INTERNATIONAL JOURNAL OF COMPARATIVE STUDIES IN INTERNATIONAL RELATIONS AND DEVELOPMENT
VOL 3 NO 1, JULY 2014.ISSN PRINT: 2354-4298, ONLINE 2354-4201
http:www.internationalpolicybrief.org/journals/international-scientific-research-consortium-journals

ECO-CITY DESIGN-TOOL TO MITIGATE CLIMATE CHANGE

[1]Jegede Kehinde Jacob (MNIA) &[2]Adeaga Olawale Waheed
[1&2]School of Environmental Studies, Department of Architectural Technology
The Federal Polytechnic Offa, Kwara State, Nigeria

Abstract
Evidence from the Intergovernmental Panel on Climate Change (IPCC, 2007) is now overwhelmingly convincing that climate is not only real but can also become worse. Climate change poses many challenges for Cities and Urban centres across the globe. The vulnerability to Climate Change related disasters is regularly brought to public attention by the incidences of tropical cyclones, floods, landslides and even drought through local and international media. Responses to climate change include adaptation to reduce the vulnerability of people and ecosystems to climatic changes and, secondly, mitigation to reduce the magnitude of climate changes impact in the long term. However, neither adaptation nor mitigation alone can offset all climate change impacts. This calls for the simulation of how nature operates into city design process to evolve eco city concept. This study will therefore identify green infrastructure component of eco city principles including introduction of non-motorized transportation mode; street tree programme; wetland restoration and management to accommodate small scale aquaculture and home gardening; and establishment of parks as effective climate change mitigation measures in the city.

Keywords: Climate change, Eco-city, Adaptation, Mitigation, Greenhouse gases, Wetland restoration and Management.

Background to the Study
The issue of climate change and its attendant impacts have been a subject of public discourse for quite sometimes now. The world Meteorological organisation and the United Nations environment programme jointly established the Intergovernmental Panel on Climate Change (IPCC) in 1988 as a scientific intergovernmental body. Its main task is to evaluate the risk of climate change resulting from human activities (wikipedia 2008).

At RIO in 1992, there was an agreement for the establishment of United Nations Framework Convention on Climate Change (UNFCCC). The prime aim of the UNFCCC is the stabilization of atmospheric concentrations of greenhouse gases (GHGs), at a level preventable to dangerous anthropogenic interferences with the global climate system.

The Kyoto Treaty (protocol to the UNFCCC) signed by 141 nations in 1997 is an international and locally binding agreement to reduce greenhouse gases emission. The treaty came into effect in February 2005 (Barrow, 2006). All over the world, cities account for 60 percent of water consumption, 70 percent of greenhouse gas emissions and two thirds of global energy demand.

Demographic change, climate change and urbanisation are forcing cities to make their infrastructures more efficient. With technological innovations, sustainable cities can increase the quality of life for their residents, cutting costs, and become more environment- friendly. As per climate change, both urban policy and research tend to focus mainly on the issue of mitigation, particularly on the reduction of greenhouse gases emissions from urban activity.

According to UNFPA (2007) report, it has been established that the use of new architectural and urban forms, new materials and innovation such as air conditioning; have driven up both energy cost and the contributions of cities to greenhouse gas emissions. Furthermore, the urban form, the type of urbanisation, the size of the urban centre including its function and land use all contribute to the effect. This presentation, therefore attempts to apply Eco-city Design concept in mitigating the adverse effects of climate change in the environment:-

Objectives of the Study

To achieve this aim, the following four basic objectives were formulated

(1) To examine climate change and causes
(2) To identify the challenges of climate change on our environment
(3) To examine the eco-city design
(4) To look into how eco-city can serve as mitigating tool for climate change.

Statement of the Problem

Causes of Climate Change

(a) The earth's climate is dynamic and always changing through a natural cycle but speeded up by man's activities. Thus the causes of climate change can be divided into two categories- those that are due to natural causes and those that are created by man.

