

Flooding and Flood Risk Reduction in Nigeria: Cardinal Gaps

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Abstract

This study reflects on critical issue relating to flooding in Nigeria such as causes, impacts and remedies. Flooding which arguably has been more damaging for Nigeria has worsened recently due to a number of possible factors including rapid population growth, urbanization, poor urban planning and climate change especially in increased frequency and intensity of rainfall. Attempts to tackle the hazard in Nigeria appear to be limited by lack of flood data and other remote causes which are yet to be identified. In view of this background, the present study reviews the widespread flooding in Nigeria and efforts to tackle it. Over the period 1985 to 2014, flooding in Nigeria has affected more than 11 million lives with a total of 1100 deaths and property damage exceeding US\$17 billion. Lagos state has experienced most of the floods while more frequent floods are recorded in Niger, Adamawa, Oyo, Kano and Jigawa states possibly due to the influence of rivers Niger, Benue, Ogun and Hadeja. It is argued that more robust and scientific approaches to flood risk reduction such as: flood modeling and vulnerability assessment are lacking. To align the focus of flood risk reduction in Nigeria with the objectives of such a task in more developed countries (such as the United States, United Kingdom and the Netherlands) which is among three fundamental issues to be addressed in Nigeria, the present study makes pivotal recommendations.

Keywords: Flooding; Developing countries; Nigeria; Flood risk; Climate change; Flood modeling; Flood vulnerability assessment

Introduction

Arguably, the rate of flooding occurrence in recent times has been unprecedented. With 70 million people globally exposed to flooding every year, and more than 800 million living in flood prone areas [1], climate change with more frequent and severe rainfall events, sea level rise, rapid population growth and urbanization, the rate of development on floodplains, the level of awareness of flood risk and the ineffectiveness of efforts towards tackling flooding in many places are factors of concern within the global [2,3]. The economic consequences of flooding reported in the last two decades amount to tens of billions of US dollars [4]. Over 3700 flood disasters globally are recorded in the EM-DAT database, covering the period 1985 to 2014 [5]. These events were responsible for hundreds of thousands of deaths mainly in Asia (most notably China, Thailand and Bangladesh) and adversely affected billions of people mostly through homelessness, spread of diseases, physical injuries, mortality (mainly through drowning) and psychological conditions mainly depression, anxiety and post-traumatic stress [6-10]. In the US, 32.9% of the total natural disasters in 2012 were hydrological with floods accounting for the most part, affecting more than 9 million people and causing about US\$ 0.58 billion worth of damage [5]. The same source shows, for that year, more than US\$4.7 billion worth of damage recorded for Europe, and about US\$0.83 billion and US\$19.3 billion damage for Africa and Asia respectively resulting from flooding. Four different floods that hit cities in UK in 2012 caused a total loss of \$2.9 billion, with hundreds of people who were affected [4]. In many African countries for example Nigeria, flooding has impoverished hundreds of thousands of people through displacement from homes and loss of tangible properties [11].

In Nigeria, flooding and means of addressing its challenges are critical issues [12]. Evidently, the country has experienced devastating floods which affected millions people and caused fiscal losses amounting to billions of US dollars [13]. These hazards were generally linked to poor urban planning and climate change especially in increased frequency and intensity of rainfall [11,14-16]. The impacts of floods in

Nigeria include mortality, physical injuries, widespread infection and vector-borne diseases, social disorders, homelessness, food insecurity, economic losses (mainly through destruction of farmlands, social and urban infrastructure) and economic disruption (most notably in oil exploration in the Niger delta, traffic congestion in many cities in Nigeria, disruption in telecommunication and power supply) [17-19]. In 2012, Nigeria experienced the worst flooding in more than 40 years as a result of heavy rainfall that lasted for many days. The incidence affected 32 states with 24 considered severely affected [13]. The floods extended from July to October that year and affected 7.7 million people with more than 2 million others reckoned as internally displaced (IDPs). More than 5000 people were physically injured along with over 5900 houses which were destroyed.

