

ISSN 0024-9521
IJG Vol. 43, No. 2, December 2011 (181 - 194)
© 2011 Faculty of Geography UGM and
The Indonesian Geographers Association

INDONESIAN JOURNAL OF
GEOGRAPHY

CONCEPTUALIZATION OF URBANIZATION STRUCTURE AND CLIMATE CHANGE IN LAGOS, NIGERIA

Adejobi Oladepo Samson

depoprince@yahoo.com

Faculty Social Science, Lagos State University

Olorunnimbe Rafiu O

odezi455@yahoo.com

Faculty Social Science, Lagos State University

ABSTRACT

Urbanization is synonymous with environmental challenges. In developing countries, the challenges have assumed higher dimensions proportionally due to multifarious issues of rapid changes in the environment, due to development, through population growth and industrialization, and accompanied by all kinds of pollution such as air pollution, waste disposal, land use degradation, and vehicular pollution as the resultant effects of man's interaction with the environment. The main characteristic effect is the raised temperature of the city centre (UHI) leading to excessive energy use for cooling and putting urban population at great morbidity and mortality risks. This paper literally explores the conceptual framework of interaction between urbanization structure and understanding social impacts of climate change and variability for the evaluation of strategies in the urbanized environment that might serve as adaptive response to climate change. The urbanization structure that affects Lagos state is discussed in relation to the location of the city, the size, the population density, urban geometry, thermal property, air pollution, land use pattern, wind speed and anthropogenic activities. The study revealed that climate change is posing increasing challenges for cities placing greater stress and impacts on multiple social and biophysical systems, including urban infrastructure, water and energy demand simultaneously, followed by a strong global trend towards urbanization of urban poverty. The study concluded that climate change has impacted greatly on virtually all the socio-economic aspects of man.

Key words: urbanization, pollution, environmental challenges, climate change, Variability in Urban Heat Island (UHI), Greenhouse Gases (GHGs)

ABSTRAK

Urbanisasi identik dengan tantangan lingkungan. Di negara berkembang, tantangan telah dianggap sebagai suatu hal yang lebih berat semata-mata karena adanya beragam masalah dalam perubahan lingkungan yang terjadi sangat cepat yang diakibatkan oleh pembangunan; yang terjadi melalui, pertumbuhan populasi dan industrialisasi, dan diikuti oleh berbagai macam polusi seperti polusi udara, pembuangan limbah, degradasi penggunaan lahan, polusi kendaraan, yang semuanya merupakan beberapa akibat yang ditimbulkan dari interaksi manusia dengan lingkungan. Akibat yang utama adalah kenaikan suhu udara dari pusat kota (UHI) yang mengarah terhadap penggunaan energi yang berlebihan untuk pendinginan dan menempatkan penduduk perkotaan pada risiko morbiditas dan mortalitas besar. Makalah ini membahas kerangka konseptual interaksi antara struktur

urbanisasi serta pemahaman dampak sosial dari perubahan iklim dan variabilitas untuk evaluasi strategi dalam lingkungan yang dapat berfungsi sebagai responsnya terhadap perubahan iklim. Hasil penelitian menunjukkan bahwa perubahan iklim mengakibatkan tantangan yang semakin besar bagi kota-kota besar yang lebih menitikberatkan pada sistem sosial dan biofisik ganda, termasuk infrastruktur perkotaan, permintaan air dan energi, yang diikuti oleh kecenderungan global yang kuat terhadap urbanisasi kemiskinan perkotaan. Studi ini menyimpulkan bahwa perubahan iklim telah berdampak besar pada hampir semua aspek sosial-ekonomi manusia.

Kata kunci: urbanisasi, polusi, tantangan lingkungan, perubahan iklim, variabilitas urban heat, gas rumah kaca

INTRODUCTION

Urbanization is the process by which urban areas increase in size and population density. A city is the biggest and the most populated urban area. A large city is one with at least 2 million people, a megacity is one with 10 million people or more, of which there are currently twenty-four in the world today. The largest and fastest growing cities are in the developing countries of Africa, Asia, and Central and South America. Currently about half of the world population is urbanized and this is expected to increase to 80-90% in the future [Cunningham and Saigo, 1990].

Urbanization is inter-twined into the process of evolution of a city as it grows from rural to metropolitan status. A modern city like Lagos is to perceive as a complex institution with multiple problems. Such problems may have physical, social, economic, political and cultural dimensions. Sometimes urbanization is a fallout of a city's technological advancement.

Urbanization and its attendant air pollution, and other human economic activities have, in the last 100 years, contributed to an increase in the concentration of greenhouse gases in the atmosphere leading to the enhanced greenhouse effect which in turn resulted in climate change arguably the most important and dangerous and certainly the most complex environmental issue to

date [IPCC, 1996; Holden, 1992; Kandlikar and Sagar, 1999 and Hamilton, 1999]. Its impact and their implications on the socio-economic and socio-cultural resources in many parts of the world have been a great concern to many nations [USCP, 1999].

