



**FEDERAL UNIVERSITY OF TECHNOLOGY
MINNA**



**SCHOOL OF ENVIRONMENTAL TECHNOLOGY
INTERNATIONAL CONFERENCE (SETIC 2016)**

SETIC 2016

Conference Proceedings

EDITORS:

**Yekeen A. SANUSI
Olatunde F. ADEDAYO
Richard A. JIMOH
Luqman O. OYEWOB**

THEME:

**SUSTAINABLE BUILT ENVIRONMENT
AND CLIMATE CHANGE:
THE CHALLENGE OF POST 2015
DEVELOPMENT AGENDA**

DATE:

**TUE. 10TH - THUR. 12TH
MAY, 2016**

VENUE:

**SCHOOL OF ENVIRONMENTAL
TECHNOLOGY COMPLEX**

TIME:

**9:00AM - 5:00PM
DAILY**

CHIEF HOST:

PROF M. A. AKANJI
VICE CHANCELLOR, FEDERAL UNIVERSITY
OF TECHNOLOGY, MINNA

HOST:

PROF Y. A. SANUSI
DEAN, SCHOOL OF ENVIRONMENTAL TECHNOLOGY,
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

**School of Environmental Technology
International Conference
(SETIC) 2016**

10-12 May 2016

**Federal University of Technology Minna,
Niger State, Nigeria**

Conference Proceedings

Editors

**Yekeen A. SANUSI,
Olatunde F. ADEDAYO,
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Conference Proceedings of the School of Environmental Technology International
Conference (SETIC) 2016

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10th – 12th May 2016

School of Environmental Technology,
Federal University of Technology, Minna, Niger State, Nigeria.

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FOREWORD

The organising committee of the 1st School of Environmental Technology International Conference is pleased to welcome you to Federal University of Technology Minna, Niger State Nigeria.

The conference provides an international forum for researchers and professionals in the built and allied professions to address fundamental problems, challenges and prospects that affect the Built Environment as it relates to Climate Change and Sustainable Development. The conference is a platform where recognised best practices, theories and concepts are shared and discussed amongst academics, practitioners and researchers. The papers and scope are quite broad but have been organised around the sub-themes listed below:

- Infrastructure Development and Financing
- Sustainable Practice Theories
- Urban Resilience and Energy Conservation
- Waste Management and Sanitation
- Health and Safety Issues
- Climate Change and Threat to Sustainability of the Built Environment
- Climate Change Induced Disaster
- Designing the Human Settlement for Climate Change
- Conceptual Issues on Climate Change and Sustainable Development
- Sustainable Materials
- Cross Cutting Issues

The peer review process saw us making use of 48 senior academics and specialist as reviewers drawn from institutions in Nigeria and England. There were some papers were outside the theme of the conference but we had to create a cross cutting issues to accommodate such papers this is in spirit that every knowledge is important.

We hope you enjoy your time at our conference, and that you have the opportunities to exchange ideas and share knowledge, as well as participate in productive discussions with the like-minded researchers and practitioners in the built environment and academia.

Professor Yekeen Adeeyo Sanusi
Conference Chair

School of Environmental Technology International (SETIC) 2016
Federal University of Technology Minna, Niger State Nigeria.
May 2016

ACKNOWLEDGEMENTS

The success of the 1st School of Environmental Technology International Conference holding at the Main Campus of the Federal University of Technology Minna, Nigeria is predicated on the support and goodwill from Vice-Chancellor of Federal University of Technology and many other highly motivated people.

I sincerely wish to appreciate you for attending this maiden event and to warmly welcome you to the city of Minna the capital of the *POWER STATE*. It is a great honour to have you in the beautiful campus of Federal University of Technology Minna, Nigeria, **THE MOST PEACEFUL UNIVERSITY IN NIGERIA**. I am aware of the great sacrifices made by many of you to be present in this occasion and I will definitely not overlook the long distances some of you have had to cover to get to this conference venue. We genuinely appreciate all your efforts. It is our singular hope and desire that the conference meets your expectations and gives you unquantifiable experience and tremendous developmental networking opportunities for a life fulfilling career.

We are grateful for the presence of the Vice Chancellor of the Federal University of Technology Minna – Professor Musbau Adewumi Akanji whose leadership and distinguished academic career has served as inspiration and encouragement to many young academics. His desire to see the University compete at International level has led to the upsurge in the organisation of International conferences, Public lectures and Seminars on regular basis within and outside the university. We are happy to have you as the Chief host to declare the conference open and deliver the welcome address.

We are grateful to the Dean of School of Environmental Technology, Federal University of Technology Professor Yekeen Adeeyo Sanusi for providing the robust platform, academic support and leadership for the organisation of the conference. You threw the challenge and provided the required resources and strategies for achieving its success, it is a great honour of having the opportunity to learn at your feet. We are happy to have you as the host and keynote speaker at the conference. I wish to thank also all the special guests particularly leaders of the Industry, Built Environment and Academia.

SETIC is beginning at the foundation this year and for this I wish to thank all those who have supported us through various forms of participation. Specifically I wish to thank the delegates and the partners for contributing significantly to the conferences. I wish to thank Prof. Oluwole O. Morenikeji (DVC Academic), Prof. Stella N. Zubairu and Prof. A. M. Jinadu who genuinely and consistently monitored the progress of the conference preparations. It is my desire that SETIC becomes a constant feature in the calendar of the university and global conference listings.

Delegates to SETIC 2016 are from 39 different academic and research institutions that are spread across six different countries. This offers participants a wonderful opportunity for exchange of cultural, social and academic ideas during the conference periods. It is also an opportunity to create awareness about programmes and events at the participants' individual institutions. I encourage you all to make good use of the networking opportunities that are available.

We received a total of 226 abstract, based on a quick review we were able to accept 175 of them and the authors were communicated on what they needed to focus on while developing the full papers. A total of (129) full papers were received and reviewed, the reviewers report for the authors to make corrections and submit revised papers. It was after the process that we were able to accept 112 papers for presentation at the conference, I therefore congratulate all the authors whose papers made it to the conference. We acknowledge the amount of hard work you had all put in producing these papers. It is my sincere believe that the presentation of the different ideas in your paper would go a long way in improving the knowledge of the participants and also generate meaningful discussions at the tea beaks, lunch and beyond.

I wish to express my utmost gratitude to each reviewer for a wonderful job done and for tolerating our deadlines and Oliver Twist syndrome. It is your dedication and expertise that has ensured that the conference is a success.

