact that the major occupation of the inhabitants of NJMA is agro-based, general consensus with the various civil society groups and stakeholders especially the traditional leaders ought to be done. Adequate education ought to be undertaken so as not to create an UGI which would eventually be rejected or encroached upon by the indigenes of NJMA due to ignorance. An alternative source of income especially manufacturing and services (Tourism related) need to be strengthened so as to ensure that the guidelines becomes effective and not counterproductive. The major ethical question is: ***How do you convince a jobless and hungry local about the quality of air and eco-system functions when there is bush meat or game to hunt and forest to cut for firewood?*** The hunting ought to be regulated and permitted at some areas and continual education done to make the community accept the UGI as part of their survival. Special fast growing trees can also be introduced so as to utilise them for the wood fuel without affecting the integrity of the entire UGI network in NJMA. The following guidelines may be considered when planning the UGI system in NJMA to make it ecologically responsive:

- All streets and roads should be tree lined unless there are sound technical reasons preventing this. The full contribution of verges to UGI should be realised, and land allocations should both allow for this and accommodate underground services and all necessary sight lines.
- All buildings, structures and underground services should be constructed to standards that minimise the risk of structural damage from subsoil ground movements caused by tree roots, drought or water logging.
- All hard surfaces should be permeable unless there are sound technical arguments overriding this requirement.
- At least one major, well equipped and very high-quality town park, offering a variety of facilities, services and experiences for all age groups and able to accommodate a wide range of community events. It should include landmark structures and spaces that foster the town’s identity and sense of place. This park should be associated with the town centre and should be easily accessible from other parts of the town by public transport and by those cycle ways and footpaths forming part of the wider UGI.
- A range of garden-equipped spaces providing social and amenity space (which is especially attractive to older people), possibly associated with toddler play areas at a neighbourhood scale;

- Semi-natural spaces, including designated nature reserves that will combine passive recreational access and activities with biodiversity value and a variety of habitats;
- Wherever possible they should incorporate appropriate educational facilities or features to encourage use by school groups.
- A range of sports facilities and pitches designed and maintained for use by the whole community, not just schools and other institutions.
- A network of greenways to connect larger or more expansive open spaces;
- A presumption of public access to all GI (with the exception of private gardens) unless there is sound reasons to restrict this. Basic GI facilities and services needed to enable full use of the GI by all sections of the community. Such facilities include toilets, shelters, waste disposal arrangements, seating, public art, transport access and secure bicycle parking, and signage for interpretation and way marking, except where these would detract from otherwise wild or natural qualities. In more intensively used spaces, buildings such as pavilions, refreshment facilities, event arenas/staging and community halls may be compatible inclusions within GI areas (but should be excluded from GI area calculations).
- A network of streets, open spaces and parks, with safe routes linking them to homes and schools, allowing children to both play in their own neighbourhoods and move around without traffic danger (adapted from TCPA, 2008, p.15).

One of the reasons why the UGI in most developed countries as discussed in the first and second level case studies earlier are successful is because of a functional development controls which are in place and being enforced to the letter. The highly informed populace who understands the benefits of the eco-system functions of the UGIs always resist any development which may have fulfilled the development control requirement but fall short in other sustainability requirements.

10.4.2 Ecological Aesthetics and Connectivity

As part of the UGI network strategy in ensuring the ecological responsive development of NJMA, the strategy of apply ecological aesthetic and connectivity is proposed. NJMA can be a typical or flagship Afro-Green Community through the implementation of its UGI which ought to be edifying, enabling and sustainable. An Afro-Green NJMA Community needs not only have Connected UGI but also connectivity between the people and the environment. According to Wikipedia[86], Aesthetics is a branch of philosophy dealing with the nature of beauty, art, and taste, and with the creation and appreciation of beauty. It is more scientifically defined as the study of sensory or sensori-emotional values, sometimes called judgments of sentiment and taste[87]. More broadly, scholars in the field define aesthetics as "critical reflection on art, culture and nature. Judgments of aesthetic value rely on our ability to discriminate at a sensory level. Aesthetics examines our affective domain response to an object or phenomenon. Immanuel Kant, writing in 1790, observes of a man "If he says that canary wine is agreeable he is quite content if someone else corrects his terms and reminds him to say instead: It is agreeable to *me*," because "Everyone has his own (sense of) taste". The case of "beauty" is different from mere "agreeableness" because, "If he proclaims something to be beautiful, then he requires the same liking from others; he then judges not just for himself but for everyone, and speaks of beauty as if it were a property of things." Aesthetics is the philosophical notion of beauty whilst taste is a result of an education process and awareness of elite cultural values learned through exposure to mass culture. Bourdieu examined how the elite in society define the aesthetic values like taste and how varying levels of exposure to these values can result in variations by class, cultural background, and education.

In the same direction, when people feel connected to their environment and to the natural world they will appreciate it more, handle it with more respect and sustain it for future generations. Yet, to connect people to the natural world, nature needs to have cultural value (van Lierop, et al., 2010). That is to say, ecologically functioning is NJMA community unlikely to last in human dominated environments if it is aesthetically unattractive (Gobster, P.H., et. al., 2007; van Lierop, et al., 2010). When NJMA urban environments is planned and developed to be both ecologically sound and evoke enjoyment, approval and admiration are more likely to be sustained by appropriate human care over the long term (van Lierop, et al., 2010) despite prevailing economic problems. van Lierop, et al., (2010), opined that through the land- and cityscape that people leave their heritage consisting their

[86] http://en.wikipedia.org/wiki/Aesthetics#Aesthetic_judgment

[87] Zangwill, Nick. "Aesthetic Judgment", *Stanford Encyclopedia of Philosophy*, 02-28-2003/10-22-2007. Retrieved 07-24-2008.

values and beliefs but through the landscape they share their experiences with future generations. However in the case of NJMA and most communities in TSSA, the anthropological believes is strongly expressed in the natural environment and nature as well. Rivers, forest, mountains are usually considered as deities. In NJMA, the exhilarating Obuotabiri hills are also considered as a deity as well as all the rivers in the area.

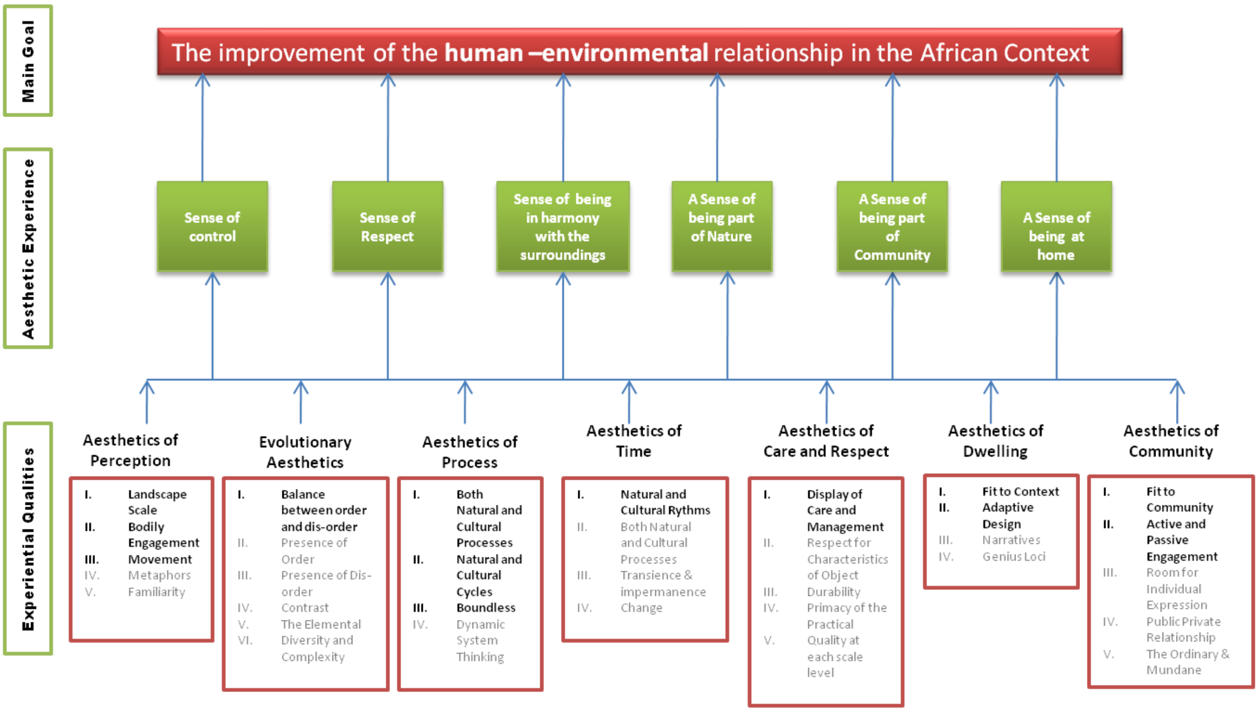
Consequently, it is of great importance how the landscapes of NJMA are planned, design and developed. Designs can change a person's aesthetic appreciation of landscapes as he observes and interacts with his surroundings. The NJMA Planning and Designs can help inhabitants to become more aware of the environment and their impact on it (van Lierop, et al., 2010). For example if the annual Akwantukese(The Great Exodus) Festival of the NJMA people is thematised into a hiking trail(with interesting scenes of history) within the UGI network it would not only create a cultural attachment but revive its traditional pride of the people and the forest and the entire UGI that forms part of it would be protectd by the community themselves.Its also imperative to know that designs of everyday environments have a major influence on how people perceive and experience the natural and cultural aspects of their surroundings. (van Lierop, et al., 2010). Designers need to understand that 'aesthetics have a powerful influence on how society perceives the natural world and on how individual people experience ecological processes in their daily life' (Forman, 2002; van Lierop, et al., 2010).

Thus if Landscape Linkages, Conservation corridors, Green Belts, Reserves, Managed Nature Landscapes, Ecological Sites, Cultural or Historic or Recreational Sites etc., in NJMA are planned and designed with the language of aesthetics that appeal to the people, the UGI in NJMA would be a resounding success. In order to design naturally and culturally sustainable NJMA designers and planners need a new 'design language that fuses form, feeling, meaning and human and ecological functions' (Spirn, 1998; van Lierop, et al., 2010). As explained by van Lierop, et al., (2010), an aesthetic experience is caused by sense-perception of certain qualities. With sense perception we mean not only visual perception, but also sound, taste, smell and touch. The aesthetic experience evokes a certain feeling, either positive or negative, in a person. We concentrate on positive aesthetic experiences which make a person 'feel good and encourages' a person 'to continue or return to the experience which gives it pleasure' (Leath, 1996; van Lierop, et al., 2010). This type of feeling ought to be in context with the local setting in NJMA as what would excite a European might be a taboo for an African. However the basic experiential feeling of being in harmony with the surrounding may be the same across cultures. A certain combination of experiential qualities can cause an aesthetic experience like “a sense of being part of nature” (van Lierop, et al., 2010).

The cultural context of NJMA and any location in TSSA is an important attribute which have great influence on how people experience their environment. Thus this suggests that designers and planners of the UGI in NJMA also need to take into account the cultural preferences of the community. The experiential quality “fit to community” states that a designer should take the aesthetic preferences of the community into consideration. Other theories suggest there are also experiential qualities that are preferred by all people no matter what culture they are from. These preferences are more instinctively and are developed during our evolution. Examples of such preferences are the “presence of order”, “balance” and “the elemental”.

Therefore these preferences are termed evolutionary aesthetics. If for example the Aesthetic experience of sense of being part of a community is being targeted by planners in NJMA through the UGI provision the experiential qualities that have to be triggered in the users are; aesthetics of process, time, dwelling and community with its subsequent unique elements as shown in table 8 below. Along the UGI network in NJMA multiples of aesthetic experiences would be required to express the goal of human –environmental relationship in the African context. Which means for example, cemeteries would need to evoke the aesthetic experiences of sense of respect and sense of being at home. Ecological sites on the other hand have to evoke the sense of being part of nature and harmony with the surroundings.

Figure 10-5: A combination of Experiential Qualities which may be needed to evoke Afro-Green Paradigm



Source: (Adapted from van Lierop, et al., 2010, p.7)

Landscape corridors would also require the senses of control, harmony with the surroundings and being part of the community. It's therefore important to recognise that this proposal of ecological experience can only be utilised effectively if the planners of the UGI understands the socio-cultural and natural environmental milieu of NJMA. This is because apart from being local based and site community dependent, what may be useful for a hub within the UGI may be different from a linkage.