The most recent assessment report compiled by IPCC observed that "changes in atmospheric concentrations of greenhouse gases and aerosols, land cover and solar radiation alter the energy balance of the climate system, and that increases in anthropogenic greenhouse gas concentrations are likely to have caused most of the increases in global average temperatures since mid 20th century". Apart from human-produced greenhouse gases (anthropogenic), other greenhouse gases have sources from the ecosystem in general (natural).

Climate change therefore is a significantly drastic change or total shift from the normal climatic condition experienced in an area over a considerable period of time, triggered by both Natural and human activities. Despite the length of time it takes the changes to manifest matters, the level of deviation from the normal and its impact on the ecology are most paramount. This prompted Ayoade, [2003] to state that secular variations in climate occurring over a period of 100 to 150 years may not qualify as a climate change if conditions will quickly reverse later, but change in climate usually takes place over a long period of time or at least 150 years with

clear and permanent impacts on the ecosystem. Climate change is different from the generally known terms like climatic fluctuations or climatic variability. These terms denote inherent dynamic nature of climate on various temporal scales. Such temporal scale variations could be monthly, seasonally, annually, decadal, periodic, quasi-periodic or non-periodic.

Urbanization produces radical changes on the morphology and composition of air in built-up area resulting in perturbation of the radiation, energy, humidity and wind balance and leading to the modification of local climate [Warner and Hertig, 1984] a consensus is held on the variation that exists between the microclimate conditions found within an urban area and its surrounding countryside [One, 1981; Ibadan, 2005 and Roth, 2007]. But given the large and increasing population and size of urban areas across the globe, it is becoming increasingly clear that the impacts of the ever increasing cities on the environment are not just limited to the actual footprint in a place, but may indeed occur at regional and global levels. Though cities produce their own microclimate, they are still connected to regional and global climates through the chemistry of atmospheric effect on radiation balance and greenhouse gas emissions.

It is the climate or state of the earth's atmosphere that makes the life on earth possible and sustainable. Henderson-sellers, [1990]; Oyo and Oni, [2001] define Climate as the total experience of weather at any place over some specific period of time. The definition points out its dynamism and coverage. It takes into account of the average and deviations and allows for in-depth and extensive examinations of climatic data. One truth that is glaring is that earth's climate has never been in a static state.

The Federal Government of Nigeria, [1988] has also observed that the

present high rate of population growth is already contributing substantially to the degradation of the ecology of the country. It observes that land fragmentation, over farming and over grazing have led to soil erosion and desertification and that overcrowding has led to the spread of shanty towns and urban blight; all of which would worsen if the present population growth continues [NEST, 1999]

This dossier on urban environmental inadequacies in Nigeria affects the quality of life in the cities. It can also serve as a drag on overall national development. The problem of course, is that there is no quick-fix solution in sight.

It is now established that humanity is altering the concentration of greenhouse gases and aerosols, both of which influence, and are influenced by climate. Recently, and especially over the past three or four decades, the issue of global climate change due to the greenhouse effects, including global warming and sea level rise have been a subject of scientific discussions and public debate.

Climate change has been blamed upon human activities which result in increased release of green house gases and widespread deforestation both of which alter the balance of atmospheric gases in favors of the green house gases (GHGs). These greenhouse gases are carbon dioxide-carbon monoxide (CFCs) and most recently, the newly identified trifluoromethyl sulphur pentafluoride (SF5 CF3) [Fawehinmi, 2007]. In addition, methane nitrous oxide and chlorofluorocarbons (CFCs) added to these gases increase these GHGs leading to the progressive depletion of the ozone layer in the stratosphere [Goldberg, 1994]. The ozone layer is the shield that absorbs about 90% of the harmful ultraviolet energy emitted by the sun on the earth. The abundance of greenhouse gases result in phenomenon of greenhouse effect, the greenhouse gases allow shortwave energy

to get to lower atmosphere but hold back long wave radiation from escaping, thus regulating the earth's heat budget.

Nigeria, like other developing countries, contributes insignificantly to the greenhouse emissions but no matter the level of contribution, climate change and rise in sea level will have significant impacts locally, regionally and globally, creating problems for sustainable development and resources management. Indeed climate change and sea level rise would compound the serious problems of sustainability of the environment and management of resources, as well as the current serious problems in population consumption patterns and characteristics in many parts of Africa and other developing countries.

In Africa, only a few countries account for the bulk of the region's emission from fossil fuels. These are Nigeria, Egypt and Algeria which together combined account for 35.5% of total fossil fuels emissions from the continent [Marland *et al.* 2003]. In fact, Nigeria is the largest contributor of carbon dioxide and other greenhouse gases in the West African sub-region [Maryland *et al.* 2003]. The country accounted for 1% of Africa's total emissions in 1996 [African Development Bank, 2001]. In Nigeria, only a relatively small proportion of the natural gas produced is utilized and as much as 76% of the gas is flared *World Bank Report*, [1995]. Nigeria natural gas comprises 90% methane, 1.5-2.0% carbon dioxide, 1.4-2.4% heavier hydrocarbons and 3.9-5.3% ethane among other compounds [Jones *et al.* 1998] thereby contributing substantially to greenhouse gases locally and invariably to the global climate.