Historically, flooding in Nigeria which dates back to the early 1950' are fluvial, coastal and pluvial in nature and have been a major cause of concern for rural areas and cities within the country [20,21]. Fluvial and coastal flooding both of which affected mainly coastal environments were influenced by seasonal interruption of major rivers and water overtopping their natural and artificial defences and overflowing areas not typically submerged [22]. Fluvial floods account for the majority of the flood threats experienced in locations along the plains adjoining major rivers in the country, including rivers Niger, Benue and Hadeja. The states in Nigeria mostly affected by such floods are Adamawa, Kano, Niger, Jigawa, Kaduna, Cross River and Kebbi [23,24]. The worst fluvial flood in Nigeria was the Kaduna flood

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disaster of 2006 which affected hundreds of thousands of human lives with economic loss worth millions of US dollars [25,26]. Coastal floods in Nigeria affect the low-lying areas in the southern part of the country (comprising for examples Lagos, Oyo, Ondo, Akwa-Ibom and Bayelsa states). The impacts of such floods have been severe due to the number of human populations exposed following the attractions of coastal areas for economic and social reasons [27]. Nigeria is globally ranked with the top 20 countries whose present population and future scenarios in the 2070s (including climate change and socio-economic factors) are exposed to coastal flooding [28].

Pluvial floods usually occur annually during rainy seasons (between July and October) and affect mainly the urban areas in Nigeria. Such floods which are arguably unprecedented in recent times are caused by more frequent and severe rainfall which overwhelms the efficiency of drainage systems and soil infiltration capacity [29,30]. The significance of urban areas in the economic and political development of Nigeria is generally acknowledged [31]. However, urbanization is a critical anthropogenic influence on climate change and hydrological cycle in the country given that much impervious surfaces increase surface water runoffs and reduce soil infiltration capacity [32-35]. Along with urbanization is the rapid population increase in many Nigerian cities which is also a global concern within the context of flooding in urban areas [36]. It is estimated that more than half of the world's population has been residing in cities since the last 6 years and by 2030 the number of people living in urban areas (with urban areas of developing countries (DCs) accounting for the most part) will grow to 5 billion (i.e. 60% of the world's population) [37-39]. Regrettably, a major challenge with rapid population growth and urbanization in Nigeria which also seems to influence the risk of flooding in the country both presently and in the future (if not addressed) has been poor urban planning (in particular inadequate drainage system and the range of poorly serviced urban utilities) [14]. The authors argue that urbanization in Nigeria has not to be accompanied by corresponding strategies to support humanitarian needs and anthropogenic activities. Apparently, this concern has not received adequate attention in the literature, especially with regards to the implications of future urban scenarios on environmental sustainability. Moreover, the reality of widespread flooding in Nigeria coupled with the notion that floods are inevitable phenomena which can never be fully constrained within the natural environment appears to overwhelm efforts towards finding a solution. Thus, it is rather easier to feel some developing attitudes of anticipating increasing human vulnerability within the country as the years succeed each other, and the authors perceive that *"there seems to be fear on the horizon"*.

However, various levels of government, the community and other stake holders have been active with measures to tackle flooding in Nigeria [40]. These measures have been criticized as ad-hoc, non-generalizable and not well established [12]. In the light of 'best practices' in flood risk reduction and 'lessons learned' from other countries' experiences of flooding, it can be argued that such stake holders' efforts are at best limited most probably due to lack of quality data, which among other things are needed to systematically tackle flooding, poor perception of flooding among the general public, lack of funds and improved technology as well as poor political will power. Best practices in flood risk reduction ideally is based on "living with floods and not fighting them" idea, which dominates key environmental risk research themes (for examples: Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA)) and integrates structural and nonstructural measures to reduce the impacts of flooding on social systems and to achieve key requirements in risk management which are prevention/

mitigation, preparedness, emergency response, recovery and lessons learned [41-47].