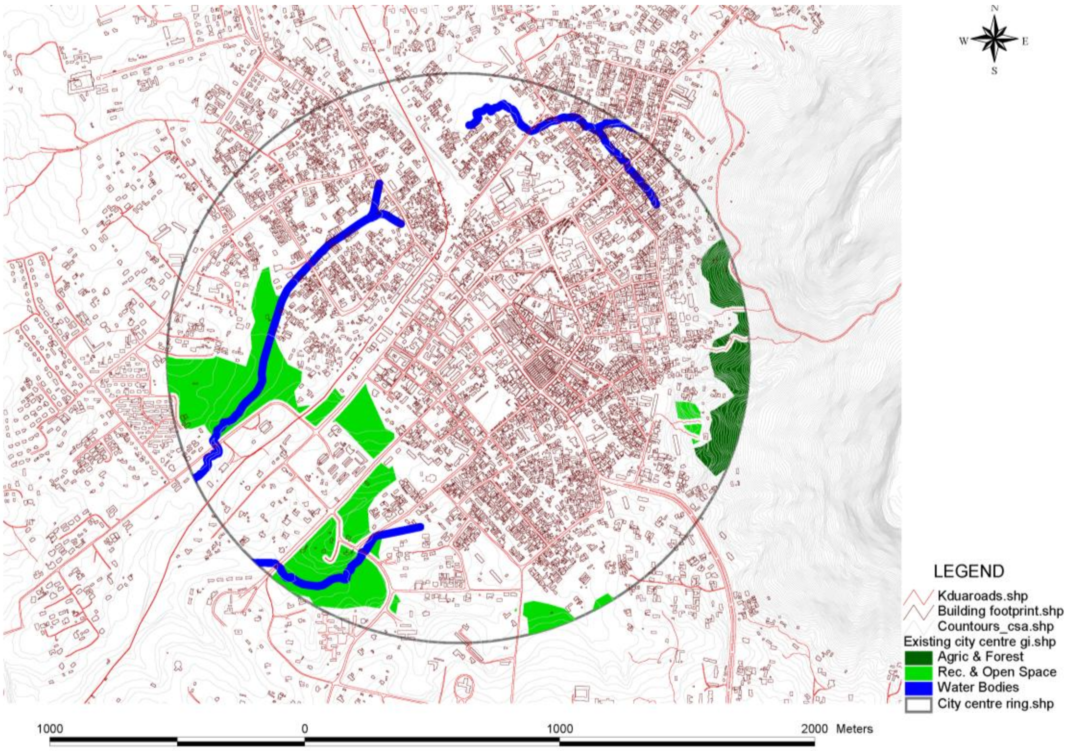
Table 9: Examples of Typical Combinations of Elements Needed for Given Experiential Quality

1	**A SENSE OF BEING PART OF NATURE**	
Experiential Qualities		**Experiential Elements**
A	**Aesthetics of Perception**	Landscape Scale Bodily Scale Movement
B	**Aesthetics of Process**	Both natural and cultural processes Natural and Cultural Cycles Boundless
C	**Aesthetics of Dwelling**	Fit to Context Adaptive Design
D	**Aesthetics of Community**	Fit to Community Active and Passive Engagement
2	**A SENSE OF BEING PART OF COMMUNITY**	
Experiential Qualities		**Experiential Elements**
A	**Aesthetics of Time**	Natural and Cultural Rhythms Both Natural and Cultural Processes
B	**Aesthetics of Process**	Both natural and cultural processes Natural and Cultural Cycles Boundless
C	**Aesthetics of Dwelling**	Adaptive Design Genius Loci
D	**Aesthetics of Community**	Fit to Community Active and Passive Engagement Room for Individual Engagement

Source: author with inputs from van Lierop, et al., 2010

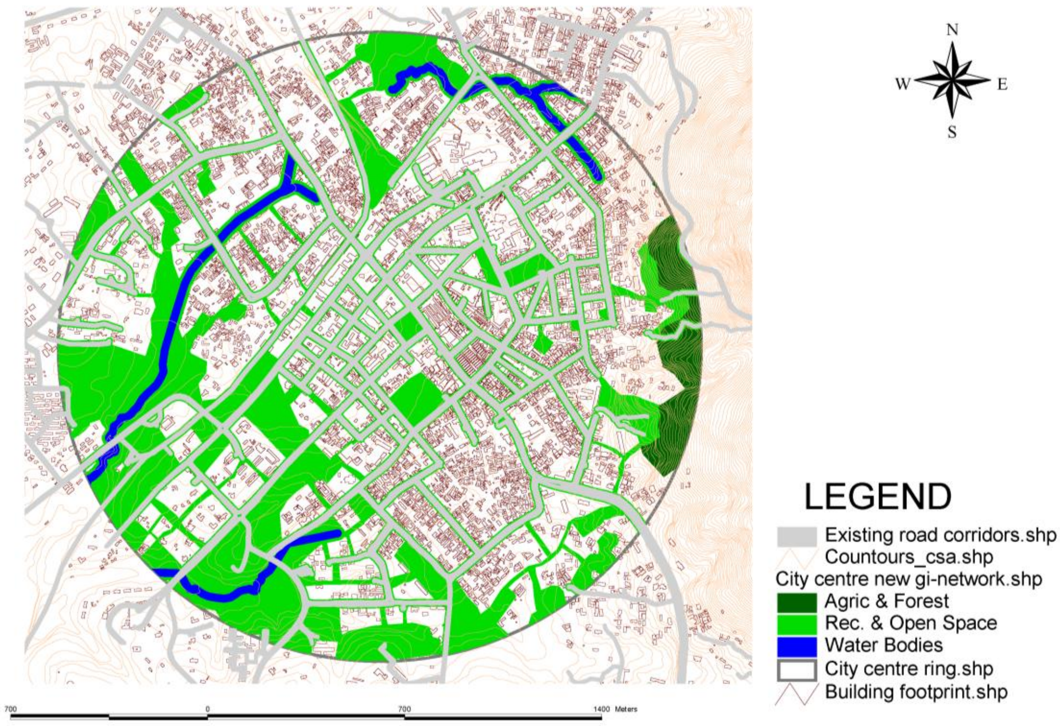
For example in considering the existing Green infrastructure Network of NJMA, the core city centre (as shown in figure 9-6 below) has been ripped off from any greens and the entire city is sprawling uncontrollably. Thus in applying the strategy of Ecological aesthetics the aspects of landscape architecture, environmental psychology and geo-anthropology was applied to come up with a proposal. The Green Infrastructure was then networked and the other guidelines applied as shown in figure 9-7 below.

Figure 10-6: Existing Green Infrastructure Network of NJMA Urban Core



Source: Author

Figure 10-7: Updated Green InfrastructureNetwork of NJMA Urban Core



Source: Author

10.5 EXPECTED BENEFITS ECO-NERGY EFFICIENCY TO NJMA AND THE VARIOUS REGIONS WITHIN TSSA

The expected benefits of implementing the above mention proposal in NJMA and TSSA as a whole are numerous and difficult to quantify. They range from **Environmental, Economic, Socio-cultural and to Liveability of** the urban communities benefits that can be accrued directly or indirectly.

10.5.1 Environmental and Eco-system Functions and Benefits

One of the major benefits of the proposals identified and enumerated above earlier for NJMA and other urban areas of TSSA(if applied) is the environmental and eco-system functions and benefits. The functions that can be provided by the eco-system after it had been ecologically re-vitalised by the UGI is also a great benefit for the NJMA community and other TSSA cities where its applicable.

I. Eco-System Functions of the UGI in NJMA

The eco-system functions provided predominantly by the UGI net work includes Provision, Regulation, Habitat, and Cultural and Amenity functions.

- **Provision Function:** It supplies physical services in terms of resources like food (crops,livestock, wild foods, etc.) and fibre(timber,cotton/hemp/silk, wood fuel). This function can be classified into two categories namely; Production and Carrier Function. The former category cover resource produced by natural eco-system(harvesting wood in natural forest), while later category include resources that produced by human intervention(agricultural) (Millenium Ecosystem Assessment,2005; Sawsan, 2011,p.24). Genetic Resources, Biochemicals, natural medicines and pharmaceutical provisions are also other provision functions provided by GI Provision function.
- **Regulation Function:** this reflects the capacity of ecosystem to mitigate(regulate) climate, air quality, hydrological and bio-chemical cycle, earth surface process and variety of biological process. (Millenium Ecosystem Assessment,2005; Sawsan, 2011,p.24). These services also include erosion regulation, water purification and waste treatment, disease regulation, pest regulation, pollination and other natural hazard regulation. Air quality for example affects the health of everyone, and is a major factor in illnesses ranging from cardiovascular disease to cancer and respiratory ailments (Moore, 2002). According to the State of the Air 2004 report issued by the American Lung Association (2004), all monitored Maryland counties, including Cecil County, received an air quality grade of “F” for the number of days with high ground ozone levels. This is of critical concern to those with respiratory problems. Ozone forms in chemical reactions in

the atmosphere when nitrogen oxides and volatile organic compounds, primarily from burning fossil fuels, come into contact with sunlight and heat (American Lung Association, 2007). It attacks lung tissue and causes numerous health problems, including asthma attacks (American Lung Association, 2007). Of a population around 90,000, Cecil County have an estimated 2,000 children and 5,419 adults with asthma, 2,929 people with chronic bronchitis, and 976 with emphysema (American Lung Association, 2004). Although there are no statistic or data on NJMA how air quality is affecting the people, it can be deduced that there is some benefits that can be accrued from the UGI in terms of air quality. In the USA Nationally, asthma accounts for an estimated three million lost work days annually, and the annual direct health care cost of asthma is estimated at $8.1 billion (American Lung Association, 2001; Moore, 2002) and this would be interesting also to find out for Ghana and other countries in TSSA.

The trees within the UGI network would provide air quality benefits by absorbing sulphur dioxide and nitrogen oxide, two major components of acid rain (American Forests, 1999). In addition, these trees can trap ozone, carbon monoxide, and particles in the air, all of which can be harmful to humans (American Forests, 1999). According to a study by American Forests (1999), trees in the Baltimore-Washington urban corridor removed 34 million pounds of air pollutants in 1997, at a value of $106 million per year (adjusted to 2006 $).

- **Habitat Function:** This consist of the ecosystem role in maintaining natural process cycle and biodiversity function. However the relationship between biological diversity and ecosystem function are inherently complex and operate at many spatial and temporal scales. This can be sub-dived as refugium and nursery function. The former has the role of ecosystem in providing habitat for endangered species, whilst the latter represents ecosystem providing the function for suitable location for reproduction and thereby have regulating impact of population elsewhere. (Millenium Ecosystem Assessment,2005; Sawsan, 2011,p.24)

- **Cultural and Amenity Function:** This includes the non-material benefit to people. It covers the sensual functional and visual benefit that people gain from landscape through recreation, cognitive development, relaxation and spiritual reflection (Millenium Ecosystem Assessment,2005; Sawsan, 2011,p.24)

Apart from the above broad categories the UGI introduced can also act in a multi-functionality manner. For example a functional flood plain within or adjacent to NJMA or within its environs (

Box 10-2:Green infrastructure and climate change

An ability to mitigate and adapt to the rising temperatures and extreme weather events associated with climate change is essential to the success of an eco-town. GI has a vital role to play by:

- Providing a natural cooling effect to mitigate the urban 'heat island'; This should reduce the need for energy-hungry cooling systems and increase comfort levels in outdoor spaces.
- Providing space for sustainable urban drainage to absorb excess rainfall. Green spaces can provide an efficient and cost-effective 'soakaway' for rain water and a reservoir for grey water storage.
- Providing space to grow food using sustainable methods, such as organic cultivation. This can not only contribute to healthy diets for local communities but also enhance biodiversity, provide jobs, and offer educational opportunities for all ages.
- Allowing species to migrate and adapt to the effects of climate change.
- Providing vegetation to reduce the effects of air pollution and to store carbon.
- Encouraging alternative modes of transport such as walking and cycling, by providing pleasant environments – thus helping to reduce carbon emissions.

Providing attractive, cooler and shaded outdoor areas in hotter summers, readily accessible from people's homes

Source: (TCPA, 2008,p.6)

Densuagya- banks of the Densu river) should be managed to protect settlements from flooding. However, it can also:

- Provide an extensive recreational space for local people.
- Provide a valuable habitat which could also be managed as a nature reserve.
- Be agriculturally productive, with a grazing or cropping regime that maintains the capacity of the site to perform its other functions effectively.

- Provide a cleaning function for water run-off from new development, helping to protect and improve water quality. (TCPA, 2008, p.24)

Multi-functionality of the UGI in NJMA can be expressed through combining the green infrastructure with other forms of infrastructure. For example, green corridors can serve both people and wildlife by carrying footpaths, cycle ways, and tram and light railway routes alongside linear grassland habitats, wooded belts, streams and ponds. In this way GI becomes integral to an important part of the transport infrastructure (TCPA, 2008, p.24) of NJMA.

Soil fertility which affects food security can be enhance through the muti functionality attributes of the UGI. Organisms in the soil enrich it by breaking down litter and other organic matter, transforming nutrients into forms plants can use, and circulating the soil through burrowing and other movement. Pimentel (1998) wrote, "One hectare of high-quality soil contains an average of 1300 kg of earthworms, 1000 kg of arthropods, 3000 kg of bacteria, 4000 kg of fungi, and many other plants and animals. These soil biota enhance crop productivity because they recycle the basic nutrients required for all ecosystems, including nitrogen, phosphorus, potassium, and calcium. The movement of earthworms and other biota through the soil further enhance the productivity of the soil by increasing water infiltration. Other activities of soil biota – mixing the soil components, enhancing aggregate stability, and preventing soil crusting – improve soil productivity as well. Earthworms bring between 10 and 500 t/ha of soil to the surface each year, and insects can also bring up between 1 and 10 t/ha of subsurface soil. These activities redistribute nutrients, aerate the soil, facilitate topsoil formation, and increase infiltration rates, thereby enhancing the quality of the soil and plant productivity." (Weber, 2007)

10.5.2 Economic Functions and Benefits

Economically, the proposals enlisted above have the potential to cause an appreciable rise in the property values of NJMA whilst increasing the vitality of the local economy and commerce. The shaded paths and streets with increase NMVs have the potential to increase retailing and shopping in the urban core. The suggested UGI Network and Energy efficiency strategies if successfully implemented would also create a high quality environment which would attract and retain quality work force and middle to high income groups in Ghana. This would also create a strong accessibility between the urban core and the rural fringes thereby boosting the trade of foodstuffs and agric products. It indirectly would also trigger sustainable food productions as post harvest losses due to non-availability of ready markets would be minimised or curtailed entirely. The chronic problem of waste management would be addressed due to the introduction of waste to energy (biogas) on pilot scale and money spent in this aspect could be channelled to maternal health and other amenities. According to Energy Commission of Ghana (2006,p.21), oil imports accounted for about 80% of the total trade deficits in Ghana and the cost of oil imports rose from 561 million USD in 2000 to about 766 million USD. Thus if the energy efficiency strategy proposed for NJMA is successful and adopted nationwide the economic benefit that would be accrued from the reduction in Oil and Gas imports would significant as its targeted to reduce transportation by 20%. An efficient and sustainable water and flood risk management which affects the production of local water quality and supply as well as functioning hydrology would be improved significantly thereby reducing the budget needed for NADMO to spend as relieve items on internally displaced persons due to floods.