Interaction between Urbanization Process and Urban Climatic Factors

Many observation and modeling studies have confirmed that higher concentrations of carbon – dioxide in the atmosphere is enhancing the greenhouse effect thus making the globe warmer for example

[IPCC, 2001; Santer *et al.* 1996; Wrigley *et al.* 1998; Hansen *et al.* 1998 and Crowley, 2000]. A warmer world could on the negative side imply increased frequency and magnitude of coastal flooding emanating from powerful and destructive hurricanes propelled by strengthened storm systems [Ayres and Walter, 1991 and Meyer, 1996].

It is clear that climate has major impact on urbanization. Temperature, precipitation, humidity, wind, sunlight and other climatic parameters can greatly influence the design of the city in terms of its general structure, orientation, building forms, materials and the like *Shahmohamadi et al.* [2010]. For instance, in coastal areas, structure of the city is dense and compact in order to avoid penetration of sunlight.

It is not always a one way influence from climate toward urbanization. Urbanization, especially in higher density of built-up areas, has more influence from climate. Buildings in cities influence the climate in five major ways [Bridgman *et al.* 1995].

1. By replacing grass, soil and trees with asphalt, concrete and glass;
2. By replacing the rounded, soft shapes of trees and bushes with blocky, angular buildings and towers;
3. By releasing artificial heat from buildings, Burning of fossil fuel, industry and automobiles;
4. By efficiently disposing precipitation in drains, sewers and gutters, preventing surface infiltration; and
5. By emitting contaminants from a wide range of sources, which, with resultant chemical reactions can create an unpleasant urban atmosphere,

Urban areas are the sources of anthropogenic processes, carbon dioxide emissions from the burning of fossil fuels for heating and cooling, from industrial processes, transportation of people and goods, etc [Oke, 1981]. Increased in pollutant sources both stationary (industrial) and non-stationary (vehicles)

result in worsening atmospheric conditions [Roth, 2002].

The urban environment affects many climatologically parameters. Global solar radiation is seriously reduced because of increased scattering and absorption. Many cities in the tropics experience weak winds and limited circulation of air which helps the accumulation of pollutants [Roth, 2002]. The wind speed in the canopy layer is seriously decreased compared to the undisturbed wind speed and its direction may be altered. This is mainly due to the specific roughness of a city, to channeling effects through canyons and also to the heat island effects [Santamouris, 2001]. In addition, higher temperatures increase the production of secondary, photochemical pollutants and the high humidity contributes to a hazy atmosphere.

This paper aims to literally explore the conceptual framework of interaction between urbanization Structure and understanding social impacts of climate change and variability.

THE METHODS

This research employs a combination of methods, *i.e.* reviews of literature and relevant publications as well as secondary data analysis. Relevant literatures and publications are analyzed to develop a theoretical base in understanding the relationship between urbanization and climate change. Besides, the paper examines the proposed theoretical frameworks through an analysis of secondary data on urbanization and climate change of Lagos, Nigeria.

RESULT AND DISCUSION

Factors of Urbanization Structure in the Formation of Climate Change with a Glance at Lagos Nigeria

Lagos, situated on the narrow coastal lowland stretch bordering the Atlantic Ocean and originally covered with mangrove swamps, has experienced

significant land cover changes due to past and present reclamation activities to secure more and more land for urban development. Urbanization process involves industrialization, forest depletion and land degradation, in which natural endowment has been replaced by artificial one, and most of the rural settlement has been transformed to urbanized environment.

Like any other cities in the developing world, Lagos state has its own share of urban problems. It is clear that climate factors have major impact in urbanized environment *i.e.* temperature, wind, ultraviolet radiation and population density. As a matter of facts, the existing interaction between urbanization and climate factors are major determinants of the micro-climate of the city. As observed, if the percentage of *UHI* formation is high when great interaction exists, it can turn cities into hot areas because greenhouse gases must have trapped heat in the atmosphere. Climate change has a cumulative effect on natural resources and the balance of Nature.

Givoni, [1998] states that the differences between the urban and the rural temperatures are affected by two types of factors: (1) they are correlated with meteorological factors such as temperature, cloud cover, humidity, and wind speed, and (2) various features of the urban process and structure such as the size of cities, the density of population, the density of the built-up areas, and the ratio of buildings' heights to the distances among them can have strong effect on the magnitude of the urban heat island at micro-climate level and eventually cause global climate change.

Chandler, [1976]; *Landsberg*, [1981] and *Oke*, [1982] noted that microclimatic effects of urban parameters on heat island are: population size, topography, rivers and other water bodies, wind speed, anthropogenic heat, water runoff and

clear and permanent impacts on the ecosystem. Climate change is different from the generally known terms like climatic fluctuations or climatic variability. These terms denote inherent dynamic nature of climate on various temporal scales. Such temporal scale variations could be monthly, seasonally, annually, decadal, periodic, quasi-periodic or non-periodic.