Special thanks to all our keynote speakers, Prof. Oluwole O. Morenikeji (Deputy Vice-Chancellor Academics, Federal University of Technology Minna), Prof. Hussein Makun (Director, Directorate of Research Innovation and Development, Federal University of Technology Minna), Prof. Musa Aibinu (Director, Centre for Distance Learning), Prof. Mustapha Zubairu (Director, Centre for Human Settlement and Urban Development), Dr. Appolonia A. Okhimamhe (Director, WASCAL) and Prof. Yekeen Sanusi, (Dean School of Environmental Technology, Federal University of Technology Minna).

It is important to appreciate the roles and efforts of the following people for their selfless and very significant contributions made towards the successful organization of the conference: Adedokun John, Idowu Oqua, Akhabue Oriwoh and Ailoyafen Dorcas (for being available to run around at very short notice), Arc. Oyetola Stephen and Tpl Samuel Medayese (for typesetting the papers for the conference proceedings).

I have come to realise that it is not easy to organize conference without dedicated individuals offering to serve. My heartfelt gratitude goes to Dr. R.A. Jimoh, Dr. L.O. Oyewobi, Dr. Taibat Lawanson, Dr. P. Ayuba, Dr. J.J. Dukiya, Dr. A.I. Anunobi, Dr. N.I. Popoola and Dr. O.A. Kemiki for their unflinching support all through the process.

It is our sincere hope that this conference will serve as a forum for the advancement of research in the urban sphere towards achieving a sustainable environment. It is our sincere believe that academics and professionals in practices will continually participate in this forum.

Once again I wish to thank you all for creating time out of your busy schedule to attend this conference. Please do enjoy your stay at Federal University of Technology Minna, and the city as a whole. Ensure that you make use of the different fora created throughout the conference to build new relationships for the future and strengthen existing relationships. I look forward to seeing you all in future.

Olatunde Folaranmi ADEDAYO
Chairman SETIC 2016 Organising Committee
May 2016

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DECLARATION

PEER REVIEW AND SCIENTIFIC PUBLISHING POLICY STATEMENT

10th May 2016

TO WHOM IT MAY CONCERN

I wish to state that all the papers published in SETIC 2016 Conference Proceedings have passed through the peer review process which involved an initial review of abstracts, blind review of full papers by minimum of two referees, forwarding of reviewers' comments to authors, submission of revised papers by authors and subsequent evaluation of submitted papers by the Scientific Committee to determine content quality.

It is the policy of the School of Environmental Technology International Conference (SETIC) that for papers to be accepted for inclusion in the conference proceedings it must have undergone the blind review process and passed the academic integrity test. All papers are only published based on the recommendation of the reviewers and the Scientific Committee of SETIC

Names and individual affiliation of members of Review and Scientific Committee for SETIC Conference 2016 are published in the SETIC 2016 Conference Proceedings and made available on www.futminna.edu.ng

Olatunde Folaranmi ADEDAYO
Chairman SETIC 2016
Federal University of Technology, Minna, Nigeria

Papers in the SETIC 2016 Conference Proceedings are published on www.futminna.edu.ng.

ADAPTING TO CLIMATE CHANGE FLOODING IMPACTS- A GUIDE FOR ACHIEVING SUSTAINABLE BUILT ENVIRONMENT IN NIGERIA.

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Flooding, a situation where land is covered with water (due to overflowing river caused by heavy rain) is one of the climate change natural disasters generated by human activities which constitute a threat to human life, property and the built environment. Although risks cannot be fully eliminated, however, adaptation to climate change can reduce the exposure and vulnerability to extreme climate and sustain the built environment. This work surveyed literature on climate change flooding and its effects on Nigerian built environment to find out that most developed nations with longer water bodies and greater exposure to flooding disaster have been able to curtail the negative effects of climate change induced flooding over the years than Nigeria were able to minimise the negative effects of climate change flooding on their built environment whereas, Nigeria with comparable minimum and manageable length of water bodies continuously have higher negative impacts from flooding. The study found that the application of adaptation theory will mitigate against the effect of climate change flooding and lead to the achievement of a sustainable built environment in Nigeria. The work eventually recommended concerted efforts of all stakeholders in the built environment to cooperate among themselves for the actualisation of gains of adaptation approach to climate change flooding in Nigeria towards achieving sustainable built environment.

Keywords: *adaptation, built environment, climate change, flooding, sustainable-development.*

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INTRODUCTION

Every human activity affects the environment directly or indirectly and that increasing population and urbanisation are man's greatest activities that impact on the environment. Rapid urbanization and the growth of mega cities, especially in developing countries like Nigeria, have led to the emergence of highly vulnerable urban communities, particularly through informal settlements and inadequate land management. In the wake of this, as the concentration of urban populations is increasing coupled with growing occurrence of climate change induced disasters, millions of naira in property is lost and its cost is increasing by the day. According to United Nation Development Programme (UNDP) in 2010, Climate change is one of the major challenges of our time and adds considerable stress to our societies and the environment. From shifting weather patterns that threaten food production, to a rise sea level that increase the risk of catastrophic flooding, the impacts of climate change are global in scope and unprecedented in scale. Without drastic action today, adapting to these impacts in the future will be more difficult and costly. Flooding has been observed as one of the climate change causative natural disasters generated by human activities which consequently hinder sustainability of the built environment (Adeofun, 2011). It is a situation where the land is covered with water due to overflowing of river triggered by heavy rainfall, an aspect of negative response to climate change, and due to its destructive effects on the built environment. It is an impediment to sustainable development. Flooding is identified as threats to human life, property and the built environment worldwide, most frequent in the developed countries, but mostly the degree of its vulnerability is much felt by the developing countries (Ojo, 2011), perhaps due to lack of proper adaptation. Hundreds of millions of urban dwellers in developing nations are at risk from the direct and indirect impacts of climate change. The trend and occurrence of flood rise and flooding are a factor of increased frequency and incidents severity.