More so, by adhering to the energy efficient strategies proposed, the recurrent 25-30% (Energy Commission, Ghana, 2006) energy losses due to transmission of power would be minimised significantly. If emissions reductions in accrued as a result of the proposed strategies are implemented under the Kyoto Protocol CDM initiative, approximately in this could earn Ghana yearly about $USD 13 million(Faah, 2008, p.141) (adequate to build school facilities for 130 schools under trees).

Base on deductions and comparative analysis from Faah (2008) and Energy Commission of Ghana, (2006) reports, impact of Eco-Nergy Efficiency Strategy (ENES) proposed in this study on energy demand is expected to be significant. For instance, should the ENES be implemented in Ghana by 2015 and sustained up to 2025, an average of about 15% savings in total energy consumption per year by 2020 and about 25% per year by 2025? This translates to an average of about 4,200 GWh yearly savings by 2025 equivalent to a 600 MW thermal power plant (1.5 times Bui Hydro Dam and 3.75 times Kpong Hydro Dam's installed capacity) and about 1.4 billion USD[88] cost savings in total energy expenditure for the year 2020. The value of these economic benefits may rise if empirical quantification of the value of the eco-system services provided by the proposed UGI network strategy for NJMA is carried out.

10.5.3 Socio-Cultural Benefits

Behavioural and attitudinal paradigm of the people of NJMA would be significantly affected after the throughout the implementation of the proposals. Though socio-cultural benefits are difficult to quantify, but anecdotal evidence suggests the NJMA community would be different with changed

[88] Based on the cost projections from Energy Commission for 2020

people if the implementation is a success. Cultural identification and empowerment through the planning process where stakeholder consultation and consensus building is a mandatory part is one of the boosters. The human environment connectivity experience and dimension introduced through the ecological aesthetics reinforces the cultural identification and empowerment process. Thus the proud and economic savvy Juabens would regain their traditional heritage and would respect the environment and have a vision to develop an attractive community as a flagship project in Ghana.

10.5.4 Quality of Life and Community Liveability Benefits

Berke et al, (2006) explains that liveability of communities encompass urban design which ranges from the micro scale of the block, street, and building to the macro scale of the city, municipality, metropolis and the region. With the implementation of the three elaborated interventions for NJMA, the community would be able to provide ample opportunity for sociability, personal development and community participation. These would include identifiable neighbourhoods, incorporate multi-task accessible green space, community meeting spaces with programs to address cultural and recreational needs, and make people of all ages feel comfortable and alive. The UGI Network through its implementation would for example provides recreational, quiet enjoyment and health benefits(physical, spiritual and mental) apart from providing community cohesion through civic pride, sense of place, social avenues and provision of public space for art. Apart from the air quality improving, there would be an enormous opportunity for heritage preservation and cultural expression. The provision of NMVs which hitherto was non-existent in NJMA would also preserve the functionality of the open spaces. Opportunities for children to play freely and free of charge in their own Neighbourhood and on routes to schools and other play areas is also going to be possible. More so apart from the provision more opportunities for young people to spend time in public space with their friends, with no particular agenda regular exposure to nature and boosts to awareness of environmental issues would also is available. These benefits would thus make the urban fabric improve in quality and the community and neighbourhood ethos and liveability tremendously enhance.

11 RECOMMENDATIONS AND CONCLUSION

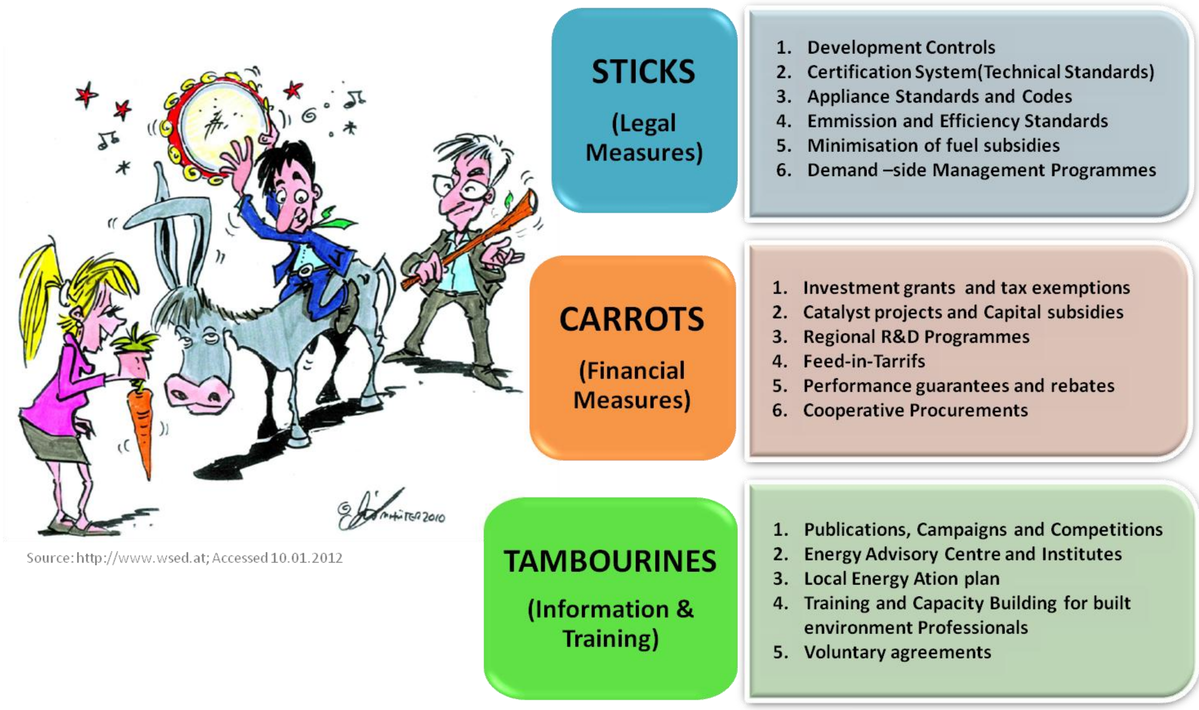
11.1 GENERAL RECOMMENDATIONS AND DISCUSSION

In order for the proposals discussed in chapter 9 above to be feasible, the under listed recommendations which seeks to create the enabling environment for its implementation may have to be pursued. It's recommended that the proposal be replicated across TSSA after it has been adapted to the local socio-cultural and geo-physical condition whilst the urban growth in TSSA is managed effectively through pragmatic strategies tailored to the region. Supporting policy and conceptual framework on urban milieu ought to be in place for all the other strategies to be implementable and further areas that need to be researched into had also been outlined.

11.1.1 Sticks, Carrots and Tambourines Strategy

In other to get the proposals enlisted in chapter effectively assimilated into the development plans of the urban areas within the TSSA, the analogical Sticks, Carrots and Tambourine principle for making the donkey (which represents the TSSA Development Politics) move. For the donkey to move one needs to give it some sticks or beatings as well as lure it with some carrots and make noise with the tambourines to keep its focus on the carrot and not sleep off or wonder away.

Figure 11-1: Sticks, Carrots and Tambourines Content



Source: Author

As far as **“sticks”** are concern these includes but not limited to **s**tringent and well-enforced building and appliance standards, codes, and labeling should be made obligatory for all new buildings and retrofits. As indicated in figure 11-1 above, this can be seen as the enactment and enforcement of development controls and introduction of certifications systems to standardize the technical detailing. Appliance standards and codes as well as emission and efficiency standards ought to be introduced and enforced by the appropriate authorities. In poor countries, subsidies on energy price, which encourage energy use and thus wastage, should be minimized to absolutely necessary situations and periods. It could be applied instead to capital investment into energy efficiency improvements and sustainable energy generation, which will deliver cheaper and cleaner energy services for a greater number of people.

“Carrots” could refer to the financial measures which would include the use of energy pricing and taxation to encourage efficiency. In France, for example, new buildings respecting certain environmental criteria can be exempt from property tax for 15–30 years. Public sponsorship of catalyst projects and capital subsidies could go a long way in helping energy efficient lifestyle and eco-responsive development become beneficial and competitive. It could also mean the sponsorship of regional research and development programmes like what is being practiced by the European Union. Feed-in-Tariffs, performance guarantees and cooperate procurements are all innovative ways of encouraging and incentivizing energy efficiency TSSA urban development and growth.

The “tambourines,” it could refer to capacity-building efforts to retrain all stakeholders in the construction process as well as consumers, building owners, operators, and dwellers must take place. In most countries the creation of comprehensive, integrated programs at universities and other educational establishments is needed to train current and future building professionals in the design and construction of low-energy buildings. The development of pilot projects is helpful to demonstrate the effectiveness and the everyday functionality of the new buildings to the public and investors. In this context, the role of the public sector as an early adopter is crucial. The development of the ‘*Passivhaus’* scheme in Germany has been instrumental in the strong development of low energy buildings over the past decade. It is further hoped that through lifestyle, cultural, and behavioral changes, still further significant reductions in building energy use will be possible.

However, it is worth noting that the order of implementation in Ghana would be Tambourines, Sticks and Carrots. This is because general education and capacity building is critical for attitudinal change whilst the punishment or sticks would follow. However to make the energy efficiency lifestyle to be competitive for communities which have acute scarcity of financial resources, the carrots would then be brought in to pacify and encourage those who would want to save some money through living Green.

11.1.2 Replication by Adaptation in TSSA

In a region where less emphasis is placed on research in building physics and there is wholesale importation of recommended building materials from the western world, there is also a danger of misapplication of building materials on the wrong surface of buildings in the urban fabric. According to Emmanuel (2005, p.49), if heat absorbing materials are used in wrong oriented urban canyons, the effect of the heat island will be more pronounced and may caused the dwellers to require mechanical ventillation to increase thermal comfort. Its therefore recommended that a comprehensive state of the community or urban area report which consist of detailed urban and enviromental analysis to ascertain how to tailor any of the proposals to fit the country or community in question.

Urban vegetation enhancement strategies must take into account the excessive amount of tree cover needed to achieve the desired level of Eco-Nergy efficiency as well as the cost of maintaining the trees (McPherson, 2001; Emmanuel, 2005, p.49). In a developing a economy like Ghana where food insecurity is a problem, it would take more than research to lobby the politcal will to follow this cause. A guiding vision ought to be set out for UGI across communities in TSSA and secure wide stakeholder buy-in. This is because it is around an imaginative and inspiring vision that a strong partnership or coalition will come together. This can be aided by face-to-face stakeholder consultation events to elicit information and data, test ideas, and expose the emerging strategy to constructive criticism and it must be devoid of partisan politics.

Strategies to enhance albedo ought to consider the practical issues in maintaining light colour in a dusty urban context of TSSA. Paint degradation due to excessive UV radiation poses eminent threat to light-coloured surfaces in TSSA. The option for light coloured tile is also economically prohibitive whilst compact living in a developing economy may also cause ecological stress at the micro-scale (Whitford et al., 2001, Emmanuel, 2005, p.47). Thus for an effective adaptation to take place within the region, resourceful and well equipped research institution focussed on the built environment like that of Curitiba's Research and Urban Planning Institute of Curitiba (IPPUC), and Masdar City's Masdar Institute of Science and Technology need to be in place as support for the process . In order to accelerate the process of Eco-City development especially with emphasis on ECO-NERGY Development, the neighbourhood model of community development ought to be adopted. This falls in line the generic form of community development as described in chapter 3.3.2 (Morphological Analysis of the Community Spaces in Tropical SSA). The Afro-Green Neighbourhood Model seeks to change the form of development from a pattern of sprawling, isolated buildings to a more compact and interconnected design which would have considered the principles of ecological aesthetics in the planning and design of its green infrastructure.

a. The Afro-Green Neighbourhood Model as a Building Block for TSSA Communities

This according to Albemarle County Board of Supervisors (2001, p.7), the neighbourhood model accommodates walkers, bikers, and public transportation so that mobility can be a reality for the elderly, the young, and those with limited access to automobiles. In the case of NJMA and the African context, this model would also make open space integral to overall design so that residents and workers can walk to a public park, experience preserved natural areas, and enjoy public gathering places. Since most of the building types in NJMA was developed out of the incremental type of construction and have the courtyard system in the final output, this can be maintained whilst the bio-climatic characteristic also respected. Hence attempt would be made to keep buildings and spaces at a human scale so that street views are attractive and pedestrian friendly. In order for the replication to work effectively, a comprehensive plan and layout for the various planned neighbourhoods within the communities would be prepared. Consequently, varying densities which gradually allows for an overall increase in density in the Development Areas would also be incorporated to meet the goals of the Comprehensive Plan. Most importantly to solve the problem of having a kiosk or a turning parking lots and open spaces to retail the neighbourhood model would contain a mixture of residential and non-residential uses, so that residents would have convenient access to work, to services, and to entertainment as it exist informally. More so, in an Afro-Green Neighbourhood Model of community development, interconnected streets would be provided within developments and between developments so that pedestrians can walk easily to many destinations, traffic has alternative routes, and car trips are reduced in number and length. Off-street parking out of sight would also be introduced whilst encouraging on-street parking. For the community to be socially responsive and sustainable, mixes housing types and markets would be have to be provided so that the full range of housing choices is offered within the neighbourhood. The development control codes and policies would have to emphasize re-use of sites and the adaptation of development to site terrain so that natural topography can be preserved and enhanced. The Afro-Green Neighbourhood model for community in TSSA would also ensure that the neighbourhoods have a designated centre (Community Centre as called in Ghana) to bring diverse and continuous activity to a neighbourhood.