Arguably, given the growing number of flood victims and the constrained sustainable development caused by flooding within the country, researches into solutions to widespread flooding in Nigeria are weak towards flood risk reduction. Recent studies focus attention on the impacts of flooding and its remedies in local communities, geopolitical regions and various states within the country [27,48-52]. It is argued that a more comprehensive understanding of the widespread flooding in Nigeria requires wide ranging discussions and accounts which few studies presented [12,20,53-58]. The influence of climate change and anthropogenic activities, poor urban planning and environmental management on the widespread flooding in Nigerian cities has been extensively discussed [14,50,54,59]. While the lack of definite measures and capacity to radically address the challenges of flooding within the country has been arguably overwhelming, concerted efforts in the form of environmental and infrastructural planning, policy directives, social responses, physical intervention and enhanced public enlightenment programmes, vital to tackling the prevailing flood hazard in the country have been considered [20,21,24]. Other vital tools needed to address flooding in Nigeria are community based early warning systems [56], humanitarian aids from government and private sectors [54,60] and appropriate level of preparedness and capacity building [57]. The need for science and technology to embrace environmental education in Nigeria is posited [58]. In [27,48,61,62], flood hazard mapping and assessment of vulnerabilities of lives and properties to flooding are important procedures factors which play key roles towards building community resilience to flooding. Few studies considered modeling of flood by means of hydrodynamic, GIS, cellular automata and statistical techniques [63-72]. The importance of reinforcing present strength and capacities of all agencies, including local communities within Nigeria to deal with flood hazard situations underlined [12]. The study investigated existing institutional approaches that deal with flood challenges in Nigeria with a view to more efficient, robust and satisfactory flood intervention strategies in the country.

Although these studies explored flooding in Nigeria, still the question: "what is the remedy to the recurrent flooding in Nigeria?" remains unanswered. The lack of flood data and other ancillary data which is a major setback towards tackling flooding in Nigeria was not addressed. Attention has solely rested on general knowledge of the causes, impacts and remedies of flooding, suggesting that the general view of the situation in these studies has been lop-sided and sloppy. The need for more scientific approaches such a flood modeling which drives flood risk management in more developed countries was not highlighted. A general critique, which should provide a nuanced understanding of the strengths and limitations of present efforts to addressing the threats of flooding in the country, is lacking and gaps between increasing flood occurrences and vulnerabilities of local communities were not identified. It is well known that the success of flood risk reduction depends to a large extent on knowledge-based decision, robust institutional framework and flood risk communication [3,18] but these factors are missing in Nigeria and where they exist they are poorly addressed. Knowledge-based decision uses available information relating to flooding to draw conclusions on possible strategies to be adopted for tackling flooding. Flood risk communication aims at creating awareness of flooding and its impacts in stake holders and the general public. Institutional framework that tackles flooding in Nigeria refers to government response procedures which include policies, regulations, guidelines and agencies engaged in planning and managing flood emergency conditions or in helping victims to cope

with and recover speedily from extreme flooding events [12]. Many flood risk based studies argue that these requirements are fundamental to information relating to flood hazard and its consequences and may be sourced from public opinions, expert knowledge, research findings and flood risk/hazard maps of an area [73-75]. It has also been argued that various flood modelling approaches are pivotal components of flood risk reduction because they are capable of quick, continuous and routine simulation of flood data (most notably flood water depth, inundation extent and duration as well as water flow velocity) required for flood hazard / risk assessment [30,76,77].

Despite the lack of these critical data for tackling flooding in Nigeria, flood modelling is poorly carried out [69]. Although the acquisition of these datasets (particularly the flood risk/hazard maps) have been a daunting task for Nigeria as they require critical understanding of the drivers of flood hazard/risk. However, it is important to acknowledge the specific roles flood modelling can play in this regard and in general towards tackling flooding in Nigeria. Over the recent past and in many flood management policies such as the EU commission directive on flood, the United States flood control policy, national flood insurance program (NFIP) and other regionally-based flood risk management policies, the relevance and provision of flood data highlight the significance of flood modeling [30,45]. For Nigeria, besides the general roles of flood modelling, the technique can assist in provision of critical information for strategic planning and effective flood risk management within the country. It will equally drive an improved understanding of flood phenomena and prompt improvements into more robust flood management approaches such as flood forecasting, flood early warning system and flood damage estimation.