According to Satterthwaite et al (2007) a third of the world's population are most at risk from sea-level rise and from the heat waves, storms and floods (as recently experienced in India, Indonesia, United States of America and United Kingdom) and many of the urban centres will need to adapt fast to avoid serious impacts of climate change flooding. The developing countries have large deficiencies of the preconditions for successful adaptation because they are ill-equipped due to inadequate provision for the infrastructure and services needed to reduce climate-change-related risks and vulnerabilities. Without effective adaptation measure to climate change flooding, there will be very serious consequences for the people, the environment and the national economies. For instance, in England and Wales 10,000 properties were flooded during Autumn in 2000 with negative effects on the road and rail services which made insurance claims total 1 billion pounds, also in Scotland, the average annual damage from flooding was put around 20 million pounds (Ojo, 2011). In the wake of unavoidable climate change, over exploited coastal resources posed a great threat to the built environment in Nigeria because of lack of proper development and effective flood management. In 2011, Ibadan experienced a flood disaster that washed away 2,105 properties and 25 bridges and culverts which, according to the Oyo state task force on flood prevention and management will require 100 billion Naira and 4.31 billion respectively to reconstruct (Ojo, 2011). Also in 2012, there was a general flood affecting over 80% of

component states in Nigeria, although the total loss was not documented, but it had a huge loss and damages to people and the built environments.

In preparation against negative effect of future flood, Olusina & Odumade (2012) used geographic information systems (GIS) to model future climate of Nigeria for 50 years (2000-2050) by comparing climate data from Nigerian Meteorological Services (NIMET) with World Clim model and application of their variation to obtain polynomial for predicting future temperature and rainfall change for Nigeria covering the period. The finding of the research indicated that future range of the changes in rainfall and maximum temperature to be between -192 to 198 (mm) and -1.59 to 2.48 (degree centigrade) respectively. Further findings include; expected negative and positive variations in rainfall across Nigeria, increase in temperature, coastal regions to expect average increase of 100mm rainfall monthly during rainy season. This however is a pointer for all stakeholders in the built environment in Nigeria to adapt to climate change flooding. The questions agitating the mind of these researchers are; which aspect of climate disaster is mostly noted in Nigeria and what are its causes? What are the effects of climate change flooding on the Nigerian built environment? To what extent can adaptation strategy be of use to flood disaster in Nigeria? And what are the adaptation strategies that can be applied for a reduction in flood disaster in Nigeria?

The focus of this paper is therefore on changes in the floods that might be related to changes in climate (i.e., referred to as 'climate-driven flooding'), rather than changes in engineering developments or land use and how such changes can be reduced and prevented for the purpose of having a sustainability in Nigerian built environment. To achieve the aim of the paper, it has been structured into 8 sections. The second section is devoted to climate change concept followed by section 3 which identify flooding as major visible natural disaster from climate change while section 4 discussed the climate change flooding effects on the built environment. Section 5 is on climate change flooding adaptation to built environment, section 6 observed flooding as a visible climate change induced disaster in Nigeria, the way out of climate change-flooding negative impacts on the Nigerian built environment was the focus of the seventh section before the work was concluded at the eighth section.

Climate change

Climate Change, according to Intergovernmental Panel on Climate Change (IPCC) (2012) is a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. This definition differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change is defined as: "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods." The UNFCCC thus makes a distinction between

climate change attributable to human activities altering the atmospheric composition, and climate variability attributable to natural causes. Global warming, as a resultant effect of climate change and the abuses of man on the environment is however noted to be the major causes of prolonged torrential showers of rains and the resultant runoff that lead to devastating floods.

According to Mosha (2011) climate change indicate any long term and significant change in weather (temperature, precipitation and wind patterns) experienced by a given region. Climate events have increased in frequency or magnitude, but populations and assets at risk have also increased, with consequences for disaster risk (IPCC,2012). Adverse impacts are considered as disasters when they produce widespread damage and cause severe alterations in the normal functioning of communities or societies. Climate extremes, exposure, and vulnerability are influenced by a wide range of factors, including anthropogenic climate change, natural climate variability, and socioeconomic development. Figure 1 present the relationship between the climate change and the implied disasters attached to it. However, climate change may pose short term changes (e.g. flooding, storms, heat waves and drought) and long-term changes (e.g. increasing average temperatures and sea level rise).

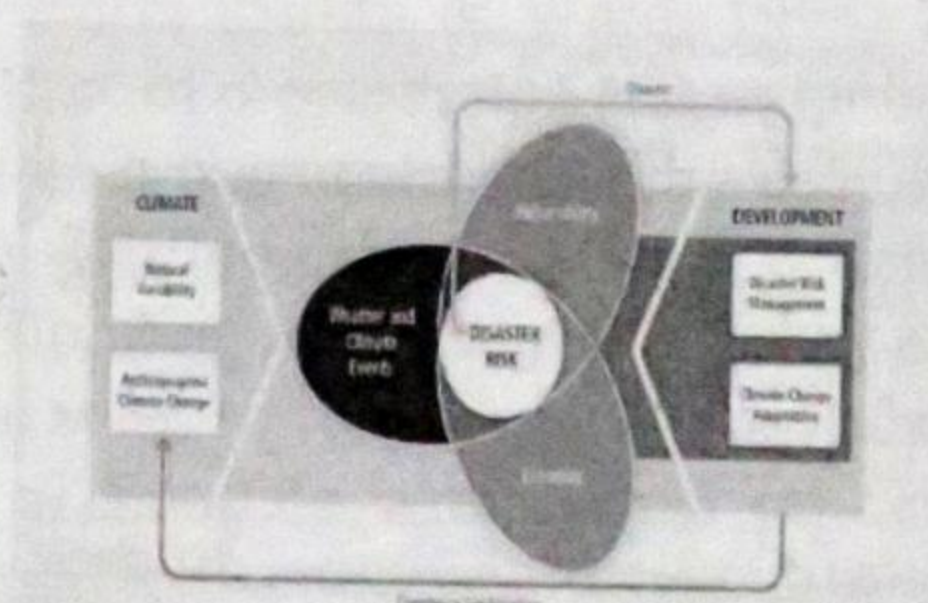


Fig. 1 The relationship between climate change and adaptation culled from IPCC, 2012

Within the built environment sector, climate change may be for adaptation or for mitigation purpose. Mitigation means efforts to limit the man-made causes of climate change, it has to do with taking actions aimed at reducing the extent of climate change factors, but adaptation is often used simply to mean changes that can be made to the design or construction (less often the operation or use) of buildings and landscaping in order to cope with the consequences of one or more of the impacts of climate change. Both terms therefore mean reduction of natural cause and prevention of human cause of climate change impact on the built environment. Currently, many existing buildings are wrongly adapted, indicating that the way they have been built increases their potential vulnerability to the effects of climate change. Moreover, in some cases it is not considered cost-effective to modify existing buildings to cope with a changing climate. Population growth and the planning system therefore, have a significant influence on the built environment and its evolution, including how it adapts to climate change. It is actions taking to minimize the negative effects and taking advantage of the opportunities, of climate change (both current and those yet to come).