As a matter of principle, the Open Spaces within the various communities of the TSSA Area would have to be treated to offer opportunities for public and private outdoor recreational areas for active and passive recreation. More so, a network of streets, bikeways, pedestrian paths, and bus routes would connect new neighbourhoods as well as existing residential areas and non-residential districts. Attempts would have to be made to create appealing Streetscapes which are clean with interesting vistas. As the fundamental element of public space within the neighbourhood, the street will make the neighbourhood inviting with street trees and landscaping. Sidewalks or paths that connect houses to each other and to centres and common areas will be the norm. Walks will connect sidewalks to front doors and main entrances. Convenient routes for pedestrians, bicyclists, and buses will augment the street network. Public transit stops will be located within 700-1000m and walking to them will be safe and convenient.

11.1.3 Urban Growth Management and Principles

The African urban population, which was projected to more than double its 2007 level of 373.4 million by 2030 show through projections that by 2030 there will be 759.4 million African urban dwellers, more than today's total number of city dwellers in entire Western hemisphere(UN-HABITAT, 2008, p.4). According to the UN-HABITAT (2008, p.4), the world's shortest urban population doubling time, less than nine years, is found in the East Africa region, from 50.6 million in 2007 to a projected 106.7 million by 2017. Though East African urbanization is a poverty-driven economic survival strategy, with urban populations growing significantly faster than the urban economies, between one-third and two-thirds of the people in East African cities now experiences at least one shelter deprivation (UN-HABITAT), 2008, 14). This type of growth when uncontrolled, promise to pose a major setback to the implementation of the proposals set out in chapter 9. As a result of the astronomical urbanisation in TSSA, the cities are sprawling and the urban core deteriorating into slums due to lack of commensurate infrastructure to support the growth. In order to prevent sprawling of cities in TSSA, which inadvertently affects the transportation energy efficiency negatively, the growth of the urban centres would need to be strategically managed. A combination of compact and smart growth principles would need to be adopted so that even the fractal communities can be managed reasonably. Amongst these growth management strategies are;

- ❖ **Urban infill** – urban growth takes place within the boundaries of existing cities and towns (Breheny, et al., 1993). It takes cognisance of the existing architecture and socio-cultural milieu of the place in context. The land use plan ought to give priority to internal development over outward expansion with the aim of strengthening the character and variety of the urban centres.
- ❖ **Urban extensions** – development takes place at the edges of existing urban areas, typically on green fields or on other open land at the urban fringe (Breheny, et al., 1993).In a planned manner the urban extensions help to reduce leapfrog type of sprawling in a controlled manner
- ❖ **Key village extensions** – new development takes the form both of expansion at the edge of the village, and intensification at its centre (Breheny, et al., 1993);
- ❖ **Multiple village extensions** – as above but spread through any/all villages (without selecting any in particular for provision of critical mass of services, etc.) (Breheny, et al., 1993);
- ❖ **New settlements** – a free-standing settlement, where the completed new development – of whatever size – constitutes 50% or more of the total size of the settlement, measured in terms of population or dwellings (Breheny, et al., 1993).

More so, some basic urban design principles would have to be respected and adhered to make the urban growth tie into the over local contextualisation. These include some urban design principle, City Structure, Character Areas, Permeability and Accessibility (Hall, 2007, p.88-89).

I. Design Principles

a. In view of the huge housing deficit and the lack of any strong pattern or architectonic character within the built environment, the new housing areas should create their own strong character, pattern of development and identity and reflect it with their surrounding landscape;

b. The existing site features and constraints should be taken as the basis for the new community layout and used as opportunities to create features focal points and interest within the development and its immediate environs.

II. Structure

a. Within the sites, the new development should be laid out to form a coherent network of spaces, enhanced by appropriate built form. These should be designed for the pedestrian viewpoint relating to the human scale and creating an environment which encourages cycling and walking to reach local destinations.

b. Visual interest and variety should be created by an unfolding sequence of spaces, varied design of buildings and open views.

III. Character Areas

a. The non-residential elements which serve the development should be grouped in an integrated manner to form a core urban space.

b. In addition to the core, housing should be structured around a series of nodal points. These should be irregular or regular shaped urban spaces formed at junctions of routes and emphasised by key buildings or building groups. Areas with their own identity can thus be created.

c. Dwelling sizes and forms should be mixed within the development so as to assist the creation of visual variety, interest and townscape.

IV. Permeability and Accessibility

a. It should be possible for pedestrians and cyclists to move freely between all parts of the layout, both locally and on a wider scale. If culs-de-sac are used, their heads should be linked by creating pedestrian/cycle links between the road systems to avoid dead ends.

11.1.4 Policy and Conceptual Framework

After a detailed analysis and evaluation of the state of given community in TSSA , it is recommended that a vision for an urban renewal or re-structuring programme with focus on ecologically responsive and energy efficient community be formulated for a policy framework drafting.

The Policy framework would set down a framework which takes into account and evaluate demands of different types of development as well as economic and ecological considerations. For example Faah (2008, p.140) in his research revealed that if no major change in policies or economic determinants from the existing trends in meeting road transport and energy demand in Ghana, then the 2005 emissions value is expected to rise by 36% in 2010 and over double in 2020 i.e. from 4.6 Mt to 6.25 Mt and 9.77 Mt CO_2 e in 2010 and 2020 respectively. General Policies and Programmes for the environmental responsiveness need to be visually mapped out for education and communication. For example as part of the UGI network of a TSSA Community the following policy maps are recommended;

- A Nature Conservation Strategy Policy map which defines sensible and valuable areas as priority for climate, soil and water resources.
- Landscape Scenery Policy Map which aim to incorporate ecological aesthetics to improve specific qualities of urban natural landscapes
- Recreation and Use of Open Spaces Policy map which would identify existing open spaces and delineate their functions. For example Culture and Sport week-end conflict (The conflict between youth who want to use open space on week-ends for sports and organisers of funerals who also want to use the same space for their function.

In these policy maps, identification of those existing green space and environmental assets that need to be protected and enhanced are done. It also involves strategies which provide a framework for identifying and protecting key habitats and very valuable social spaces. This requires a comprehensive ecological, landscape, historical and social stock to be taken. Only a full and all-inclusive survey of existing assets will provide a sufficiently accurate and up-to date baseline of data to allow a decent UGI plan to be developed. More so Inclusion of an implementation plan, including a funding and management strategy identifying how both initial set-up costs and long-term revenue funding and other management can be secured (TCPA, 2008, p.20).

In countries where there are already energy efficient strategies and policies in place, a study of it to incorporate the missing components would be necessary. In Ghana for example, the energy efficient action plan proposed by the GoG Energy Efficient Strategy policy Framework includes;

- Procurement of 8 million CFLs to support on-going DSM activities
- Retrofitting of public buildings, purchase of load controllers for industries, promotion, etc
- Standards testing laboratory
- Natural gas and renewable distributed/Grid connected co-generation (CHP) activities
- Promotion and dissemination of improved cook stoves, kilns, setting up of institutional structures

  Promotion and dissemination of proven solar dryers and water heaters (Energy Commission, Ghana, 2006, p.70)

In this scenario, the three proposals in Chapter 9 may still be applicable when adapted to the Ghanaian context. Additionally, a policy on introducing Smart Meters[89] to the new middle to high income gated communities to assist them in their attitude towards energy consumption would be also quite effective. Smart meters are the next generation of gas and electricity meters. They collect information about your energy use - electronically at regular intervals.

The in-home display connected to the smart meter will show users how much energy they are using, enabling them to monitor their usage more easily, change habits and cut down waste.
They are able to see instantly when they are using lots of energy and how much it's costing them and it make it easier for them to identify ways they could make savings. These Smart meters and displays have been trialled in countries ranging from Sweden to the USA and results show that smart meters can reduce household energy bills by 5-10 per cent. Introduction of it to the middle class homes would help them save money by enabling them use energy at 'off-peak' times; when demand for electricity is lower and it is cheaper. They may also help them to sell energy back to the grid if they generate their own energy by using solar panels, for example. Energy suppliers may also offer other services to enable them to track their energy usage, for example online accounts or through mobile phone applications.

11.1.5 Assessment with Key Performance Indicators

ECO-NERGY Development Key Performance Indicators (ED-KPI) is a proposed assessment tool for Energy Efficiency and Ecological Responsive Community or neighbourhood development in the TSSA context. Based on the proposal as explained in the Chapter 9 the ED-KPI assessment or rating system would to focus beyond the building level and evaluate whole community—or multi-building projects that contribute to neighbourhoods. Under the broad thematic strategies of Urban Transport Energy Efficiency, Residential Energy Efficiency and Urban Green Infrastructure Networks, the tool seeks to prioritize criteria such as site location, urban design, transportation, walkability, and neighbourhood-wide green infrastructure, catalyst Projects and Incentives, mobility Management, Development Controls enactment and enforcement and ecological aesthetics. The LEED-ND is used for projects may constitute whole communities, portions of communities, or multiple communities. As shown in

[89] http://www.energysavingtrust.org.uk/Home-improvements-and-products/Smart-meters-your-questions-answered

ECO-NERGY Development Key Performance Indicators (ED-KPI) is not meant to be a national standard that replaces zoning codes or comprehensive plans, nor has it been designed to certify sector plans or other policy tools. Local development patterns and performance levels vary greatly across the TSSA and within countries, because land regulation is largely controlled by local governments. The rating system should therefore not be considered a one-size-fits-all policy tool.

Instead, ED-KPI should be a voluntary monitoring standard, and local governments should consider promoting its use by the development community or public-private partnerships. In addition, ED-KPI can be used to analyse whether existing development regulations, such as zoning codes, development standards, landscape requirements, building codes, or comprehensive plans are "energy efficient and ecologically responsive. public sector projects (e.g., those sponsored by the local government or the ministry of works and housing(as in the case of Ghana) can use this as litmus test to monitor its environmental responsiveness and energy efficiency of the project. In order to check the biasness and subjectivity inherent in the application of the ED-KPI for monitoring and assessment of existing and on-going projects, a sensitivity analysis would have to be performed where the relative scores weight can be altered. This assigned weight reflects in the aggregated scores for each broad category of assessment More so a minimum of 5 key stakeholders with different background with apparent different value system would have to assess the project and the average of the 5 can be taken as the better estimate of the performance of a given project or community. These stakeholders may include; Economist, Sociologist, Ecologist, an Engineer/Architect and a Community Based Organisation Volunteer. Further expatiation and the detailed meaning and implication of each indicator would have to be done prior to the data collection for this performance or monitoring evaluation.

There are about 3 main broad thematic areas of assess with 6 sub-divisions and about 59 checklist for the assessment. For these 59 checklists as indicated in appendix 4, a project or a community can score about 70-89 points to be rated one star,90-109 points for 2 stars, 110-129 for 3 stars and above 130 points for 4 stars ECO-NERGY EFFICIENCY. A maximum of 48 points however can be scored under either Urban Transport Energy Efficiency or Urban Green Infrastructure Network which represent about 30% each of the total scores, Nonetheless, under the Residential energy efficiency which forms about 40% of the total available points, a score of maximum 64 points can be awarded based on the performance. This weighting system was based on the analysis performed under the energy consumption by sector for TSSA countries which showed that more that 50% of the energy demand was from the residential sector. Unlike the LEED-ND which assigned marginal importance to the regional context, the ED-KPI places much emphasis on the local context through the sub-thematic area of Ecological Aesthetic and connectivity. After the initial assessment of the existing land use and cover with the ED-KPI, the NJMA scored 40 point which was far below the certification level despite its huge Agric and Forest resource. After the interventions and re-planning, it managed to secure 75 points in the absence of all the reliable data for energy consumption which could have boosted its scores.

11.1.6 Recommendations for Future Research

Though there have not been much research in the area of Green City Development in TSSA, it's recommended that to enable countries within the region with appreciable stable governments and economies to promote Green or Eco-City Concept in Africa, research ought to be undertaken in these areas;

i. Eco-System functions impacts on Health and life expectancy of TSSA inhabitants
ii. Cost analysis of Eco-System Functions of UGI in NJMA or any TSSA urban environment
iii. Empirical studies and research into the impact of mobility management introduction on transportation energy demand.

These findings can also be adapted and replicated in the other countries and would create a wide range of information for effective environmental responsive and energy efficient strategies tailored to TSSA with empirical facts supporting it.

11.2 SUMMARY AND CONCLUSION

The big machine-like city structure of Masdar and Dongtan under the banner of Green city concept is a very good example of **what should not be done** in TSSA even if it's acceptable in the developed world as sustainable or if the countries have enough financial resources from the sale of petroleum products. These resource dependent developments of the scale of Masdar City would become a maintenance headache and a source of attraction for violent crimes since it would increase the socio-economic schism which is already a problem and a source of many of its conflicts. However an aspect of its implementation strategy which is worth mentioning and emulating is the setting up of strong institutions backed by political will to support its utopian ideas. TSSA is notorious for week and non-performing institutions due to the so called political soccer that they are subjected to. Hence a decoupling of the Energy and Environmental related institutions from political influence and backing it with the adequate legislation and funding would be a major step in the right direction.

According to the Energy Commission of Ghana(2006, p.20), the Ghana Poverty Reduction Strategy (GPRS) which was targeted to usher the Ghana to a middle income range of US$1000 per capita have been achieved by 2010 ahead of its 2015 target, it implies the anticipated demand for wood fuels which was projected to grow from about 14 million tonnes in 2000 to 38-46 million tonnes by 2012 is already in place. The projected 54 – 66 million tonnes by 2020 may be attained around 2015 and would put the nation's dwindling forest under undue stress which could culminate into serious deforestation, with serious consequences on climate change, agriculture and water resources, if no significant action is taken (Energy Commission, Ghana, 2006, p.21).