(b) Human Causes

The Industrial Revolution in the 19th century generated large scale use of fossil fuel for industrial activities. These industries created jobs and over the years, people moved from rural areas to the cities. This trend is continuing even today. More and more land that was covered with vegetation has been cleared to make way for houses. Natural resources are being used extensively for construction, industries, transport, and consumption. Consumerism (our increasing want for materials things) has increased by leaps and bounds, creating mountains of waste. Also our population has increased to an incredible extent. All this has contributed to a rise in greenhouse gases in the atmosphere. Fossil fuels such as oil, coal and natural gas supply most of the energy needed to run vehicles generate electricity for industries, households, etc. The energy sector is responsible for about ¾ of the carbon dioxide emissions, 1/5 of the methane emissions and a large quantity of nitrous oxide. It also produces nitrogen oxides (NO) and carbon monoxide (CO) which are not greenhouse gases but do have an influence on the chemical cycles in the atmosphere that produce or destroy greenhouse gases.

(c) Natural Causes

A blanket around the Earth

A layer of greenhouse gases- primarily water vapour and including much smaller amounts of carbon dioxide, methane and nitrous oxide- act as a thermal blanket for the Earth, absorbing heat and warming the surface to a life-supporting average of 59 degrees Fahrenheit (15 degrees Celsius).

Most climate scientists agree the main cause of the current global warming trend is human expansion of the "greenhouse effect" warming those results when the atmosphere traps heat radiating from Earth toward space. Gases that contribute to the greenhouse effect include Water vapour, Carbon dioxide (CO2), Methane, Nitrous oxide and Chlorofluorocarbons (CFCs). Some other prominent natural factors responsible for climate change are continental drift, volcanoes, ocean currents, the earth's tilt, and comets and meteorites.

Challenges of Climate Change

The main challenges of climate change are increases in average global temperature (global warming); changes in cloud cover and precipitation particularly over land; melting of ice caps and glaciers and reduced snow cover; and increases in ocean temperatures and ocean acidity-due to seawater absorbing heat and carbon dioxide from the atmosphere.

As a result of global warming, the type, frequency and intensity of extreme events, such as tropical cyclones (including hurricanes and typhoons), floods, droughts and heavy precipitation events, are expected to rise even with relatively small average temperature increases. Changes in some types of extreme events have already been observed, for example, increase in the frequency and intensity of heat waves and heavy precipitation events (Meehl et al. 2007). Climate change will have wide-ranging effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones. Changes in rainfall patter are likely to lead to severe water shortages and / or flooding. Melting of glaciers can cause flooding and soil erosion. Rising temperatures will cause shifts in crop growing seasons which affects food security and changes in the distribution of disease vectors putting more people at risk from diseases such as malaria and dengue fever.

In Nigeria, many cities that are not prone to flood are now experiencing flooding imagination especially at the height of the rainy season. Many factors contribute to this but of particular importance are human activity such as building on flood plains, paving of surfaces thereby reducing natural run-off, dumping of refuse into river channels (Amakoromo, 2008). The frequent large scale flooding in Lagos and large scale flooding in Ibadan in August 2011 which was repetition of that of 1980 was a result of development of density residential, industrial and commercial buildings along the channel and flood plain of the rivers involved.

Eco-City Design

The term eco-city was first coined by Richard Register in 1987. A sustainable city or eco-city is a city designed with consideration of environmental impact, inhabited by people dedicated to minimization of required inputs of energy water and food, and waste output of heat, air pollution CO2 (carbon dioxide), methane and water pollution (Wikipedia, the free Encyclopedia, 2009). In its design and functioning, an eco-city is formed by ecological principles: assiduous recycling, maintaining maximum biodiversity, being very efficient in energy and materials, having a compact generally three dimensional form like complex natural living organisms.

There is need for environmental sound and ecological sensitive physically planning and land use. According to Register, eco-cities have a long history, citing CatalHoyuk, in Turkey as one of the earliest. Other given examples of eco-cities include Venice, in Italy, Arcosanti in Arizona, USA and Curitiba, in Brazil. An eco-city conference series was started in Berkeley, California in 1990. The conference in 200u8 came up with an interesting declaration.