It may also be an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities.

(United Kingdom climate impact Panel UKCIP, 2009). Climate-change has both positive and negative current and potential effects on people and their livelihoods/investments (e.g. buildings, neighbourhood and city). These effects can be direct, as in larger and/or more frequent floods, or more intense and/or frequent storms, or heat waves, or less direct as climate change negatively affects livelihoods or food supplies (and prices) or access to water needed for domestic consumption or livelihoods. Changing climate may come along with an increase in the frequency of drought, extreme rainfall, high temperatures, wind events is expected and we can expect an exacerbation of the health impacts associated with these events, it will increase the frequency and intensity of heavy rainfall events, thereby increasing the risk of urban flooding.

Flood and flooding as climate change natural disaster

A flood is the overflowing of the normal confines of a stream or other body of water, or the accumulation of water over areas that are not normally submerged include river (fluvial) floods, flash floods, urban floods, pluvial floods, sewer floods, coastal floods, and glacial lake outburst floods (Satterthwaite, 2008). The main causes of floods generally are intense and/or long-lasting precipitation, dam break (e.g., glacial lakes), reduced conveyance due to landslides, or by an intense local storm (Smith & Ward, 1998). Usman & Tunde (2009) observed that the restriction of the flow of precipitation and water bodies as a result of human actions majorly caused flood in most urban centres thereby causing damages and losses to build and ecological environments. Distinguishing between primary and secondary causes of flooding, the primary causes of flooding with natural tendency have been traced to any or combination of; heavy or torrential rains or rainstorm, ocean storms and tidal waves along coast while the secondary cause of flooding with human influence have been traced to blockage of river drainage through indiscriminate waste disposal and development of structures along river setbacks. Flooding is affected by various characteristics of precipitation, percolation and infiltration such as intensity, duration, amount, timing, and phase (rain or snow). A change in the climate physically changes many of the factors affecting floods (e.g., precipitation, snow cover, soil moisture content, sea level, glacial lake conditions, and vegetation) and thus may consequently change the characteristics of floods. It is also affected by drainage basin conditions such as water levels in the rivers, soil character and status (frozen or not, soil moisture content and vertical distribution), urbanization, and the existence of dams, and reservoirs (Bates et al., 2008). Along coastal areas, flooding may be associated with storm surge events.

Urban flooding (Overbank, dam spills or dam burst levee failures, Flash, Coastal, Overland, and Infiltration) occurs in urban areas, where the impacts of extreme rainfall are exacerbated by high concentrations of impervious surface, infrastructure, buildings, and property and people (Omisore, 2011). Urban flooding can have serious implications for all components of built environment and infrastructure. As extreme flows of water during heavy rainfall events can cause gully erosion and damage both overland and underground storm water management infrastructure and road pavements. The resulting loss from flooding however depends on the vulnerability of the affected population to resist the hazard otherwise called resilience. Most of the associated climate-related threats could have major impacts on the

built environment. The built environment sector may therefore need to consider suitable approaches for adaptation to a changed climate because of the associated direct threats it posed to the built environment and the people dwelling in it. However, those people and buildings close to the coast are particularly at risk when storm surges are combined with sea level rise. The major adaptation strategy to climate caused flooding involved the use of constructed defences to prevent and reduce the effect of flooding on built environment, raising of river banks and flood walls, creating sufficient storage reservoirs and canalization or channelization of flood passage and establishment of standard drainage system on roads.

Climate change flooding effects on the built environment

Most of the effects of climate change flooding are negative; for instance, such water may be increased in quantity and at the same time be decreased in quality, calling for concern from government and the built environmental professionals. However, Climate change effects are not all negative. Some are beneficial in nature, and for instance it may reduce energy bills and cold related deaths and hospital admissions. It may also reduce energy consumption and increase water supply. In some cases, overheating may lead to illness or death. Without action, likely consequences of the projected climate variables will be wide ranging from increasing flood risk and coastal erosion, potential water shortages, ground instability issues to associate health impacts of increased temperatures and detrimental effects on the current and future infrastructure. Warmer summers, on the other hand, may increase the risk of buildings becoming too hot and uncomfortable for human habitation. Climate change with its consequential effect on the built environment may increase the risk of subsidence affecting the properties which subsequently, may increase the risk of flooding for both residential and non-residential properties, thereby reducing their value, for instance, Ogbonna and Otegbulu (2014) observed the reduction of between 4-12% in housing prices in Nigeria due to flooding effect. Changes in water availability, particularly reductions in the summer, may lead to less reliable supplies, more frequent restrictions and potential water shortages in the longer term, unless more measures are taken to reduce demands and develop supplies. By and large the effect of climate change flooding on built environment can be identified as: events of drier summers and drought; reduced water availability/shortages, reduced water quality, reduced soil moisture content/ increased subsidence, changes in biodiversity, sea temperature rise; sea level rise, increased sea surge height, increased precipitation or more rainfall in heavier form, increased river flooding, increased urban drainage flooding, higher wind speeds; increased storm damage, outage of emergency, infrastructure and transportation services, reduction in property value.

Climate change adaptation to the built environment

Adaptation in human systems is defined as the process of adjustment to actual or expected weather and its effects. In order to moderate harm or/and exploit beneficial opportunities. In natural systems, it is defined as the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate (Eclipse Research Consultants, 2010). Within the built environment sector, climate change adaptation is often used simply to mean changes that can be made to the design or construction (less often the