Socially, there are quite a subtle but destructive attitude and behaviour of most people in the TSSA region especially Ghana. The opulent, resource dependent life styles of Hollywood stars and western culture of living is gradually being accepted as the status quo for success. Hence new communities and real estate developers tend to respond to this demand by implementing projects that tends to consume so much land and energy but green wash with solar panels and call them as eco-friendly. This distortion makes it difficult for the public in the absence ready information to distinguish between what indicators and characteristics of community development can be called eco-responsive. Sadly, the local cultural practices which were used to help protect the environment are now being considered as outmoded and the Non-farming days and Fishing days which helped most fauna to breed are almost non-existent. A major step in this direction will be the establishment of National Energy information Centre at Energy Commission to disseminate available information on

Energy matters to the public, researchers and other stakeholders (Energy Commission, Ghana, 2006, p.67). In Sub-Saharan Africa, despite a projected increase in the electrification rate from 29% in 2008 to 47% in 2030, the number of people without access to electricity increases by 111 million by 2030. Lack of access to reliable, safe and mostly environmentally friendly energy has been identified as a major impediment for TSSA countries to some of the MDGs like; economic development, reduction of hunger and improve access to potable water, achievement of universal primary education and empowerment of women.

Thus the impact of Eco-Nergy Efficiency Strategy (ENES) on energy demand is expected to be significant. For instance, should the ENES be implemented in Ghana by 2015 and sustained up to 2025, an average of about 15% savings in total energy consumption per year by 2020 and about 25% per year by 2025? This translates to an average of about 4,200 GWh yearly savings by 2025 equivalent to a 600 MW thermal power plant (1.5 times Bui Hydro Dam and 3.75 times Kpong Hydro Dam's installed capacity) and about 1.4 billion USD[90] cost savings in total energy expenditure for the year 2020. The presence of UGI has great potential to reduce the atmospheric temperature and increase thermal comfort in TSSA countries. Using the stored energy, vegetation can also transpire efficiently. Even an isolated tree can transpire up to 100 US gallons (379 litres) of water per day (Kramer et al., 1960; Emmanuel, 2005, p.88). This is equivalent to the cooling provided by five 20,000 BTU (5800W/m^2) air-conditioners running 20 hours per day (Federer, 1971; Emmanuel, 2005, p.88). Not surprisingly, it was identified that the main barriers to eco-responsive planning in TSSA are **Technical, Economical, Political, Informational** as well as **Social**. Nevertheless proposals to ameliorate the ecological decay and neglect in the sub-region need to be something which is pragmatic, less expensive but help to change attitudes of the people to the environment whilst creating some sense of ownership. Thus within the Urban Green Infrastructure Networks strategy, what may be needed most for now is:

- Development Controls Enactment and Enforcement; and
- Ecological Aesthetics and connectivity

On the issue of Energy efficiency the identified barriers included;

- Structural barriers: conditions that are beyond the control of the individual end-user
- Behavioural barriers: problems that characterize the end-user's decision making

[90] Based on the cost projections from Energy Commission for 2020

Thus any solution to tackle the problem in TSSA ought to be channelled in creating a paradigm shift in both individual attitudes and generate enough political will to back it up with pragmatic policies. Using the case of NJMA as a representation of TSSA cities, the strategic action that is proposed pursue to achieve the envisaged transport energy efficiency(TEE) are Mobility Management and updating of the Municipal Land Use plans which seeks to produce more compact, transit-served, walk-able urban form.

Most importantly, through the study, various urban planning and design strategies which are effective in reducing energy demands and increasing the use of renewable and high-efficiency energy supply technologies have been identified and the ones that apply to TSSA elaborated. The three broad thematic proposals have also elaborated how the building professionals practicing in SSA could design and plan their urban centres to achieve more efficiency with fewer resources as well as plan their communities 'with' and 'like' nature. Using ArcGIS Software and Multi criteria analysis as well as PLACE^{3}S evaluation tool one can identify or assess the 'greenness' of an existing or proposed new community in Ghana or TSSA. In Chapter 9 and 10 strategies to incorporate green principles and achieve eco-responsiveness and energy efficiency in TSSA have been discussed whilst the benefits and relevance of green infrastructure in planning communities in developing countries been duly expatiated. New Developments or urban renewals in TSSA ought to develop land use plans that seek to provide a balanced distribution of retail concentration and mixed used areas suitable for shopping development which would increase the attractiveness of the city core.

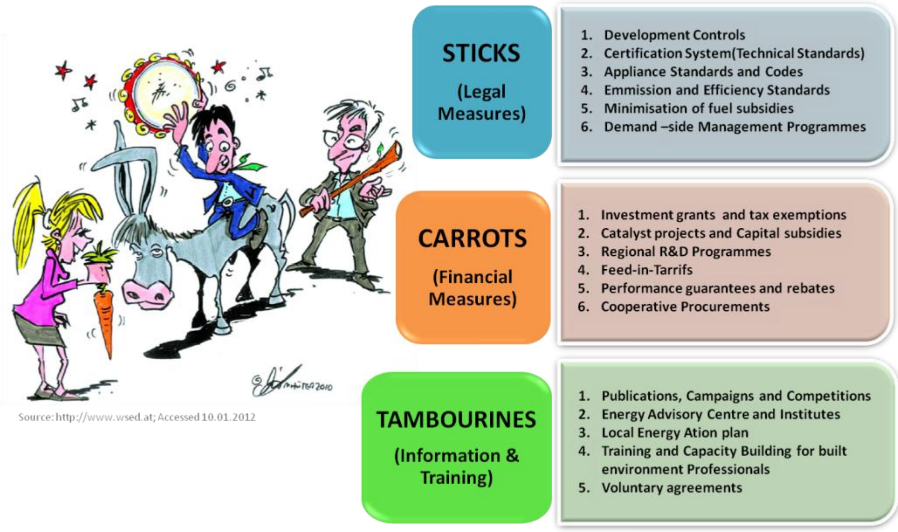
By applying the Sticks, Carrots and Tambourines strategy for urban governance and management, TSSA urban settlements could be managed, upgraded and developed with the proposals outlined above, have great potential to protect Africa's dwindling natural resources and efficient utilisation of the minimal energy available with less impact on the environment. As to whether the given TSSA urban centre is an indigenous city, Islamic city, colonial city, European city, dual city or hybrid city depicting a well organised grid iron pattern or seemingly chaotic fractal pattern, there is a potential for it to become ecologically responsive and energy efficient.

GREENING COMMUNITIES IN TROPICAL SUB-SAHARAN AFRICA:

"A Research on the Dynamics of Developing New Juaben Municipal Area in Ghana into an Energy-Efficient and Ecologically-Responsive Community"

Alexander Boakye Marful

APPENDICES



List of Appendices

Appendix1

Typical Combinations of Elements Needed for Given Experiential Quality

Appendix 1: Typical Combinations of Elements Needed for Given Experiential Quality

1		A SENSE OF BEING PART OF NATURE
Experiential Qualities		**Experiential Elements**
A	**Aesthetics of Perception**	Landscape Scale Bodily Engagement Movement
B	**Aesthetics of Process**	Both natural and cultural processes Natural and Cultural Cycles Boundless
C	**Aesthetics of Dwelling**	Fit to Context Adaptive Design
D	**Aesthetics of Community**	Fit to Community Active and Passive Engagement
2		**A SENSE OF BEING PART OF COMMUNITY**
Experiential Qualities		**Experiential Elements**
A	**Aesthetics of Time**	Natural and Cultural Rhythms Both Natural and Cultural Processes
B	**Aesthetics of Process**	Both natural and cultural processes Natural and Cultural Cycles Boundless
C	**Aesthetics of Dwelling**	Adaptive Design Genius Loci
D	**Aesthetics of Community**	Fit to Community Active and Passive Engagement Room for Individual Expression

Source: author with inputs from van Lierop, et al., 2010

Appendix 2

Typical Combinations of Elements Needed for Given Experiential Quality-continued

Appendix 2: Typical Combinations of Elements Needed for Given Experiential Quality- continued

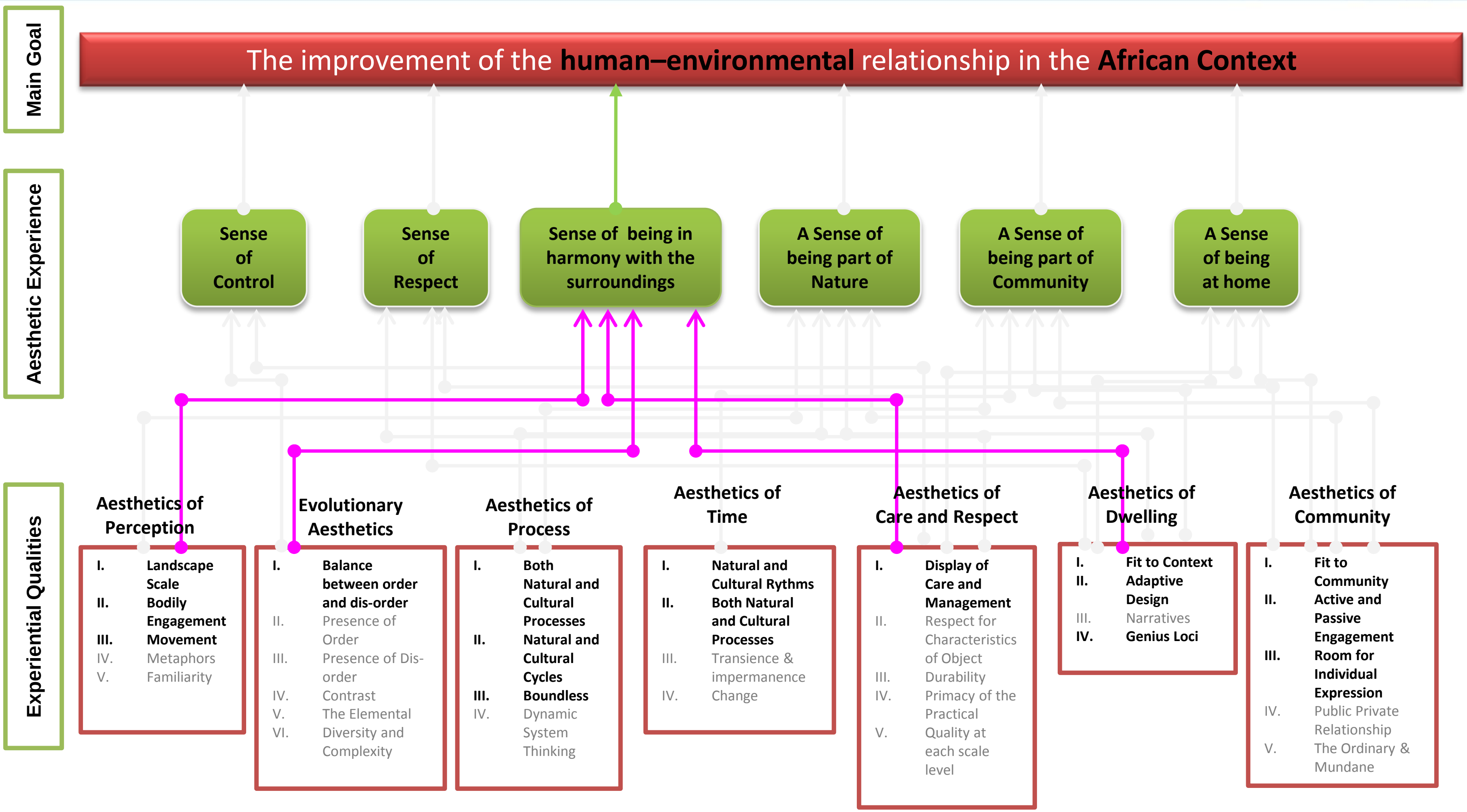
3	**A SENSE OF CONTROL**	
Experiential Qualities		**Experiential Elements**
A	**Evolutionary Aesthetics**	Balance between order and disorder The Elemental
B	**Aesthetics of Care and Respect**	Display of Care and Management Quality at each scale level
4	**A SENSE OF RESPECT**	
Experiential Qualities		**Experiential Elements**
A	**Aesthetics of Care and Respect**	Display of Care and Management Quality at each scale level
B	**Aesthetics of Dwelling**	Fit to Context Adaptive Design
C	**Aesthetics of Community**	Fit to Community Room for Individual Expression
5	**A SENSE OF BEING IN HARMONY WITH THE SURROUNDINGS**	
Experiential Qualities		**Experiential Elements**
A	**Aesthetics of Perception**	Landscape Scale Bodily Engagement Movement Familiarity
B	**Evolutionary Aesthetics**	Balance between order and disorder The Elemental
	Aesthetics of Dwelling	Adaptive Design Genius Loci
C	**Aesthetics of Care and Respect**	Display of Care and Management Quality at each scale level
6	**A SENSE OF BEING AT HOME**	
Experiential Qualities		**Experiential Elements**
A	**Aesthetics of Care and Respect**	Display of Care and Management Quality at each scale level
B	**Aesthetics of Dwelling**	Adaptive Design Adaptive Design
C	**Aesthetics of Community**	Fit to Community Room for Individual Expression

Source: author with inputs from van Lierop, et al., 2010

Appendix 3

Network of Combinations for Experiential Qualities That Could Be Utilised To Evoke Afro-Green Paradigm