The key characteristics of a perfect eco-city are the abilities of self-adjustment; self-restraint and self-organization. While this state of perfection may not be fully achieved, cities can have it as a long-term goal. The planning system that facilitates the city achieving the above goal is regarded as the eco-city planning system.

Eco-city planning methodology begins with ecological analysis starting with analysis of the carrying capacity of the environment and land. This precedes any land use layout. For the Tianjin Sino-Singapore Eco-city, Yang and Dong (2008) consider this approach as an experiment with significant meaning for urban design practice both in China and elsewhere. Eco-city planning seeks to introduce ideas including green buildings and ecological planning which highlight the integration of resource and environment.

Energy planning was an important component. The goals of energy planning are to build an economic city of low-carbon and energy savings; to optimize the efficient and sustainable utilization of energy resources, to realize low carbon emission, to integrate planning and design with renewable energy utilization and to implement several demonstration projects of energy-saving or renewable energy utilization (Lin, Qin and Liu; 2008).

Curitiba, in Brazil is considered one of the best examples of urban planning worldwide. It is referred to as the ecological capital of Brazil with a network of 28 parks and wooded area. It has a green space of 52meter square per person. Builders get tax breaks if their projects include green space. Flood waters were diverted into new lakes in parks solving the problem of dangerous flooding. Curitiba's population grew from 150,000 in the 1950s to 1.6million presently.

Climate Change Mitigating Measures

a. Sustainable Building Materials

Some examples of sustainable building materials include brick, fiber glass insulation, sustainably harvested wood, Linoleum, sheep wool, concrete (high and ultra-high performance roman self-healing concrete), panels made from paper flakes, baked earth, rammed earth, clay, vermiculite expanded clay grains, coconut, wood fibre plates, calcium sand stone, locally obtained stone and rock, and bamboo, which is one of the strongest and fattest growing woody plants, and non-toxic low-VOC glues and paints.

b. Energy Use in Buildings

Evaporative cooling, as a mitigation measure, means substantial savings in annual cooling energy use for residences. However, this type of cooling places an extra pressure on available water resources. Cooling energy use in buildings can be reduced by different measures, for examples reducing the cooling load by building shape and orientation.

c. Carbon Dioxide Capture and Storage (Ccs)

Carbon dioxide (CO2) capture and storage (CCS) is a process consisting of the separation of CO2 from industrial and energy related sources, transport to a storage location and long-term isolation from the atmosphere.

d. Wind Power

The use of undersized wind turbines in energy production in sustainable structures requires the consideration of many factors. In considering costs, small wind systems are generally more expensive than larger wind turbines relative to the amount of energy they produce. For small wind turbines, maintenance costs can be a deciding factor at sites with marginal wind harnessing capabilities. At low-wind sites, maintenance can consume much of a small wind turbine's revenue (Brower and Michael, 1990). Wind turbines begin operating when winds reach 8 mph, achieve energy production capacity at speeds of 32-37 mph, and shut off to avoid damage at speeds exceeding 55 mph (Brower and Michael, 1990). The energy potential of a wind turbine is proportional to the square of the length of its blades and to the cude of the speed at which its blades spin.

e. Solar Control and Shading Devices

Protection from the sun is always necessary. This is because the intensity, duration and the angle of incidence of solar radiation to a particular surface are the main determinants of the design precautions necessary for comfort. These factors affect the solar control measures. Such as the time of the day, the extent of screening elements required. Except for other aesthetic reasons, there is little or no justification for using the same screening devices on all the four facades of a building. The capital cost involved in providing appropriate and suitable sun-shading devices according to Odeleye (1989) helps to minimize the heat load and consequently reduce the cost of air conditioning, provide cooler indoor environment, ensure greater thermal comfort of the occupants and increase productive efforts.