Urbanization produces radical changes on the morphology and composition of air in built-up area resulting in perturbation of the radiation, energy, humidity and wind balance and leading to the modification of local climate [Warner and Hertig, 1984] a consensus is held on the variation that exists between the microclimate conditions found within an urban area and its surrounding countryside [One, 1981; Ibadan, 2005 and Roth, 2007]. But given the large and increasing population and size of urban areas across the globe, it is becoming increasingly clear that the impacts of the ever increasing cities on the environment are not just limited to the actual footprint in a place, but may indeed occur at regional and global levels. Though cities produce their own microclimate, they are still connected to regional and global climates through the chemistry of atmospheric effect on radiation balance and greenhouse gas emissions.

It is the climate or state of the earth's atmosphere that makes the life on earth possible and sustainable. Henderson-sellers, [1990]; Oyo and Oni, [2001] define Climate as the total experience of weather at any place over some specific period of time. The definition points out its dynamism and coverage. It takes into account of the average and deviations and allows for in-depth and extensive examinations of climatic data. One truth that is glaring is that earth's climate has never been in a static state.

The Federal Government of Nigeria, [1988] has also observed that the

present high rate of population growth is already contributing substantially to the degradation of the ecology of the country. It observes that land fragmentation, over farming and over grazing have led to soil erosion and desertification and that overcrowding has led to the spread of shanty towns and urban blight; all of which would worsen if the present population growth continues [NEST, 1999]

This dossier on urban environmental inadequacies in Nigeria affects the quality of life in the cities. It can also serve as a drag on overall national development. The problem of course, is that there is no quick-fix solution in sight.

It is now established that humanity is altering the concentration of greenhouse gases and aerosols, both of which influence, and are influenced by climate. Recently, and especially over the past three or four decades, the issue of global climate change due to the greenhouse effects, including global warming and sea level rise have been a subject of scientific discussions and public debate.

Climate change has been blamed upon human activities which result in increased release of green house gases and widespread deforestation both of which alter the balance of atmospheric gases in favors of the green house gases (GHGs). These greenhouse gases are carbon dioxide-carbon monoxide (CFCs) and most recently, the newly identified trifluoromethyl sulphur pentafluoride (SF5 CF3) [Fawehinmi, 2007]. In addition, methane nitrous oxide and chlorofluorocarbons (CFCs) added to these gases increase these GHGs leading to the progressive depletion of the ozone layer in the stratosphere [Goldberg, 1994]. The ozone layer is the shield that absorbs about 90% of the harmful ultraviolet energy emitted by the sun on the earth. The abundance of greenhouse gases result in phenomenon of greenhouse effect, the greenhouse gases allow shortwave energy

warm-humid regions, where natural ventilation is essential for comfort and where the general wind speed may be rather low, such windier locations may be the desirable ones.

Lagos is located on the narrow plain of the Bight of Benin on longitude $2^{\circ} 42'$ E and 32° E and latitude $6^{\circ} 22'$ N and $6^{\circ} 2'$ N. the low nature of the topography condition renders the area to be very susceptible to flooding and increased water and air pollution.

2. Population Density: The movement of a large number of population from suburbs to the urban areas causes the acceleration of urbanization and increases the size of the city. The issue of climate change phenomenon depends upon the size and density of the population, as well as of its standard of living (such as vehicular traffic, intensity of heating and air conditioning, and industrial plants. The pollution created by emissions from power generation increases absorption of radiation in the boundary layer [Oke, 1982] and contributes to the creation of inversion layers. Inversion layers prevent rising air from cooling at the normal rate and slow the dispersion of pollutants produced in urban areas [Landsberg, 1981] Lagos population density is about 4,193 persons per built-up areas. Increasing large number of buildings and population density are the major sources of environmental pollution.

The main cause of increasing Lagos city size and rapid and unstable urbanization is the

relocation of the seat of the Federal Government to Abuja on 12 December 1991 (20 years ago); Nevertheless, Lagos remains the nation's commercial capital.

3. Density of built-up area: density of the various built-up areas in a city affects the local climate in each of the discrete urban areas. In Lagos metropolis, Lagos had an area of about 200 km^2 in 1960, but by the beginning of the twenty-first century the contiguously built-up area of Lagos was estimated to be about $1,140 \text{ km}^2$. The acceleration of urbanization in order to comply demands of large number of population causes the increase density of built-up area which leads to raised temperature and heat intensity. The roofs of buildings are made up of corrugated irons sheets or aluminum materials. This increases run-off coefficient from rooftop to canals. Buildings modify the wind, the radiant balance, and the temperature conditions near the ground level. Land covered by buildings cannot be planted. Therefore, the fraction of land covered by buildings in a given area is a relevant factor in evaluating the climatic effect of urbanization. In addition, the distances between buildings along axis affect the solar exposure of the buildings and the potential for day lighting and for solar energy utilization for space and water quality.
4. Air pollution. In general, urban areas are subject to wide range of pollutants, three of the most important sources of air pollutants include industry, motor vehicles and the burning of fossil fuel for

heating generator or electricity generation. The burning of fossil fuels (the main cause of greenhouse gas emission and climate change) is a principal source of air pollution particularly in urbanized environment; Lagos state accounts for about 40% of the total fuel consumption in Nigeria, and it is the commercial pulse of Nigeria. About 70% of the nation's industries and commercial activities are carried out in the state.