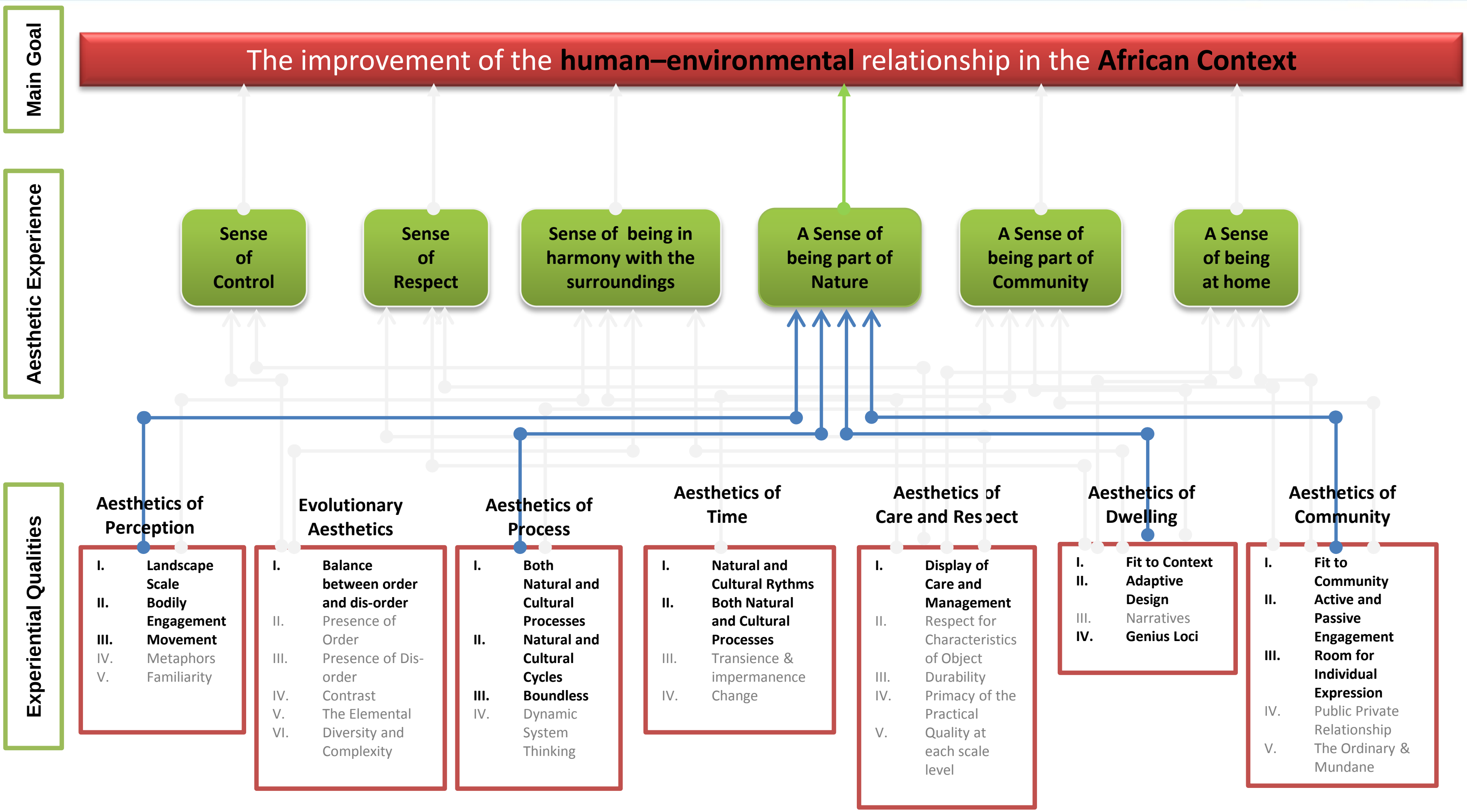
PROPOSALS - ECO-RESPONSIVE (Ecological Aesthetics and Connectivity)



A combination of Experiential Qualities which may be needed to evoke Afro-Green Paradigm

(Adapted from van Lierop, et al., 2010, p.7)

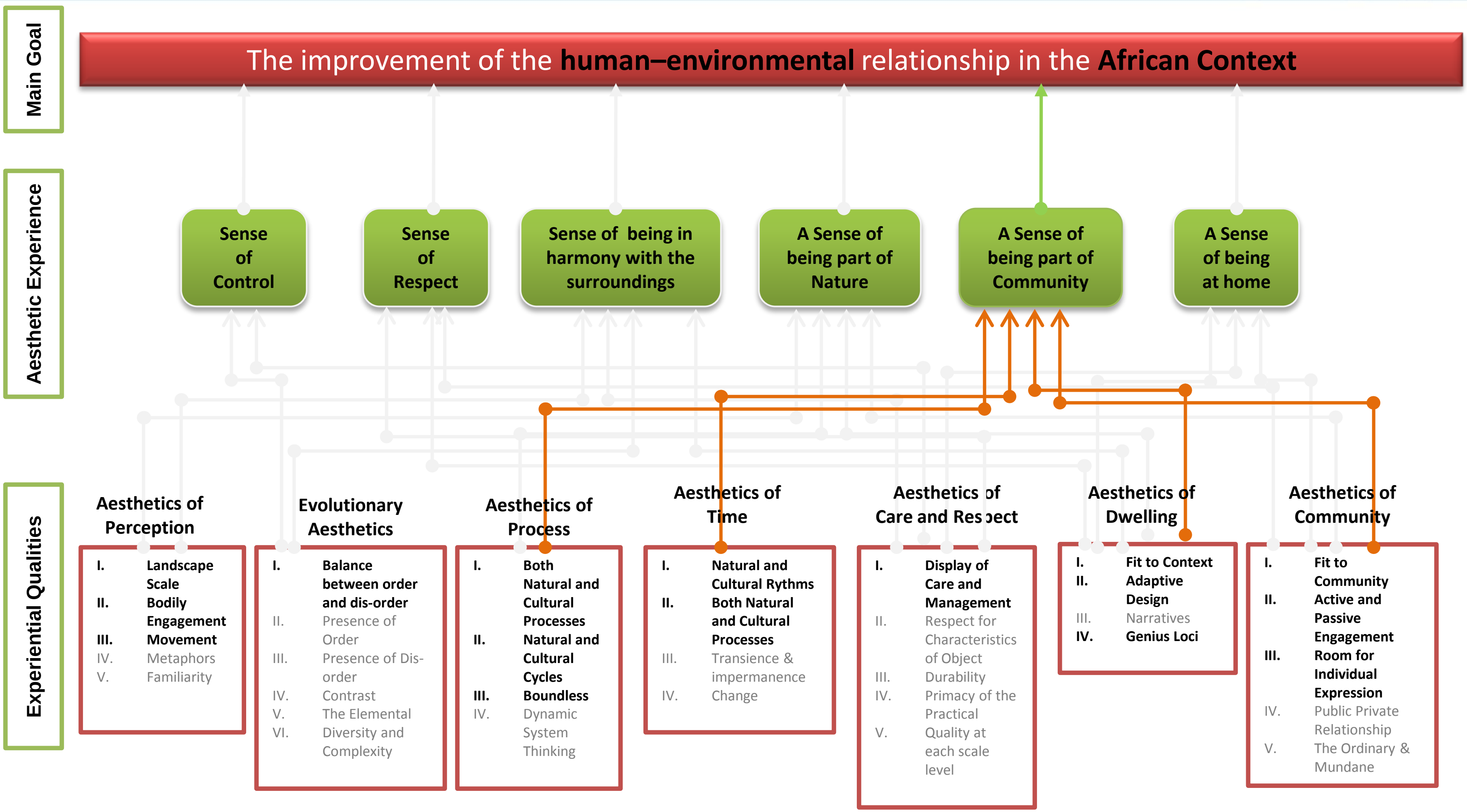
PROPOSALS - ECO-RESPONSIVE (Ecological Aesthetics and Connectivity)



A combination of Experiential Qualities which may be needed to evoke Afro-Green Paradigm

(Adapted from van Lierop, et al., 2010, p.7)

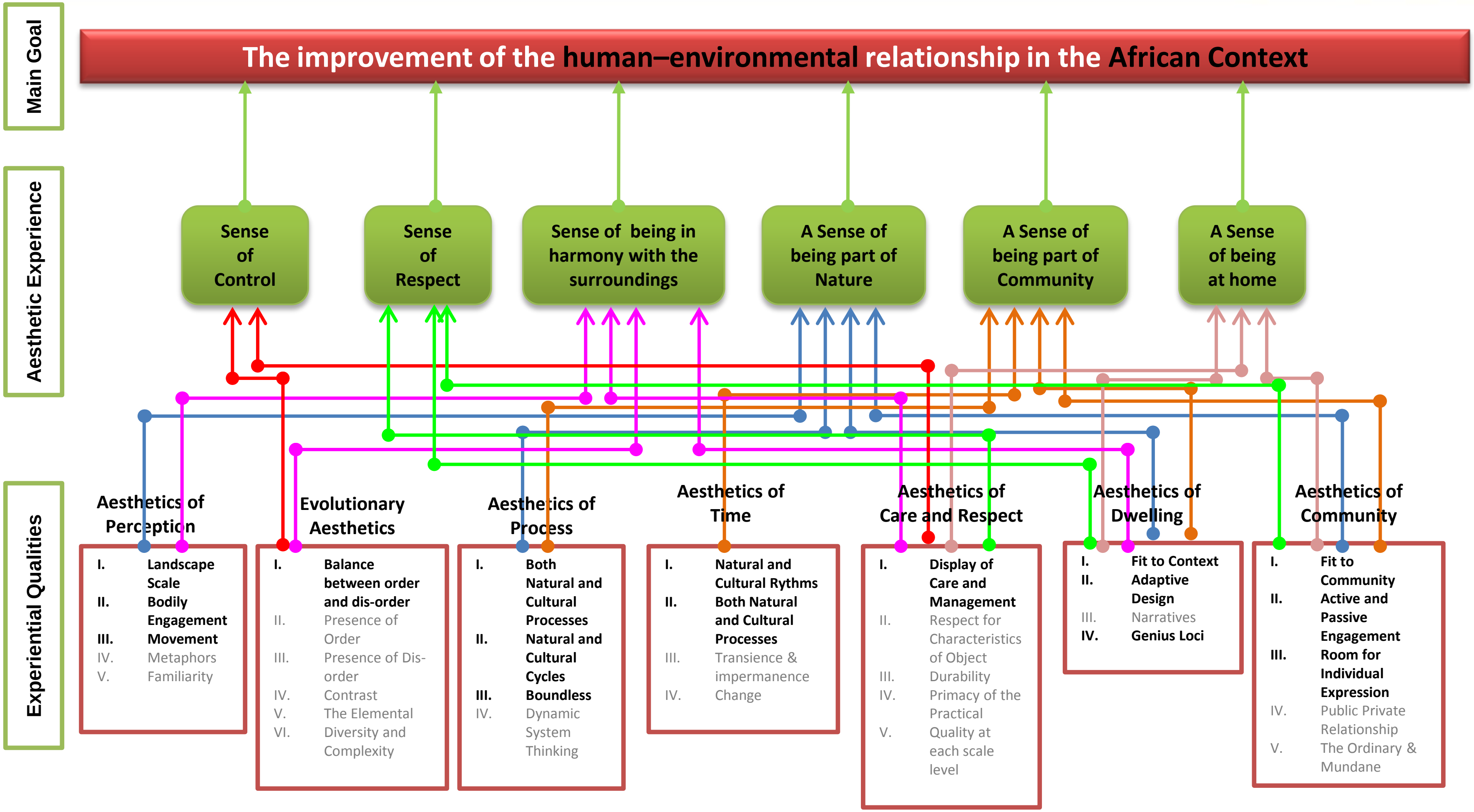
PROPOSALS - ECO-RESPONSIVE (Ecological Aesthetics and Connectivity)



A combination of Experiential Qualities which may be needed to evoke Afro-Green Paradigm

(Adapted from van Lierop, et al., 2010, p.7)

PROPOSALS - ECO-RESPONSIVE (Ecological Aesthetics and Connectivity)



A combination of Experiential Qualities which may be needed to evoke Afro-Green Paradigm

(Adapted from van Lierop, et al., 2010, p.7)

Appendix4

Checklist For LEED-ND

Appendix 3: CHECKLIST FOR LEED-ND

The checklist according to Welch et al., (2011, p.23) includes;

A. **Smart Location and Linkage**
    - Location
    - Ecosystems and Open Spaces
    - Contaminated Sites
    - Transit-Accessible Locations
    - Cycling Facilities
    - Jobs and Housing Proximity
B. **Neighbourhood Pattern and Design**
    - Walk able Streets
    - Compact Development
    - Neighbourhoods Connections
    - Mixed Uses
    - Affordable and Diverse Housing
    - Parking and Transportation Demand
    - Parks and Recreation
    - Universal Design
    - Community Participation
    - Local Food
    - School Access and Design
C. **Green Infrastructure and Buildings**
    - Construction Techniques
    - Energy Efficiency and Conservation
    - Energy Production and Distribution
    - Water Efficiency and Conservation
    - Storm water and Wastewater
    - Green Building Process
    - Historic and Existing Building Reuse
    - Heat Islands
    - Recycling and Reuse
    - Light Pollution

Appendix 5

Eco-Nergy Development Key Performance Indicators (ED-KPI)

ECO-NERGY DEVELOPMENT KEY PERFORMANCE INDICATORS (ED-KPI)
Community/Project Scorecard

Project Name: PhD Thesis- Case Study Area- New Juaben Municipal Area- Ghana
Date: 11.11.2011

Yes	?	No	URBAN TRANSPORT ENERGY EFFICIENCY(30%)		48 Points Possible
0	0	0	**Land Use Planning**		**19 Points Possible**
Y			Prereq 1	Smart Location	Required
			Credit 1	Community population with 5 minute commute of shopping center	2
			Credit 2	Percentage of the population that can easily get to shopping	2
			Credit 3	Agricultural Land Conservation	1
			Credit 4	Population Density in community(inh/km^2)	1
			Credit 5	Locations with Reduced Automobile Dependence	4
			Credit 6	Size multipurpose/Openspace available for recreation	1
			Credit 7	Housing and Jobs Proximity	2
			Credit 8	Steep Slope Protection	1
			Credit 9	Site Design for Habitat or Wetland and Water Body Conservation	1
			Credit 10	Diversity of land use in the community by distribution	2
			Credit 11	Rate of development occurring within urban area/Infill	2
0	0	0	**Mobility Management**		**29 Points Possible**
Y			Prereq 1	Walkable Streets	Required
Y			Prereq 2	Compact Development	Required
			Credit 1	Fuel consumption per capita versus state average	2
			Credit 2	Communities served by public transportation	2
			Credit 3	Street miles with designated bike routes	2
			Credit 4	Mixed-Use Neighborhood Centers	2
			Credit 5	Mixed-Income Diverse Communities	1
			Credit 6	Reduced Parking Footprint	1
			Credit 7	Number of communities accessible public transportation system	2
			Credit 8	Commuters using public transportation	2
			Credit 9	Percentage of population carpooling instead of driving alone	2
			Credit 10	Businesses cooperating with Park-Ride program	1
			Credit 11	Access to Civic and Public Spaces	1
			Credit 12	Access to Recreation Facilities	1
			Credit 13	Public expenditure on public transit	1
			Credit 14	Community Outreach and Involvement	1
			Credit 15	Percentage of streets that support alternative forms of transportation	1
			Credit 16	Tree-Lined and Shaded Streets(Walking and Cycling encourgaed)	1
			Credit 17	Neighborhood Schools	1
			Credit 18	Barrier-Free Accessibility: 100% barrier-free access	1
			Credit 19	Non-Physically Separated Pedestrain Lanes utilised	1
			Credit 20	Freight Transport management	1
			Credit 21	Reduction in Vehicular trips	2