f. Geothermal Energy

Geothermal resources have long been used for direct heat extraction for district urban heating, industrial processing, domestic water and space heating, leisure and balneotherapy applications.

g. Solar Panels

Active solar devices such as photovoltaic solar panels help to provide sustainable electricity for any use. Electrical output of a solar panel is dependent on orientation, efficiency, latitude, and climate-solar gain varies even at the same latitude. Typical efficiencies for commercially available PV panels range from 4% to 28%. The low efficiency of certain photovoltaic panels can significantly affect the payback period of their installation.

h. Passive Solar Building Design

This method allows building to hardness the energy of the sun efficiently without the use of any active solar mechanisms such as photovoltaic cells or solar hot water panels. Typically passive solar building designs incorporate materials with high thermal mass that retain heat effectively and strong insulation that works to prevent heat escape. It was stated by Brown (2001) that Low energy designs requires the use of solar shading, by means of awnings, blinds or shutters, to relive the solar heat gain in summer or dry season and to reduce the need for artificial cooling. In addition, low energy buildings typically have a very low surface area to volume ratio to minimize heat loss. This means that sprawling multi-winged building designs (often thought to look more 'Organic") are often avoided in favour of more centralized structures. Traditional cold climate buildings such as American colonial saltbox designs provide a good historical model for centralized heat efficiency in a small scale building (Brower and Michael, 1990).

i. Solar Water Heating (Solar Thermal Power)

Solar water heaters, also called solar domestic hot water systems, can be a cost-effective way to generate hot water for a home. They can be used in any climate, and the fuel they use is nothing but sunshine. There are two types of solar water systems: active and passive. An active solar collector system can produce about 80 to 100 gallons of hot water per day. A passive system will have a lower capacity.

j. Afforestation or Reforestation

Forests, generally, are expected to use more water (the sum of transpiration and evaporation of water intercepted by tree canopies) than crops, grass, or natural short vegetation. This effect, occurring in lands that are subjected to aforestation or reforestation, may be related to increased interception loss, especially where the canopy is wet for a large proportion of the year (Calder, 1990) or, in drier regions, to the development of more massive root systems, which allow water extraction and use during prolonged dry seasons. Interception losses are greatest from forests that have large leaf areas throughout the year. Thus, such losses tend to be greater for evergreen forests than for deciduous forests (Hibbert, 1967; Schulze, 1982) and may be expected to be larger for fast-growing forests. Consequently, afforestation with fast-growing conifers on non-forest land commonly decreases the flow of water from catchments and can cause water shortages during droughts.

Afforestation and reforestation, like forest protection, may also have beneficial hydrological effects. After afforestation in wet areas, the amount of direct runoff initially decreases rapidly, then gradually becomes constant, and baseflow increases slowly as stand age increases towards maturity (Fukushima, 1987; Kobayashi, 1987), suggesting that reforestation and afforestation help to reduce flooding and enhance water conservation.

k. Lower Volatile Organic Compounds

Low-impact building materials are used wherever feasible: for example, insulation may be made from low VOC (volatile organic compound) emitting materials such as recycled denim or cellulose insulation, rather than the building insulation materials that may contain carcinogenic or toxic materials such as formaldehyde. To discourage insect damage, these alternate insulation materials may be treated with boric acid. Green products are usually considered to contain fewer VOCs and be better for human and environmental health. (James, 2004).

l. Avoided / Reduced Deforestation

Stopping or slowing deforestation and forest degradation (loss of carbon density) and sustainable management of forests may significantly contribute to avoided emissions, may conserve water resources and prevent flooding, reduce runoff, control erosion, reduce siltation of rivers, and protect fisheries and investments in hydro-electric power facilities; and at the same time preserve biodiversity (Parrotta, 2002)

m. Materials Sustainability Standards

Despite the importance of materials to overall building sustainability, quantifying and evaluating the sustainability of building materials has proven difficult. The landscape today is littered with hundreds of competing, inconsistent and often imprecise eco-labels, standards and certifications. This discord has led both to confusion among consumers and incorporation of inconsistent sustainability criteria in larger building certification programs such as LEED.