According to *World Bank*, [2002] the total two-way passenger traffic crossing the three bridges between the mainland and Lagos Island in 2001 was 1.59 million per day of which 77% were public transport passengers. This represents an annual overall growth in passenger demand over the last decades of about 3.4% per annum. Thus, the consequences of this interaction are the emission of greenhouse gases. There is an evidence of the health effects of air pollution. The damaging effects of exposure to smog can range from eye, nose and throat irritation to decrease in lung function [*WHO*, 2007].

5. Drainage system: Uncontrolled and indiscriminate disposal of soil wastes especially in the available drainage systems is one of the factors responsible for flooding in Lagos Island thus causing damages. Lack of porosity materials in urban surface, a high percentage of non-reflective, water-resistant surfaces and a low percentage of vegetated and moisture trapping surface create an evaporation deficit in the city and affect the intensity of urban heat island. Vegetation, especially in the

presence of high moisture levels, plays a key role in the regulation of surface temperatures; even more than non-reflective or low-albedo surfaces and a lack of vegetation reduces the heat lost due to evapotranspiration [*Ayoade*, 1998]. In Lagos Island, construction of new buildings has crowded out the vegetation. Destroying vegetation and green spaces has caused the lack of evapotranspiration, and thus higher temperature is being experienced.

Study Area, Lagos State

Location of the Study Area

Lagos State is within a low-flying coastal zone of the southwestern Nigeria sedimentary basin. A network of interwoven rivers, estuaries, Lagoons and creeks as well as wetland and forested regional ecosystem characterized the geographical entity.

It is about the smallest of the 36 States in Nigeria. *Soneye and Omojola*, [1995] the relief ranges from along the Atlantic Coastline stretch to some 160 m towards the burden with Ogun State in the North. On the average, the aquifer is about 8 m deep *Omojola*, [1992]. It constitutes the main source of domestic water supply through shadow hand dug walls.

The state is located in the Southwestern part of Nigeria on the narrow plain of the Bight of Benin, lying approximately on Longitude $20^{\circ} 42'$ E and $32^{\circ} 2'$ E respectively, and between latitude $6^{\circ} 22'$ N and $6^{\circ} 2'$ N. Lagos state is bordered in the north and east by Ogun state of Nigeria, and in the east by the Republic of Benin, The peculiarities of Lagos is that it stretches over 180 kilometers along the Guinea Coast of the blight of Benin on the Atlantic Ocean. Its territorial extent and political jurisdiction encompass the city of Lagos and the four administrative divisions of Ikeja, Ikorodu, Epe and

Badagry collectively referred to as *IBILE* and covering an area of 358,862 hectares or 3,577 sq.km, which represents 0.5% of Nigeria's territorial landmass of 923,773 sq.km.

Demography of the Study Area

Although Lagos state is the smallest state in Nigeria, with an area of 356,861 hectares out of which 75,755 hectares are wetlands, yet it has the highest population, which is over five per cent of the national estimate.

The state has a population of 17 million out of a national estimate of 150 million. The *UN* estimates that at its present Lagos state will be the third largest mega city in the world by year 2015 after Tokyo in Japan and Bombay in India.

Of this population, Metropolitan Lagos as an area covering 37% of the land area of Lagos State is home to over 85% of the population.

The rate of population growth is about 600,000 per annum with a population density of about 4,193 persons per built-up areas of Metropolitan Lagos; the average density is over 20,000 persons per square kilometer. Current demographic trend analysis revealed that the state population growth rate of 8% has resulted in its captured Nigeria's urban population [*World Bank*, 1996] estimate at 49.8 million people of the nation's population, whereas the country's population growth is 4/5% compared to the global population of 2%. Lagos population is growing ten times faster than Los Angeles with great implication for urban sustainability. Lagos is accounted for not so much natural increase as by rural-urban migration which contributes about 75% of population growth of Lagos [*Abumere*, 2004]. The state assumes a density of about 2,267 people.

Contribution of Lagos State to Local and National Economy

Lagos occupies a pride of place in its contributions to the economic growth of the state and as one might even argue to the West-African Sub-region. The City's invaluable contributions in many respects are evident from the below analyses and the following statistics:

29 industrial estates and several business district (*CBD*) and the largest market in sub-Saharan African, home of the Nigerian capital and money market, (Financial Hub) and has the highest vehicular density over 222/km (National 11/km). Internally, generated revenue accounts for over 60% of the State's annual budget skewed in favor of capital expenditure and account for nearly 60% of Nigeria's Gross Domestic Product, and over 65% of national investments.

Thus, the remarkable growth of Lagos has been attributed to industrialization. The Lagos metropolitan district is currently the most industrialized area in Nigeria.