operation or use) of buildings and landscaping in order to cope with the consequences of one or more of the impacts of climate change. Adaptation involves taking actions to minimize the effects of inevitable climate change, and take advantage of its opportunities, both current and those yet to come (Eclipse Research Consultants, 2010). These definitions modify the IPCC (2007) definition that generically mean the “adjustment in natural and human systems in response to actual and expected climatic stimuli, such as to moderate harm or exploit beneficial opportunities.” The essence of adaptation to climate change induced flooding is to ensure reduction in risks for inhabitants and built environment and have environmental, economic and socio political sustainability of built environment. Settlement patterns, urbanization, and changes in socioeconomic conditions have all influenced observed trends in exposure and vulnerability to climate extremes. Actions that range from incremental steps to transformational changes are essential for reducing the risk from climate extremes. Incremental steps aim to improve efficiency within existing technology, governance, and value systems, whereas transformation may involve alterations of fundamental attributes of those systems (IPCC, 2012). A prerequisite for sustainability in the context of climate change is addressing the underlying causes of vulnerability, including the structural inequalities that create and sustain poverty and constrain access to resources (medium agreement, robust evidence). This involves integrating flooding disaster risk adaptation into all social, economic, and environmental policy domains. The most effective adaptation and disaster risk reduction actions are those that offer development benefits in the relatively near term, as well as reductions in vulnerability over the longer term (high agreement, medium evidence). There are tradeoffs between current decisions and long-term goals linked to diverse values, interests, and priorities for the future. Short- and long-term perspectives on flooding disaster risk adaptation to climate change thus can be difficult to reconcile. Such reconciliation involves overcoming the discord between local risk management practices and national institutional and legal frameworks, policy, and planning. Progress toward resilient and sustainable development in the context of changing climate extremes can benefit from questioning assumptions and paradigms and stimulating innovation to encourage new patterns of response IPCC (2012). Successfully addressing disaster risk, climate change, and other stressors often involves embracing broad participation in strategy development, the capacity to combine multiple perspectives, and contrasting ways of organizing social relations. The interactions among climate change mitigation, adaptation, and disaster risk management may have a major influence on resilient and sustainable pathways (high agreement, limited evidence). Interactions between the goals of mitigation and adaptation in particular will play out locally, but have global consequences. There are many approaches and pathways to a sustainable and resilient future. However, limits to resilience are faced when thresholds or tipping points associated with social and/or natural systems are exceeded, posing severe challenges for adaptation. Choices and outcomes for adaptive actions to climate events must reflect divergent capacities and resources and multiple interacting processes.

Flooding as a visible climate change induced disaster in Nigeria

Most noted flooding the world over are those of coastal, river and urban categories caused by natural causes and aggravated by human causes. According to IPCC (2012), where vulnerability is high and adaptive capacity is low, changes in climate extremes can make it

difficult for systems to adapt sustainable without transformational changes. Vulnerability is however often concentrated in lower-income countries although higher-income countries can also be vulnerable to climate extremes. Social, economic, and environmental sustainability can be enhanced by a good disaster risk management and adaptation approaches. In the ranking of countries with water bodies liable to floods, Nigeria was the least of 15 countries ranked having, 8,600km length of water bodies, while China was ranked the first with 110,000km length of water bodies (see table 1 and figure 2).

This was corroborated by the fact that the coastal region of Nigeria (Delta, Edo, Lagos, Ondo, Ogun, Akwa-Ibom, Bayelsa, Cross River and River state) covered about 70,000km² representing only 7.5% of total land mass of Nigeria indicating that Nigerian flooding problem should be manageable compared with other countries. Flooding is therefore expected to be much more pronounced in the coastal areas because of rise in sea level and riverside areas because of overflowing of river banks after torrential rainfall, the coastal land and property are more liable to wash away by sea erosion and aquatic life, wetland and tourist beaches are also threatened by the floods (New England Aquarium, 2012). In Nigeria, coastal flooding coupled with beach erosion is the most common climate change disaster applicable to the build environment and their widespread is due to the higher waves generated by on shore storm winds (Patunola-Ajayi, 2014). While Halley (2001) identifies the major cause of flood in Africa to be inadequacy of drainage, but study of cause of flood in Nigeria has been identified to be excessive rainfall (Akanin and Bilesanmi, 2011; Ojo, 2011, & Aderogba, 2012) occasioned by increased precipitation. While some of the flooding could be due to natural occurrence or closeness to coastal areas, the case of urban flooding in Ibadan, a non-coastal city in Nigeria is a typical example of man-made flood disaster. Projections of flood changes at the catchment/river-basin scale are also not abundant in the scientific literature and very rare in Africa (Taye et al., 2011). Bates et al. (2008) argued that more frequent heavy precipitation events projected over most regions would affect the risk of rain-generated floods (e.g., flash flooding and urban flooding). Despite the fact that Nigeria has a manageable length of water bodies, it still lacks the required materials and resources for flooding adaptation approach when compared with other countries with a longer length of water bodies as indicated in table 1 and figure 2. The resultant effect is that Nigeria has manageable flooding risk but magnificent negative flooding impact.

Table 1: Ranking of length of global Navigable Rivers, canal and other inlands bodies of water

S/N	Country	Length in kilometers	Rank
1	China	110,000	1 st
2	Russia	102,000	2 nd
3	Brazil	50,000	3 rd
4	United States	41,009	4 th
5	Colombia	24,725	5 th
6	<i>Indonesia</i>	21,579	6 th
7	Vietnam	17,702	7 th
8	Congo	15,000	8 th
9	India	14,500	9 th
10	Burma	12,800	10 th
11	Argentina	11,000	11 th
12	Papua New Guinea	11,000	12 th
13	Boliva	10,000	13 th
14	Peru	8,800	14 th
15	Nigeria	8,600	15 th