n. Sustainable Building Consulting

Sustainable Building Consulting is a practice or service where an intermediary party or company is utilized as a ways to forecasting consists of the identification of adherent building techniques and norms, as well as the identification of specific building.

o. Waste Management

Waste takes the form of spent or useless materials generated from households and business, construction and demolition processes, and manufacturing and agricultural industries. These materials are loosely categorized as municipal solid waste, construction and demolition (C&D) debris, and industrial or agricultural by-products (Ringel, 2005). Sustainable architecture focuses on the on-site use of waste management, incorporating things such as grey water systems for use on garden beds, and compositing toilets to reduce sewage. These methods, when combined with on-site food waste compositing and off-site recycling, can reduce a house's waste to a small amount of packaging waste.

Conclusion

Sustainable environment that can guarantee better and quality life for the present and future generation is an enormous challenge of our contemporary times. The rate at which our cities consume natural resources and generate waste is alarming and a threat to the sustainable environment that is desired the sprawling urban forms which characterize contemporary cities in less developed countries make matters worse while climate change also increases the vulnerability of the cities to hazards. The ideal of eco-city is an emerging planning response with the aim of building sustainable cities and thereby limiting susceptibility to these hazards. It is expected that every government, people group and private individual will be environmental friendly in all their operations and dealings. Eco-city design and climate mitigation should be thoroughly embarked upon by government and developers.

Recommendations

For proper eco-city design and planning the following green infrastructure are recommended:

i) Copious development of Public Parks and planning urban open spaces are necessary public nodal spaces with inherent values that make cities livable.

ii) Integrating Urban Farming Concept as a component of the city development paradigm. Urban economic and ecological systems thereby interact with urban ecosystem. In the context of creating a sustainable city, this method of food cultivation saves energy in food transportation and saves costs.

iii) Adoption of the concept of urban proximity as an essential element of current and future sustainable transportation systems. This requires that cities be built and added onto with appropriate population and landmark density so that destinations are reached with reduced time in transit.

iv) Exploration of walkable urbanism as canvassed by the Charter of New Urbanism as development strategy in opposition to suburban sprawl.

v) Development of Non-Motorized Transportation System. Eco-city strives for minimum use of automobiles as transportation mode and promotes low energy consumption automobiles, zero-emission vehicles including electric vehicle and integrated public mass transportation strategy that are technology driven.

References

Amakoromo, G. T. (2008): "Flood hazards and its effects on Urban Real Property in Port Harcourt, River state". Unpublished M.phil Yhesis, River State University of Science and Technology, Port Harcourt

Barrow C. J. (2006), "Environmental Management for Sustainable Development 2nd". London & New York: Routledge. Brower, Michael (1990), Cool Energy, The Renewable Solution to Global Warming; Union of Concerned Scientists.

Brower & Michael (1990), "Cool Energy, The Renewable Solution to Global Warming; Union of Concerned Scientists".

Brown G. Z., Mark DeKay (2001). Sun, Wind & Light.

Climate Change (2007), "The Physical Science Basis". Contribution of Working group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

John Ringel (2003). University of Michigan, Sustainable Architecture, Waste Prevention

Lin B; Y. Qin; L. Lui & y. Sony (2008): "Ecological Planning for Sine-Singapore Ecological science and Technology Town of Suzhou.´ In: China City Planning Review. Vol. 17

Meehl, G. A., et al. (2007). "Frequently Asked Question 10.3: If Emissions in the Atmosphere Decrease?". In S. Solomon, et al., (eds). Chapter 10: Global Climate projections. Print version: Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. This version: IPCC website

Odeleye, A. (1989). "The Design of Buildings for Comfort in the Nigerian Climate. " Paper presented at the Seminar on "Architecture, Climate and Environment" organized by The Nigerian Building and Road Research Institute in Lagos. October