Yes	?	No	URBAN GREEN INFRASTRUCTURE NETWORK (30%)		48 Points Possible
0	0	0	**Development Control Enactment and Enforcement**		**30 Points Possible**
			Credit 1	Local Zoning Law Compliant	2
			Credit 2	Local Building regulation Compliant	2
			Credit 3	Local Landscape Control compliant	1
			Credit 4	Acres of active forests	2
			Credit 5	Wood processing volume vs saw timber harvest	1
			Credit 6	Forest acreage damaged by fire	1
			Credit 7	Wood lot Management Programs	1
			Credit 8	Wildlife habitat restoration programs	4
			Credit 9	Rare species identified in community	1
			Credit 10	Acres parks and protected land per capita	2
			Credit 11	Recreational trail miles	1
			Credit 12	Public park acreage per 1000 population	2
			Credit 13	Net Loss of Natural Wetlands: There should be no net loss	1
			Credit 14	Native Vegetation Index: At least 70% of the plant varieties	5
			Credit 15	Per Capita Public Green Space: at least 20m^2/person	4
0	0	0	**Ecological Aesthetics and Connectivity**		**18 Points**
			Credit 1	Habitat Fragmentation avoided	4
			Credit 2	Connectivity Green Infrastructure Networked	4
			Credit 3	Evokes Sense of Control	1
			Credit 4	Evokes Sense of Respect	1
			Credit 5	Evokes Sense of being in harmony with the surroundings	2
			Credit 6	Evokes sense of being part with nature	2
			Credit 7	Evokes sense of being part of a community	2
			Credit 8	Evokes sense of being at home	2

Yes	?	No	RESIDENTIAL ENERGY EFFICIENCY (40%)		64 Points
0	0	0	**General Influential Conditions and Certification Systems**		**36 Points Possible**
			Credit 1	Energy use per capita	8
			Credit 2	Energy expenditure as % of gross community product	4
			Credit 3	Electricity and natural gas use per person per year	2
			Credit 4	Wood-fuel use per person per year	6
			Credit 5	Energy used from renewable sources should be at least 40%	2
			Credit 6	Presence of sustainable Energy conservation programs	6
			Credit 7	Proportion of Green Buildings (certified)in the Community(at least 50%)	8
					36
0	0	0	**Catalyst Project/Buildings and Incentives**		**28 Points Possible**
			Credit 1	Qualify for Ghana Green Building Council Award and any associated grant	2
			Credit 2	Proportion of Buildings that are naturally ventilated (at least 70%)	4
			Credit 3	Orientation of the building takes advantage of the solar axis	6
			Credit 4	Compact designs with open indoor plans	4
			Credit 5	Properly sized and high performance AC's and Electrical Appliances	8
			Credit 6	Energy -saving lighting strategies and systems utilised	4

Yes	?	No	Project Totals (Certification estimates)	160 Points
0	0	0		

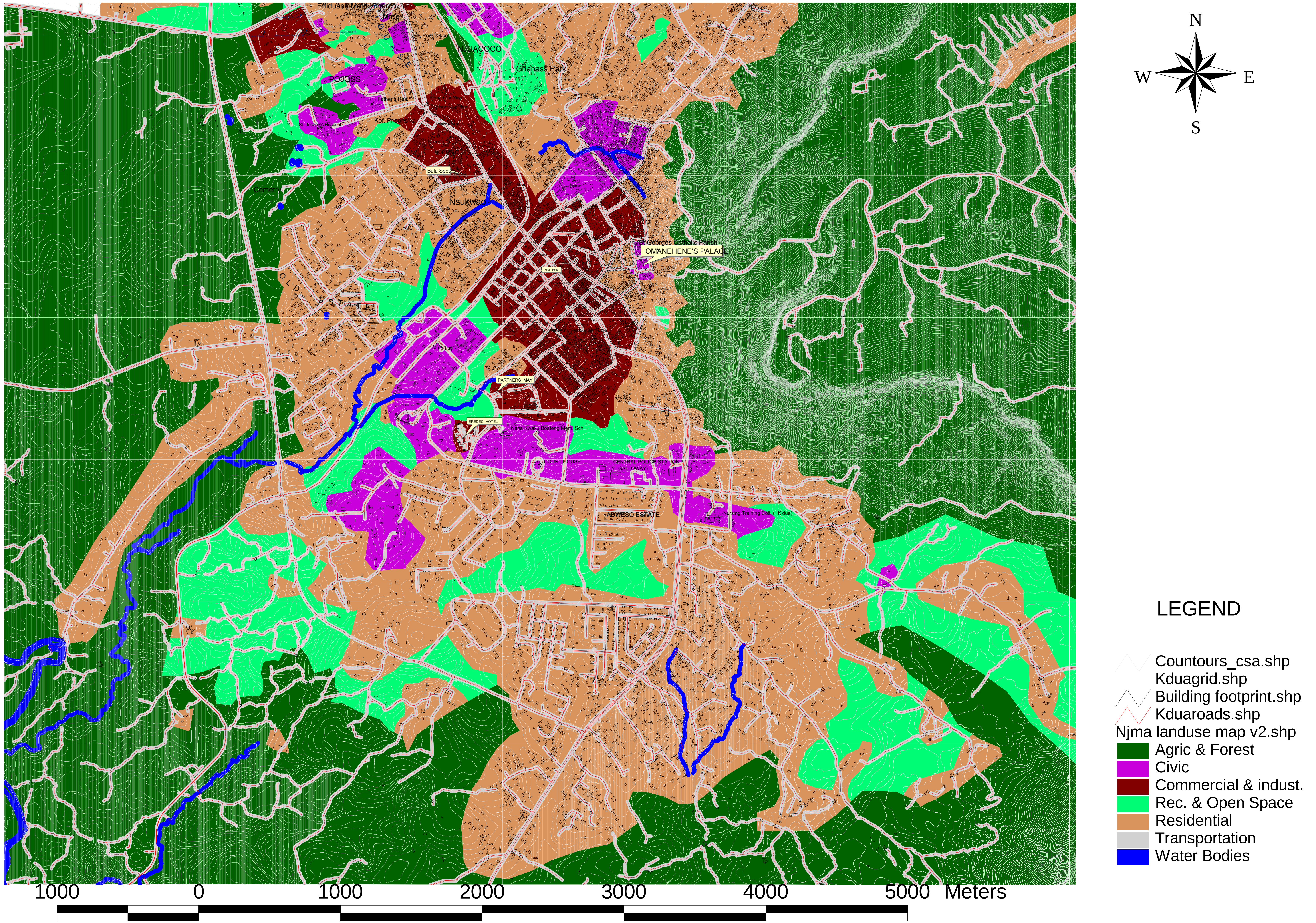
One Star: 70-89 points, 2 Star: 90-109 points, 3 Star: 110-129 points, 4 Star: 130+ points

Appendix 6
NJMA Maps Generated

Appendix 6i

Existing Land use

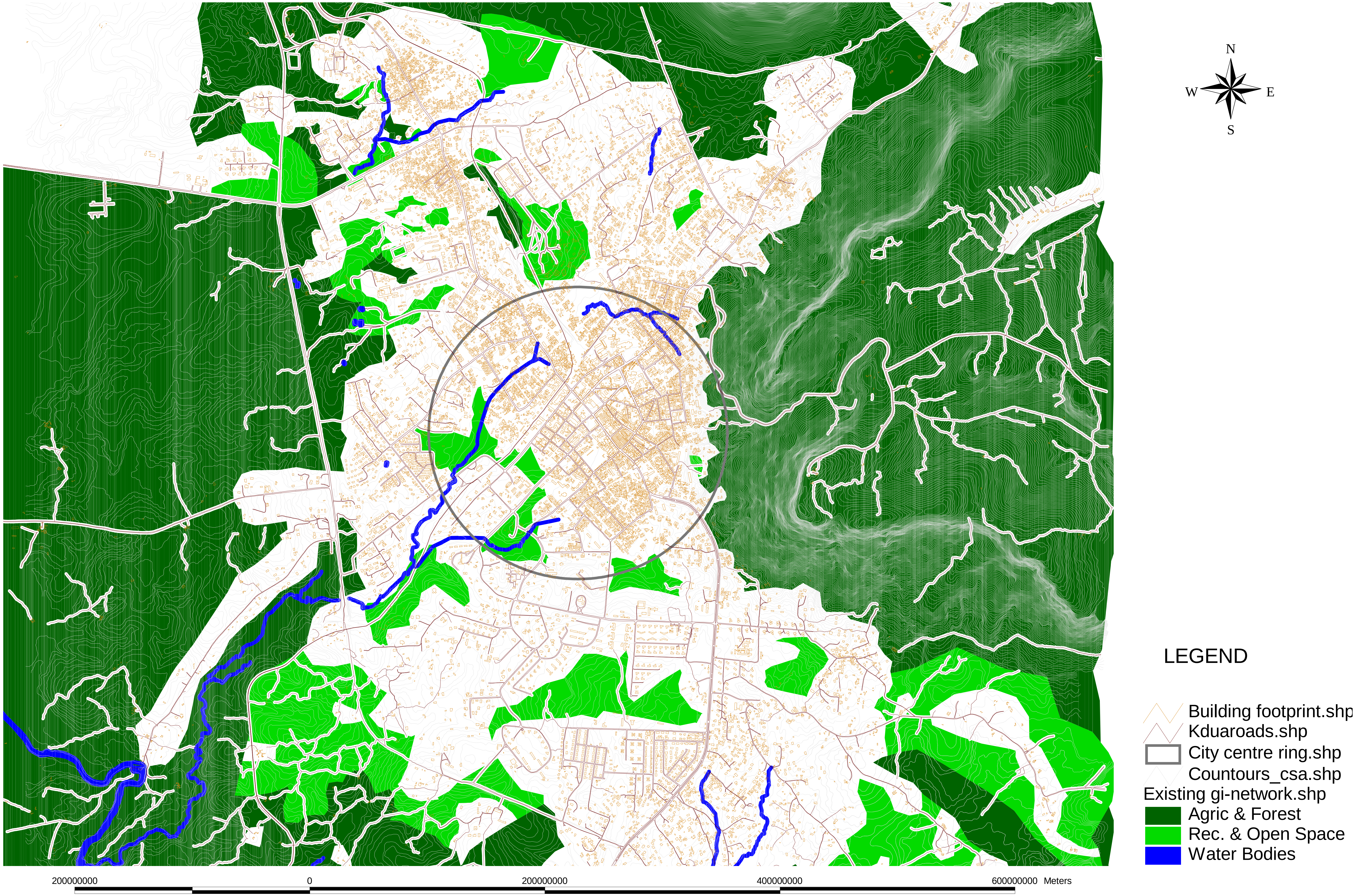
URBAN-NJMA LAND USE MAP



Appendix 6ii

NJMA Existing Green Infrastructure Network

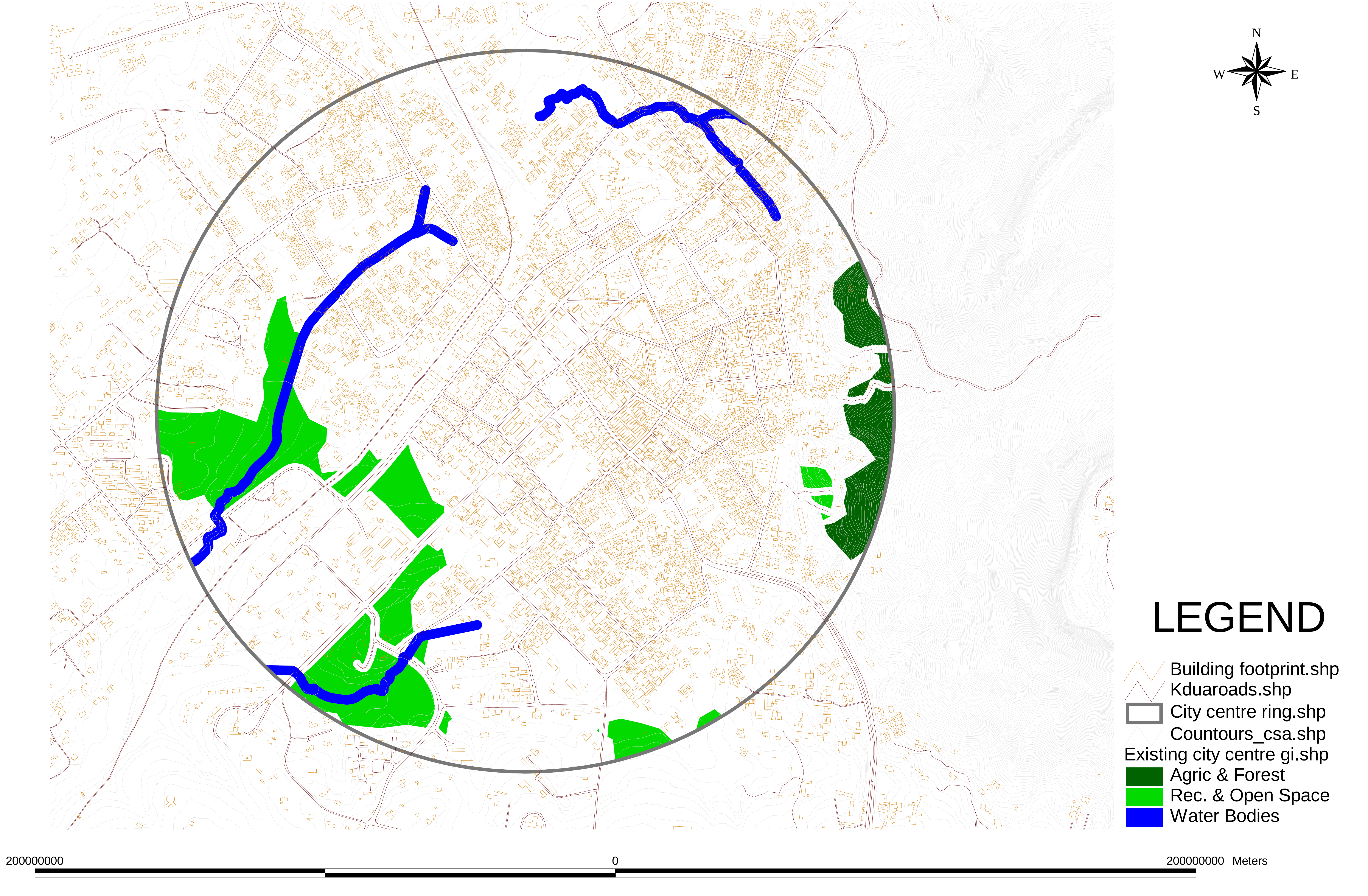
NJMA EXISTING GREEN INFRASTRUCTURE NETWORK