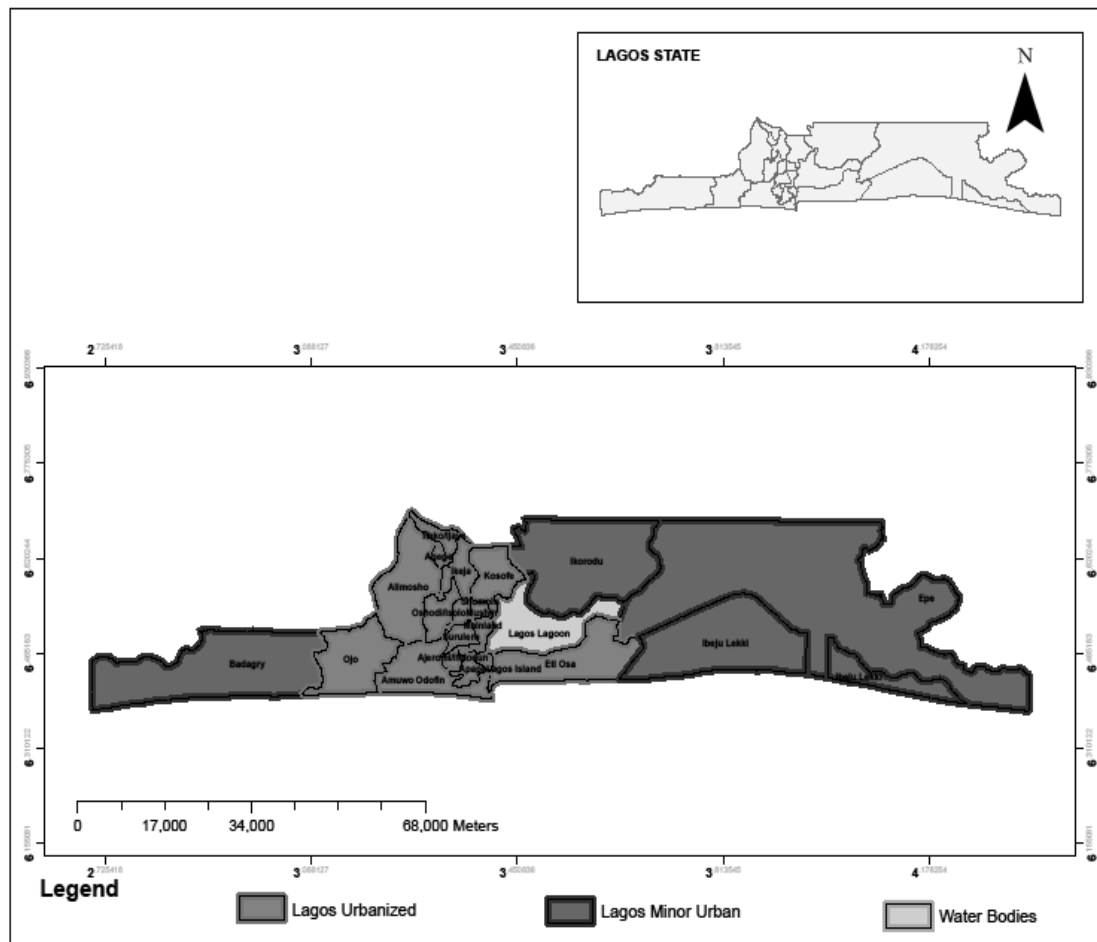
To mitigate the adverse impacts of climate change, the United Nations Framework Convention on Climate Change (*UNFCCC*) clearly defined its objective as: stabilization of greenhouse gas concentrations in the atmosphere at the level that would prevent dangerous anthropogenic interferences with the climate system. Such level should be achieved within a time frame sufficient to allow ecosystem to adapt naturally to climate change to ensure that food production is not threatened and to enable socio-economic development to proceed in a sustainable manner.

Vulnerability and Poverty Marginal Links in Lagos State

Blaiki et al. [1994] define vulnerability as "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard. The same authors argue that vulnerability is a measure of a person or group's exposure to the effect of a