Source: Patunola-Ajayi (2014) adapted from the world fact book

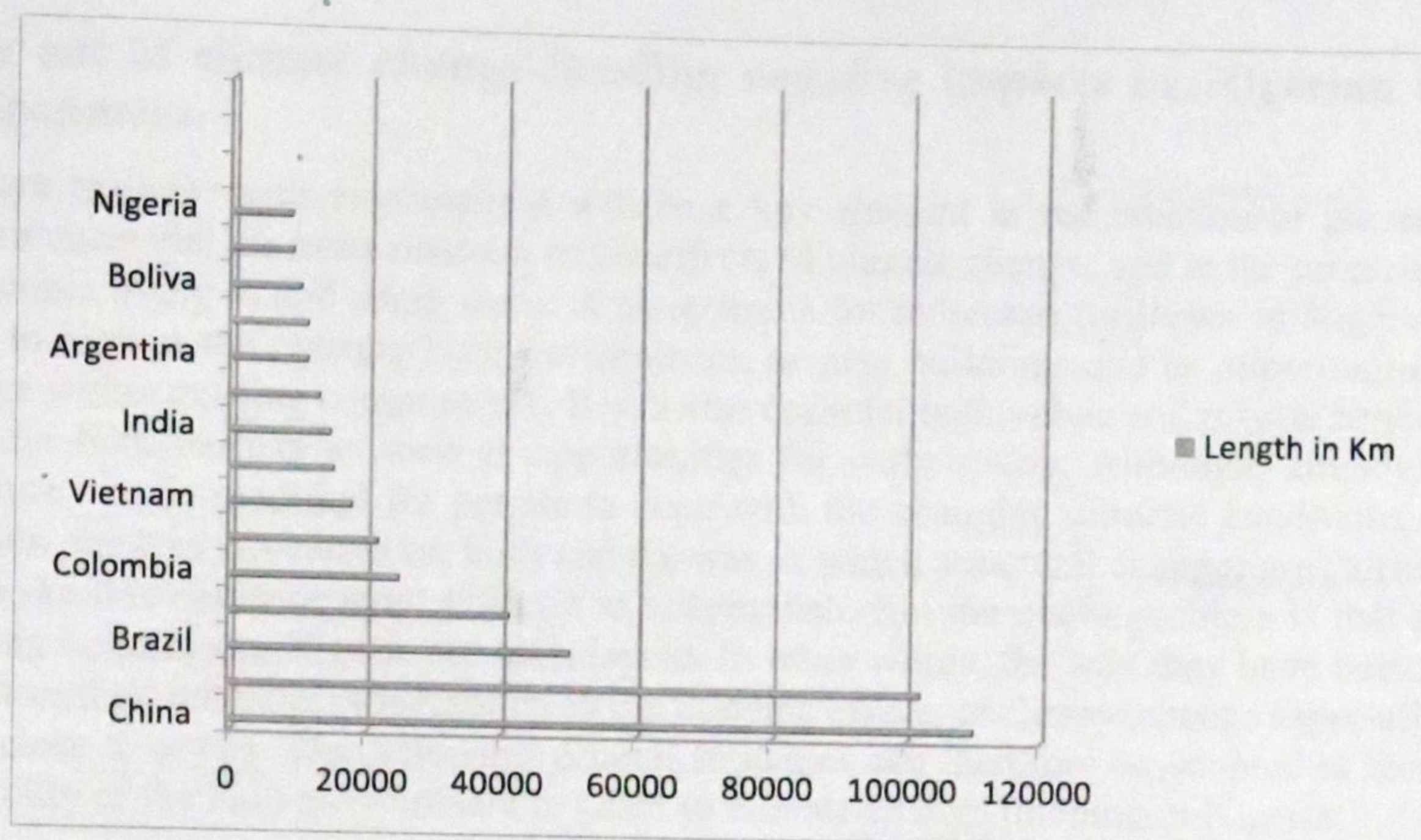


Fig 2: Ranking of length of global Navigable Rivers in selected nations

Some states with evidences of flooding occurrences in Nigeria include Oyo (1980 & 1990), Lagos (1970-2015), Kano (2001), Delta (2001), Edo (2015), Adamawa (2001-2015) and Kogi (2012) with negative effects on the built environment; destruction, submerging or washing away of buildings and structures, water pollution, bridge collapses and road wash away. The worst flooding occurrence in the history of Nigeria has been that of June/July 2012 when Benue and Niger rivers overflowed their banks. Although this was predicted early by the Nigerian Meteorological Agency, but governments at all tiers took no adaptation or mitigation actions. This singular incidence affected 30 of the 36 states in Nigeria, about 250 local government areas (representing 32% of 774 total local governments in Nigeria). About 30% of Nigerian land mass was submerged by flood affecting 7.7 million people, 300 were dead, and over 2 million people were displaced. Kogi state was the mostly affected state, but it was only in Plateau state that 200 homes were documented to have been destroyed. From the report of National Emergency Management Agency (NEMA) in 2012, between June and September 2012, over 363 lives were lost and about 1.2 million Nigerians were displaced. Adapting buildings to the impact of climate change requires an integrated approach to environmental design and the performance of buildings in use, Ezeabasili & Okonkwo (2013) are of the view that building designers and spatial planners in Nigeria are responding to adaptation of flooding through improved building design and layout of cities. The Environmental Agency (2007) was of the view that if the environmental issues are taken into account, building in the right places and in the right way can be an adaptation for mitigation of effect of climate change induced flooding for the benefit of both current and future generations.

Way out of climate change-flooding negative impacts on Nigerian built environment.

A more resilient built environment will be a key element in the creation of places and communities that are more resistant to the effects of climate change, and in the protection of the people living in and using them. A programme for increased resilience in Nigeria will need to look at the existing built environment, as new buildings and as opportunities for change within existing communities. It will also consider both public and private action and consider both barriers as well as opportunities for early action. Although, already built structure can be modified for people to cope with the changing climatic conditions, their location, the way structures are built and the way in which structural changes are carried out can make this easier or more difficult to accomplish. But the major problem is that many existing buildings in Nigeria are maladapted. In other words, the way they have been built increases their potential vulnerability to the flooding effects of climate change especially the ones close to coasts. The following general strategies can therefore be adopted to increase the ability of the built environment to adapt to climate change flooding in Nigeria:

- A strong need and emphasis on climate adaptation in planning policy, including action on coastal change and water resources are required. This must ensure that building design is done to be climate sensitive and conscious of high-risk areas through more stringent development control, building regulations is not only set but enforced, with minimum water efficiency standards to ensure their structural stability and climate change allowances is appropriately incorporated in engineering standards applied to flood defences and water supply systems.
- Continuing investment in community-wide and property-level flood protection, and steps to improve management of local flood risk. Planning policy should focus on directing most new development away from locations where it might flood especially in the coastal region or make them to be safe and resilient to flooding. The extent of future population growth must be properly analysed as it will add to the challenge of adapting the built environment to climate change in an appropriate and timely way.
- Encouragement of planting of trees to support cooling, drought resilience and drainage. To improve homeowner knowledge and risk-reducing behaviour through education and enlightenment. For instance, they should make them aware of future and potential risks posed by surface water flooding to buildings, neighbourhood and the city as a whole. Individual homeowners can have a significant role in reducing risk through protecting their own homes and reducing their contributions of storm water to municipal sanitary sewers and storm water management systems.
- Drainage should be designed in an environmentally friendly way of dealing with surface water run-off that avoids the problems associated with existing drainage practice aiming at reducing the potential impact of surface water drainage discharges in new and existing developments. There is a need to maximise the density of development in non-flood risk areas and minimise density of coastal and flood risk areas.