This need for flood modelling was emphasized by the DG of Nigerian Hydrological Services Agency [78] in a recent mission statement:

“...in view of flooding in Nigeria, governments at all levels should create awareness on the need for communities to relocate to safer terrain. Moreover, while the current trends in climate variations prevail, the need to develop flood modeling and early warning systems cannot be overemphasized... There is also need to carry out a comprehensive flood hazard mapping for all areas considered at risk of flooding in the country...”

It is argued that whilst this statement recognizes flooding situation in Nigeria and the relevance of flood data for flood risk reduction, it laments the dearth of flood data for the country and the peculiar challenges that arise from utilizing commercial flood modelling codes to simulate such data. Moreover, the fact that Nigeria is one of the most populated countries of the world with population size estimated at over 170 million people compounds the situation [79]. The theory that future population growth will drive future flood risk highlights the importance of urgency in finding means of preparing human population in the country to adapt to floods. It will be a welcome development for Nigeria to implement flood modelling since within European Union framework, such a technique is operationalized towards flood hazard/risk mapping of the constituting States [73]. In the Netherlands and the US, flood modeling, among other roles, supports investigation into estimation of damage caused by flooding [80-83]. Many Asian countries, notably China, Vietnam and Bangladesh although having ‘not too well’ established flood management systems and methodologies utilize flood modeling methodologies for flood risk assessment and mitigation [38,84].

Thus, to assist human populations towards adapting to flooding and

to support stake holders’ efforts towards tackling flooding in Nigeria, the present study is an attempt to bridge several gaps in flood risk reduction in Nigeria. The authors synthesized and analyzed relevant literature and available historical flood data spanning the period 1985 to 2014, to identify these gaps and to make relevant recommendations towards building flood resilient communities and more effective remedies to the threats of flooding. It is argued that promoting flood modelling in Nigeria will underpin current efforts at tackling the hazard.

This study in general and the recommendations in particular are driven by three key issues, which are: firstly, to demonstrate the roles more robust and scientific techniques such as flood modeling can play in flood risk reduction within the context of Nigeria, secondly, to align the focus of flood risk reduction in Nigeria with the objectives of such a task in more developed countries such as the US, the Netherlands and United Kingdom, and finally, to promote flood risk awareness in the general public as well as to delineate safer terrains for relocation of human populations during flooding in Nigeria.

The methodology and data for the research are discussed in section 2 while the study area is described in section 3. Section 4, the result, discusses efforts towards tackling flooding in Nigeria and cardinal gaps which have been identified to undermine such efforts. Recommendations relevant to strengthening present efforts of tackling flooding in the study area are presented in section 5. Section 6 gives a general conclusion of the paper.

Method and Data

A search process to identify the body of literature relevant to flooding and efforts towards addressing its threats in Nigeria was undertaken. Combination of terms such as “flooding and management in Nigeria”, “flooding and human health in Nigeria”, “flooding and modeling in Nigeria” and “flooding and climate change in Nigeria” was applicable to the search. Overall, 429 publications were identified of which 17 focused on the causes of flooding in Nigeria, 132 addressed the impacts, 181 discussed the remedies, 54 looked at climate change issues, 14 discussed public perception of flooding while 31 addressed urban management and planning (Table 1). The scientific quality of these papers was assessed based on the publishing journal. This is consistent with academic standard and regulations. Although locally published articles provided most of the information to establish the case in the present study, however, the greater weight was given to articles published by Elsevier, Science Direct, Taylor and Francis, Wiley and sons, ASCE, Nature, Sage, Springer and Copernicus publishers and on International conferences. The data that provided much of the evidence regarding the prevalence of flooding in Nigeria was sourced mainly from EM-DAT database and Nigerian ministry of Environment. These findings are fundamental to discussions presented in this study.