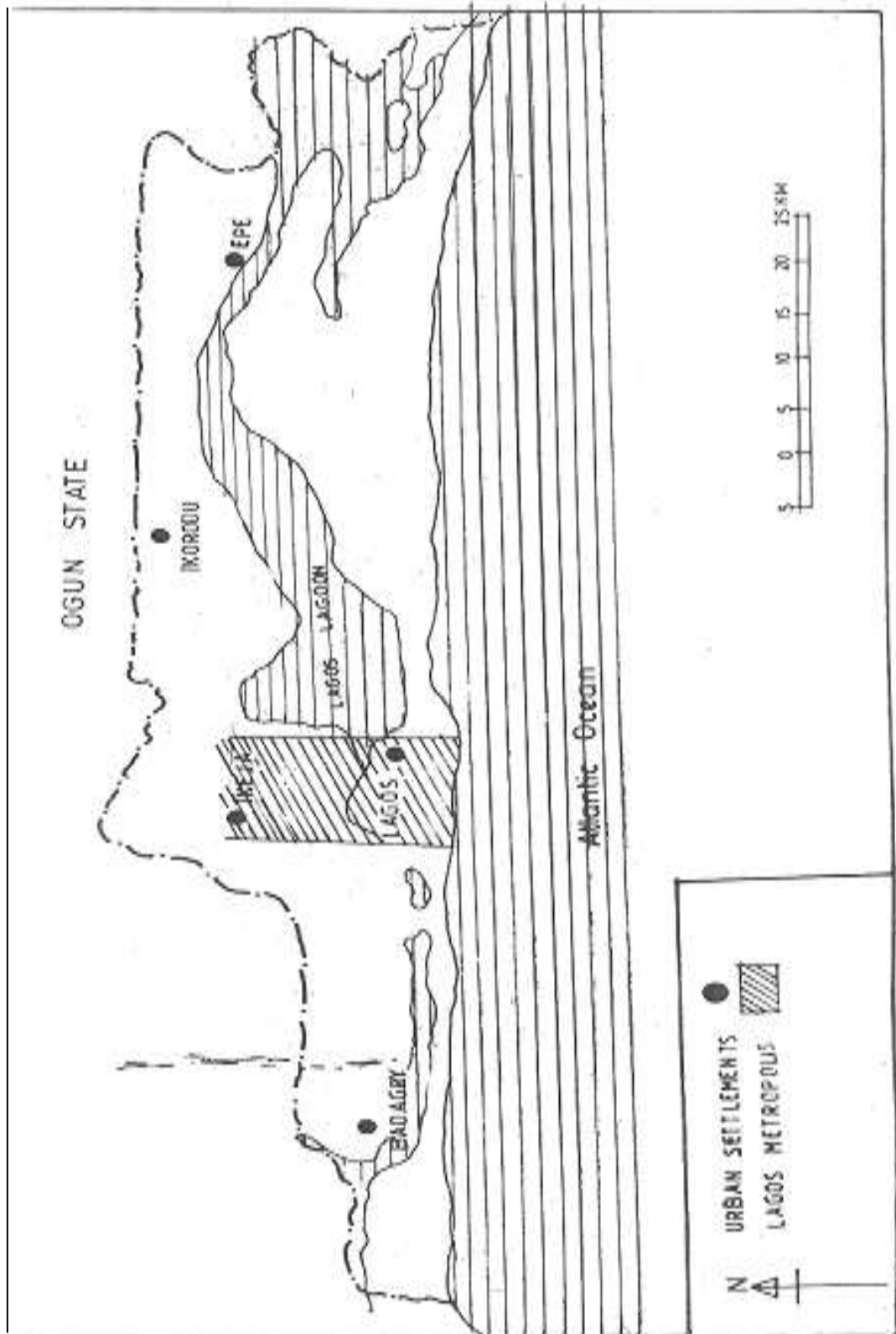
natural hazard, including the degree to which they can recover from the impact of that event. *Blaiki et al.* [1994] argue that households that have access to resources and social networks are less vulnerable. Although they may experience greater losses (in absolute terms) than the poor, it can be argued that resources-rich households are more resilient in that they recover more quickly from a stress stimulus. A common theme in the climatic change vulnerability literature is the idea that countries, regions, economic sectors

and social group differ in their degrees of vulnerability to climate change. This is due partly to the fact that changes in temperature and precipitation will occur unevenly and that climate change impacts will be unevenly distributed around the globe. This in turn is due to the fact that resources and wealth are distributed unevenly. Though vulnerability differs substantially across regions, it is also recognized that even within regions, vulnerability will vary [*IPCC*, 2001].



Source: LASU GIS/Cartographic Department

Figure 1. Study area showing the urbanized environment in Lagos State



Climate change has the tendency to increase this problem.

1. Rapid urbanization, particularly in the third world mega cities where poor migrants are usually forced to locate in cheaper land and housing in hazard prone areas that are likely to be subjected to flooding events. For instance, Lagos State was identified in 1981 by a World Bank Urban Renewal Project that the number of slums in the city is estimated to have increased to about 100 due to inadequacy of private and public institutions to provide housing for increasing population. Almost 70% of Lagos's population consequently live in slums especially in marshy areas and areas near the lagoons [LMDGP, 2006]. The estimated poverty level of 70% (Ministry of Economic Planning and Budgeting, 2004) makes Lagos one of the poorest of the world's largest cities.
2. It is clear that the poor frequently have higher levels of exposure and are more vulnerable to climate-induced natural disasters, because their ability to decide where to settle is reduced by poverty. The poor nations lack the technical expertise and financial resources to adapt to climate change and have too many competing necessities to address. Disparities in vulnerability can be found in household level, women, children, and the elderly being relatively less able to cope with climate-induced disturbances, from food scarcity, disease epidemic.

Poverty is closely tied to marginality which carries a number of implications in terms of vulnerability because being marginal implies being removed from the security and resources collected and managed through a central location or network. Poverty correlates to political, social and ecological conditions that result

in marginality i.e. the vulnerability of poor of poor urban communities in the coastal city of Lagos by exploring the links between city development in Lagos, with particular reference to the growth of slums and risks of climate change. Access to economic and financial resources is essential to reduce vulnerability in the context of climate change. The wealthier the geographical entity, the more likely it is that:

- 1 Exposure to risk will be reduced through infrastructure provision, relocation of critical facilities, best management practices and other strategies to reduce flood event affecting people and property.
- 2 Coping with climatic event will be easier because of better ability to absorb the impact and more economic and financial resources.