Buildings, neighbourhoods and cities may be vulnerable to an increasing frequency of heavy precipitation events. What are required to be done to adapt to the climate change flooding occurrence in Nigeria built environment can also be segregated to 3 levels: building, neighbourhood and city:

Building-there is a need to open water courses across the site for amenity and flood absorption on the site and provision of emergency access points. It is required to provide temporary/permanent flooding defences for properties that are at risk to flooding and a need to fit (removable) flood defence products to properties. Electrical services should be located above flood levels if it is discovered that the building is wet proof un-protectable buildings. Also, mechanical or UV light systems need to be installed to prevent damp and mould growth, peak run-off and annual surface water run-off rates need to be minimised, sustainable urban drainage systems (permeable paving attenuation systems, filter drains, ponds, wetlands) should be used, people should avoid development in flood risk locations and where already built, provide temporary/permanent flooding defences for at risk properties. Building design and building materials that can withstand flooding threats should be used and back up of drains into the building should be prevented.

Neighbourhood- soft defences should be used as the buffer as part of green infrastructure and water courses should be opened across neighbourhood for amenity and flood absorption. The development should be appropriately set back from flooding and flood defences and vulnerable users should be ensured located away from areas of high risk. Emergency access points as well as temporary/permanent flooding defences should be provided for existing and new properties at flood risk. Local safe retreat facilities should be provided against failure of flood defences as appropriate and engagement of the community in risk assessment/response. Sustainable urban drainage systems (permeable paving attenuation systems, filter drains, ponds, wetlands) should be used and landscaping including tree canopies should be encouraged to intercept and soak up rain. Lastly, impermeable surfaces should be avoided, especially where soils have high infiltration capacities and routes for emergency vehicles should be well planned to have secure access in the event of flooding, repair and construction of newly constructed drainages.

City- provision of flood plans for up and down stream flooding is highly desired in cities and emergency access routes and points should be provided alongside with city-wide safety retreat facilities against failure of flood defences. Consideration of river restoration for storing water temporarily in green spaces alongside rivers at identified vulnerable areas across the city (e.g. where known incidence of surface water flooding is detected with low drain capacity and soils with high infiltration rates). In vulnerable areas of the city the use permeable paving attenuation systems, filter drains, culverts, ponds, and wetlands should be used appropriately and permitting development in flood risk locations should be avoided entirely.

Conclusion

There exists an once-in-a-lifetime chance to develop and deploy the strategies and technologies that will secure future and realize the economic opportunities presented by climate change, being reason why developed national economies depends on well-functioning and resilient built environment in their urban centres. Urgent action is therefore

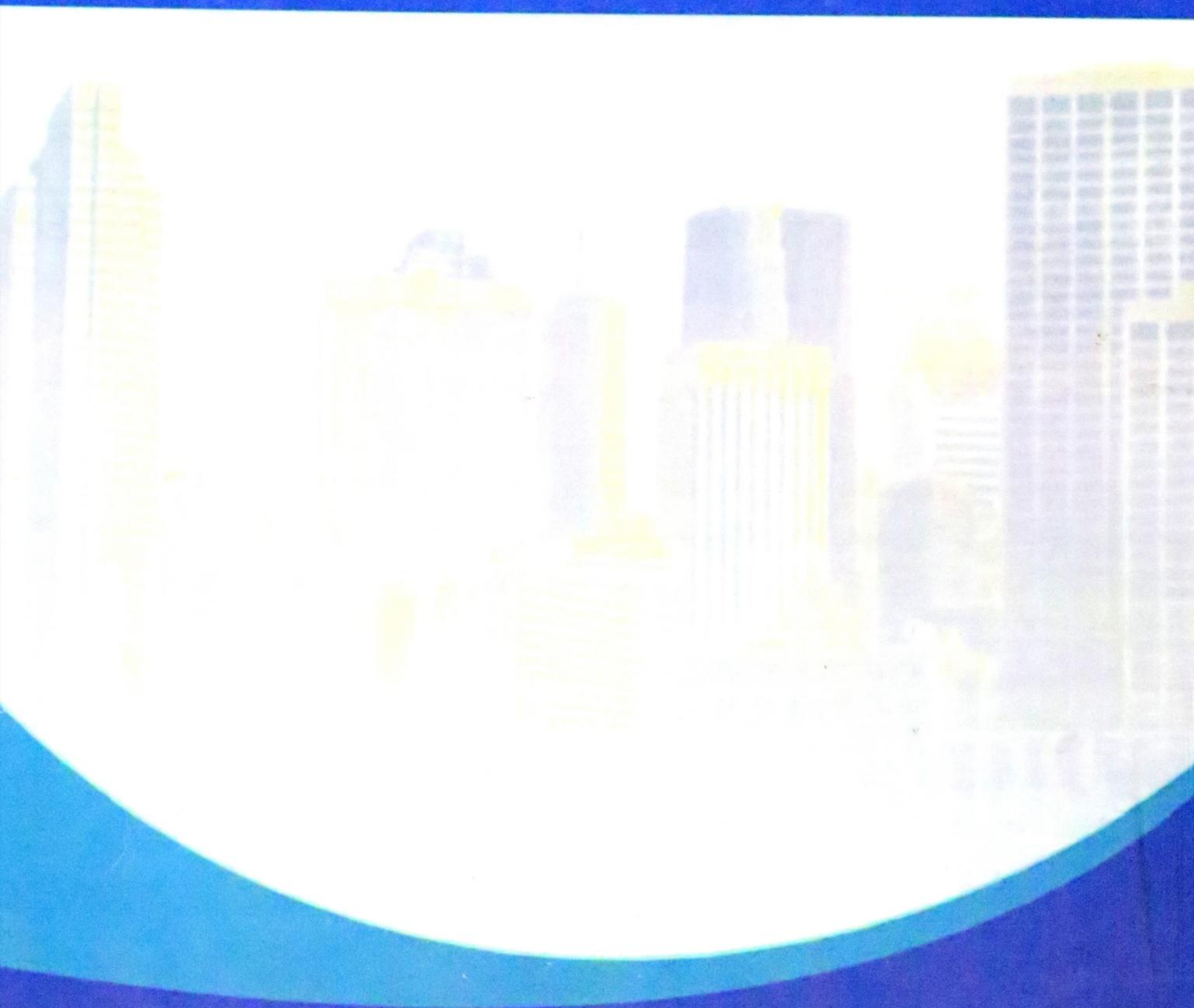
needed now both to address urban centres' current vulnerabilities to extreme weather and to build into expanding urban centres protection from likely future changes. As most buildings and infrastructure have long lives; what is built now needs to be able to cope with the climate change-induced risks over the next few decades, the epitome of sustainability. There is a need for promoting a strategy for catalyzing support for sustainable building design and construction and the key challenge is to plan, design and construct cities, neighbourhoods and buildings, in accordance with the principles of sustainable development that perform effectively not just in terms of today's climate but in the future as well. To achieve resilience of the existing built environment in Nigeria, there is a need to adapt the new buildings and ensuring modifications of existing buildings in the communities by joint actions of public and private sectors. It will also have to consider both barriers to and opportunities for early action. Although buildings can be modified later to help them stand the test of changing climatic conditions, their location, the way they are built and the way in which structural changes are carried out can make this easier or more difficult to accomplish. All big urban centres and cities have had to make very extensive "adaptations" to environmental conditions, site characteristics, natural-resource availabilities and environmental hazards to be able to function as urban centres. Climate change's multiple impacts should be taken into account when planning and designing new developments and when refurbishing and regenerating the existing stock of buildings. The importance of public awareness through effective hazard education is desired towards changing people's attitude to the climate change challenge. There is also a need for weather data for testing future performance of urban drainage and water supply systems in Nigerian urban centers. By and large, there is a need for concerted efforts of all stakeholders in the built environment (land surveyors, urban and regional planners, quantity surveyors, estate surveyors, architect, engineers, planning authorities and other statutory authorities, urban dwellers and urban building owners and governments) to cooperate with themselves for the actualisation of adaptation approach to climate change flooding in Nigeria.