Appendix 6iii

Existing City Centre Green Infrastructure Network

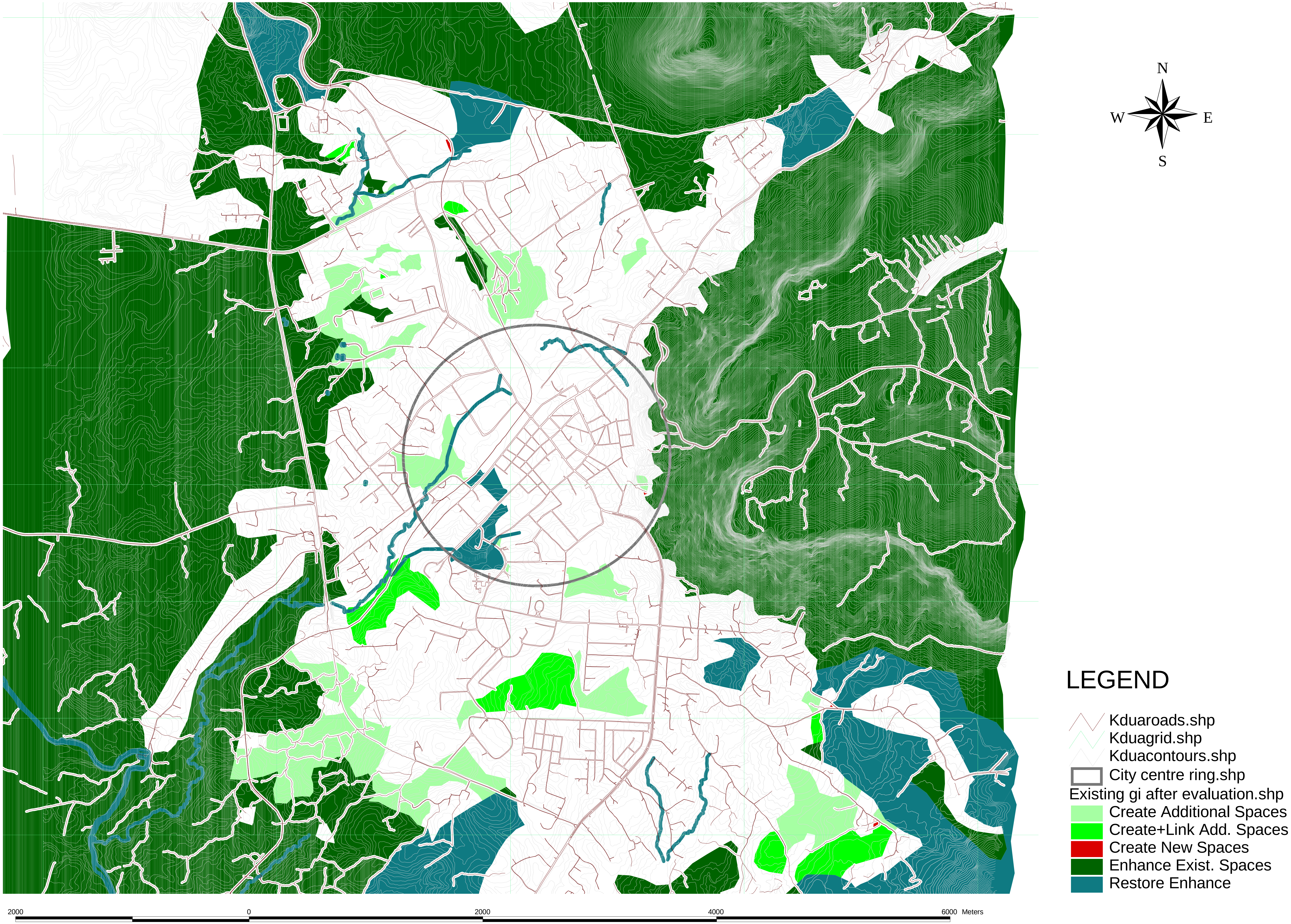
EXISTING GREEN INFRASTRUCTURE NETWORK OF NJMA URBAN CORE



Appendix 6iv

Results of the Evaluated NJMA Green Infrastructure Network

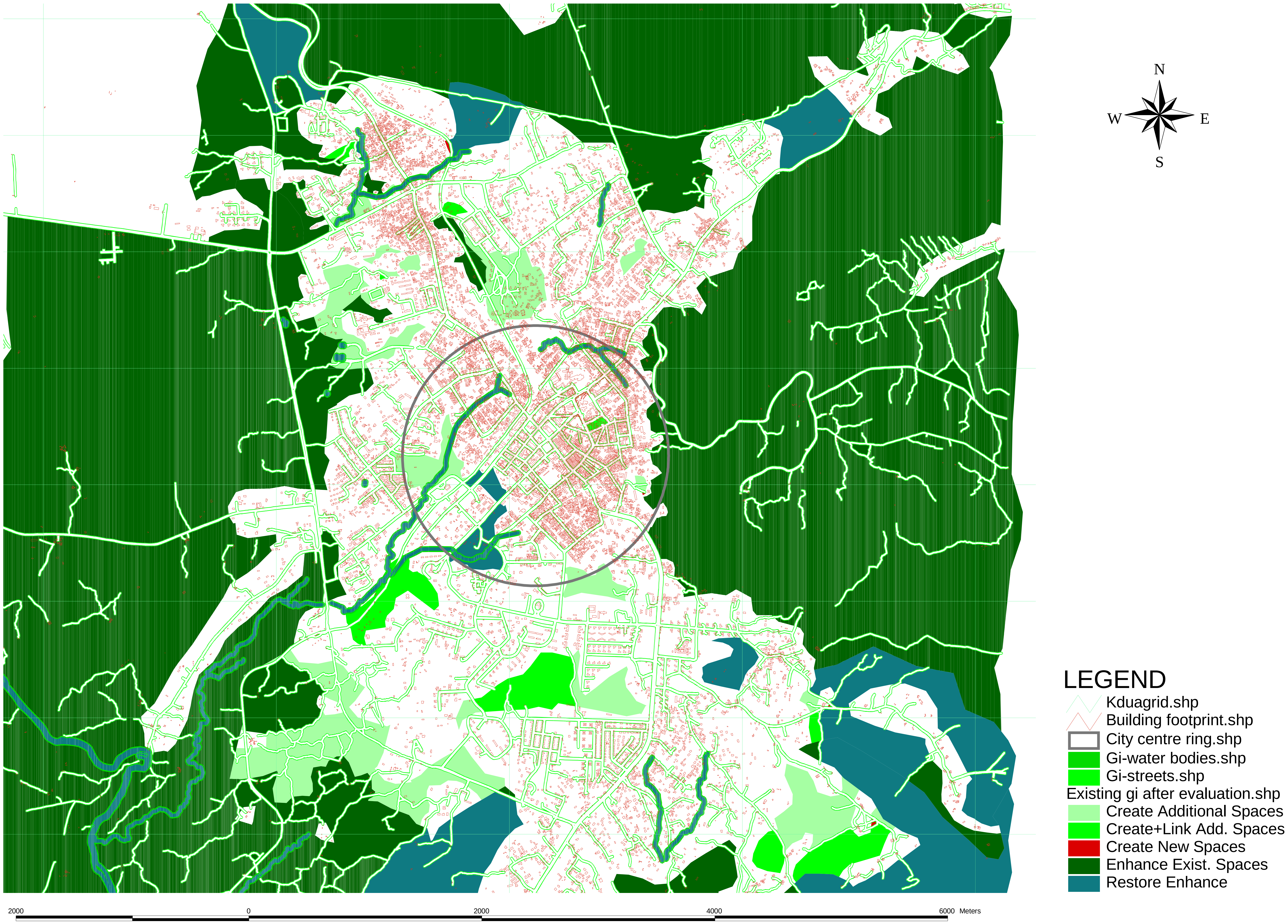
RESULTS OF THE EVALUATED EXISTING NJMA GREEN INFRASTRUCTURE NETWORK



Appendix 6v

New Green Infrastructure Network Interventions after Evaluations

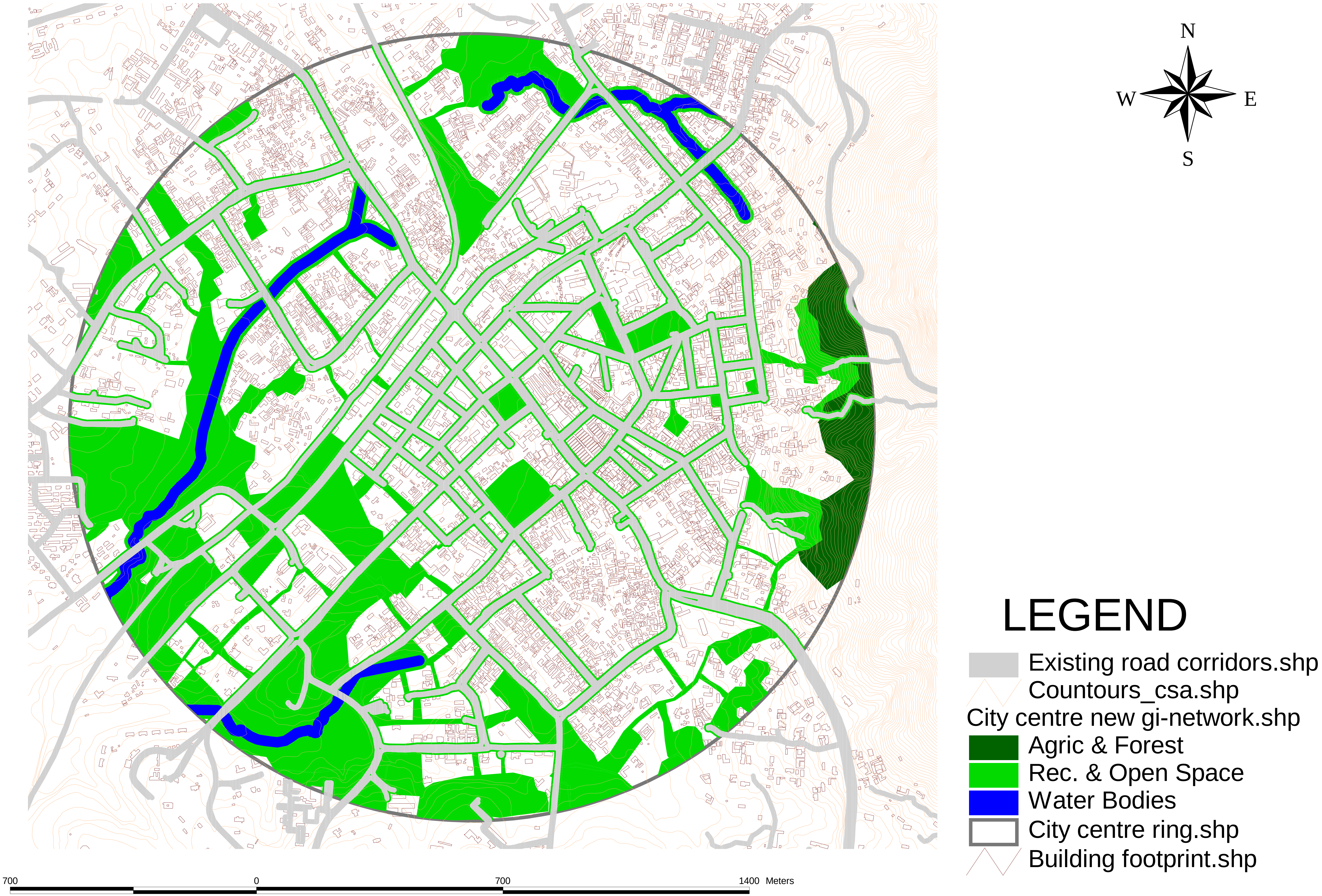
RESULTS OF THE EVALUATED EXISTING NJMA GREEN INFRASTRUCTURE NETWORK



Appendix 6v

Updated Green Infrastructure Network of NJMA Urban Core

UPDATED GREEN INFRASTRUCTURE NETWORK OF NJMA URBAN CORE



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