RECOMMENDATION

Lagos State attempts to enhance its resilience to climate change and thus certain steps become compelling include:

1. Capacity building to adapt to climate change which involves changing people's mindsets and behavior and introducing more efficient technologies and systems. This encompasses scientific and research capacity, strengthening the most vulnerable communities with respect to identifying the most vulnerable communities and based on their own socio-economic needs to help them to be better able to cope with future impacts due to climate change, specific sector capacity building, and national policy level capacities that involve policies for reducing vulnerability to climate change.
2. Designing a climatic-resilient water resource, agriculture and sustainable livable options in vulnerable areas.

3. An integration of climate change risks posed into development planning that affects critical sectors of the economy such as energy, agriculture and industrial sectors mostly affected by the change.
4. Good governance that renders policy effectiveness in the areas of public finance, energy management and environmental governance.
5. Developing and mainstreaming a National Adaptation Action Plan and Climate Early Warning Systems (CEWS)
6. Adequate mitigation and adaptation to global climate in the context of poverty and rapid urbanization by strengthening institutional capacity in the third-world mega-cities i.e. Lagos state.

CONCLUSION

Climate change is real, and directly influences every human activity and weather-sensitive economic sectors such as agriculture and land resources, energy, industrial and commercial activities, coastal areas (water resources management) and general health of the state. In general, the impacts of climate change in Lagos and Nigeria, interacting with other stress in the economy such as poverty conflicts and disease, are capable of hampering the possibility of achieving sustainable development.

In order to mitigate the adverse consequences of climate change on socio-economic activities, critical policy formulation on environment at all levels should be supported by a strong political will. Therefore, the need for a participatory approach among all stakeholders, (government, professional, public and private) is needed in order to develop our understanding of climate change for a sustainable development.

REFERENCES

- Adejuwon, S.A. (2004), Impacts of climate variability and climate change on crop yield in Nigeria. *Proceedings at the National Climate: Conference O.A.U*, Ile-Ife.
- Ayoade, J.O. (2003), *Climate Change: A Synopsis of its nature, causes, effects and management* Ibadan, Vantage Publishers.
- Ayoade, J.O. (2008), *Introduction to Agro-climatology*, University Press Plc Ibadan.
- Burton, I. (1997), Vulnerability and adaptive response in the context of climate and climate change, *Climate Change*, 36: 185-196.
- Carter, T.R. et al. (1994), *IPCC Technical Guideline for Assessing Climate Change Impacts and Adaptations*, University College London/Centre for Global Environmental Research.
- Cooper, R.N. (2000), International Approaches to Global Climate Change, *The World Bank Research Observer*, Pp 145-170.
- Council of Economic Advisers (1998), *the Kyoto Protocol and the President's Policies to Address Climate Change Administration Economic Analysis*, D.C. Processed, Washington.
- Efe, S.I. (2008), Climate Change: A Challenge to My Generation. Being A Paper Presented at a Conference Organized by the Nigerian International Secondary Schools Model United Nation (Nissmun) Club of Infant Jesus Academy, Held on July 5th, 2008, 2- 13, At Infant Jesus Academy, Asaba .
- Fawehinmi, O.F. (2007). Global Warming, *Proceedings of the 1st International*

- Conference on Socio-Economic Policies and Millennium Development Goals (MDG, S) in Africa*, 274-280.
- Fasona, M.J. and A.S. Omojola (2005), Climate change, Human Security and Communal Clashes in Nigeria, *Conference proceedings at Oslo*, June 2005.
- Grimmond, S. (2007), Urbanization and Global Environmental Change: Local Effects of Urban Warming, *Cities and Global Environmental Change*, 83-88.
- Hamilton (1999), Justice, the market and climate change, In Low, N. (ed) *Global ethics and environment*, 90-105, Routledge, London.
- Ibidun, O.A. (2005), Country Report: Urban climate research in Nigeria, *IAUC Newsletter International Association for Urban Climate*, Issue No.13, October, 2005.
- Ikeme Jekwu (2005), assessing the future of Nigeria's economy: Ignored threats from the global climate change debacle, www.AfricaEconomicAnalysis.org
- IPPC (2001), *Potential Impacts of Climate Change*, University Press, Cambridge, New-York.
- IPCC (2007), *Climate change Vulnerability, The physical Science Basis summary for Policy Makers*.
- Kandlikar, M. and A. Sagar (1999), Climate Change research and analysis in India: An integrated assessment of a South-North divide, *Global Environmental Change* 9(2), 119-138.
- Landsberg, E.H. (1981), *the Urban Climate*. Maryland, Academic Press.
- NEPAD (2004), State of Lagos Megacity and other Nigerian cities, *Lagos State Ministry of Economic Planning and Budget in Collaboration with Urban Development*, the UN-Habitat Office in Nigeria.
- Ojo, et al. (2001), *Fundamentals of Physical and Dynamic Climatology*, SEDEC Press Ltd, Lagos.
- Oke, T.R. (1982), the Energetic Basis of Urban Heat Island, *Quarterly Journal of the Royal Meteorological Society*, 108.
- Shahmohamadi, P. (2010), Reducing Urban Heat Island Effects: A Systematic review to Achieve Energy consumption Balance, *International Journal of Physical Sciences*, 5(6), 626-636.