REFERENCES

- Adeofun, C.A. (2011). "Human activities and natural disasters as major impediments to Sustainable development" being a paper delivered at the MCPD of Ogun state branch of Nigerian Institution of Estate Surveyors and Valuers (NIESV) at Abeokuta on 1st December 2011.
- Aderogba, K. (2012). "Substantive Causes and Effects of Floods in South Western Nigeria and Sustainable Development of the Cities and Towns". *Journal of Emerging Trends in Educational Research and Policy Studies (JETERAPS)* Vol. 3 No. 4 pp. 551-560.
- Akanni, O., and Bilesanmi, L. (2011). "Flood: Lagos Residents Forced to Relocate and Drowning Teenager Rescued". Published by Vanguard Media Limited Lagos. Friday, July10), pp 20.
- Bates, B.C., Z.W. Kundzewics, S. Wu, and J.P. Palutikof, (2008) "Climate Change and Water". Technical Paper of the Intergovernmental Panel on Climate Change. IPCC Secretariat, Geneva, Switzerland, pp. 210

- Eclipse Research Consultants (2010) "climate change, it is time to act-Adapting to the impact of climate change on buildings, neighbourhoods and cities a briefing guide for the North West", Prepared on behalf of CCI NW, Cambridge, March pp 1-35 available at <http://www.climatechangenorthwest.co.uk/> for the Northwest Climate Change Adaptation Group, Cambridge, March
- Environment Agency (2007) "Stepping stones; river flooding" No 1 in the series of educational fact sheet available at www.environmentagency.gov.uk
- Ezeabasili, A. C. C. and Okonkwo, A.U. (2013) "Climate Change Impacts on the Built Environment in Nigeria" African Research Review an International multi disciplinary Journal, Ethiopia Vol. 7 No. 4, Serial No. 31, September, pp. 288-303
- Halley (2001) "Impact of 1998 Flood Nutrition and Health. What can we learn from Future Disaster?" Dhaka: Helen Keller International, Bangladesh and Institute of Public Health Nutrition.
- Intergovernmental Panel on Climate Change (IPCC) (2012) "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" a Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change
- Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Z. Sen, and I.A. Mosha, A.C. (2011) "The effect of climate change on urban human settlements in Africa" in climate change and sustainable urban development in Africa and Asia. Springer; Netherlands pp.69-100
- New England Aquarium (2012) "Changing climate, changing coasts", a joint symposium on climate change and the marine environment organised by New England Aquarium and Woods Hole Oceanographic Institution, Boston.
- Ogbonna I.O. and Otegbulu A. (2014) "Valuers and security of investments in coastal/riverine areas in times of climate change" paper delivered at NIESV 44th national conference held at Uyo, AkwaIbom state on 25-29 March.
- Ojo, O. (2011) "Flooding , a major impediment to sustainable environment", being a paper delivered at the MCPD of Ogun state branch of Nigerian Institution of Estate Surveyors and Valuers (NIESV) at Abeokuta on 1ST December 2011.
- Olusina J.O. and Odumade O.M. (2012) "Modelling climatic variation parameters of Nigeria using the statistical downscaling approach" FIG Working Week 2012 TSO7F-Task force on surveyors and the climate change II,6099.
- Omisore E. O. (2011) 'Flooding , a major impediment to sustainable environment", being a paper delivered at the MCPD of Ogun state branch of Nigerian Institution of Estate Surveyors and Valuers (NIESV) at Abeokuta on 1ST December 2011
- Patunola-Ajayi, B.J. (2014) "Maritime, coastal and inland water investment and management in national development" paper delivered at NIESV 44th national conference held at Uyo, Akwa-Ibom state on 25-29 March.
- Satterthwaite, D., Huq, S., Pelling, M., Reid, H. and Patricia Romero Lankao, P.R. (2007) 'Adapting to Climate Change in Urban Areas The possibilities and constraints in low- and middle-income nations' Human Settlements Discussion Paper Series Theme: Climate Change and Cities-1 working paper produced by the Human Settlements Group

- Satterthwaite, D., (2008) "Climate Change and Urbanization: Effects and Implications for Urban Governance" Paper presented at the United Nations Expert Meeting on Population Distribution, Urbanization, Internal Migration and Development, New York, NY, 21-23 January 2008, United Nations Population Division, New York, NY, 29 pp., un.org/esa/population/meetings/EGM_PopDist/P16_Satterthwaite.pdf.
- Smith, K., and Ward, R. (1998) *Floods Physical Processes and Human Impacts*. John Wiley, Chichester, UK,.
- Taye, M.T., Ntegeka, V. Ogiramoi, N.P. and Willems, P. (2011) "Assessment of climate change impact on hydrological extremes in two source regions of the Nile River Basin". *Hydrology and Earth System Sciences*, Vol. 15 No. 1 pp. 209-222. UKCIP (2009) available at http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=54&Itemid=179
- United Nation Development Programme (2010) 'Climate change, an overview' available at <http://www.unep.org/climatechange/>
- Usman, B.A. and Tunde A.M. (2009) "Climate change and sustainable development in Nigeria planning for climate resilient cities" in *law and climate in Nigeria* edited by Egbewole W.O., Munthar, A.E. and Olugbenga A.O. University of Ilorin: Ilorin. Pp 107-121



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