S. No.	Issues relating to flooding in Nigeria	Literature search
1.	Flooding causes – causes	17
2.	Flooding – impacts	132
3.	Climate change issues	54
4.	Mitigation activities	181
5.	Public perception	14
6.	Urban planning and management	31

Table 1: The results of literature search of issues relating to flooding in Nigeria. From these results, whilst remedies have received ample attention, improving public perception of flooding is poorly addressed. This is a reason for concern knowing that the success of present approaches of flood risk reduction depends on public participation which is driven by public perception of flooding.

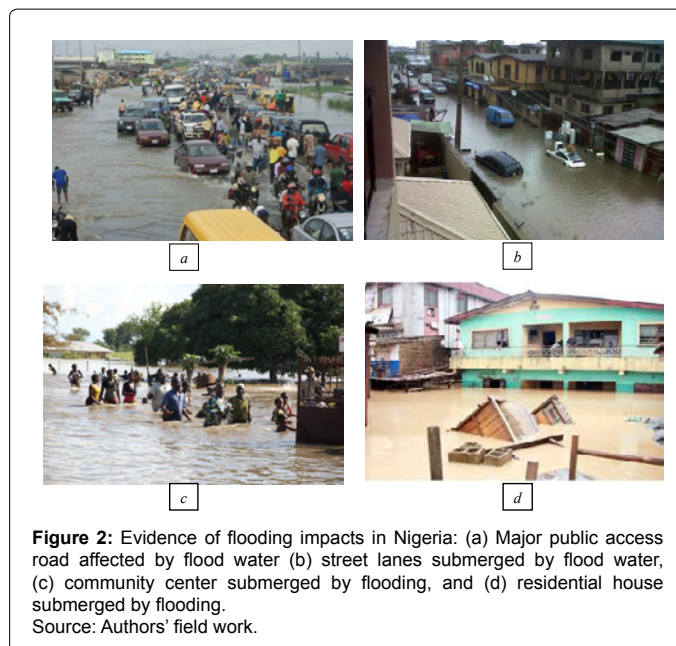
Description of the study area

Nigeria, a sub-Saharan West African country, is on the Gulf of Guinea, east of the Greenwich and north of the equator. The country, made up of 36 states including the federal capital territory (FCT), Abuja, lies between latitudes 4° and 14°N, and longitudes 2° and 15°E, with a total land area of 923,768 km² (Figure 1), and borders with Republics of Benin and Niger, Chad, and Cameroon. It maintains a large expanse of coastline, over 853 km in magnitude, with hydrological features which includes the rivers Niger and Benue, both of which confluence at Lokoja, and flows further southwards passing through the Niger Delta to empty into the Atlantic ocean.

The 2006 census confirmed over 140 million people in Nigeria, but this population has grown steadily, and is presently estimated at more than 170 million people, making the country the seventh most populous country in the world [12,85]. According to United Nations projections, Nigeria is one of the eight countries expected to account collectively for half of the total population increase in the world from 2005-2050, and will by 2100, record a population amounting between 505 million and 1.03 billion people [86].

Result and Discussion

First and foremost, the present study argues that the impacts of flooding in Nigeria continue to trigger concerns for food security, vulnerability of the general public and local communities within the country, humanitarian needs and services, primary health delivery, environmental management, solid waste management, urban development, professionalism in journalism practice and the dynamism or lethargy of Nigerian democracy and political system [12,21,27,60,87-89]. Whilst investigating these factors vis-à-vis flood risk reduction in Nigeria is vital, key features of flooding which influence its level of impacts in the country include flood water depth, inundation extent and duration as well as velocity of flood flow. Respectively, flood width, height, annual frequency and duration in Nigeria can measure up to

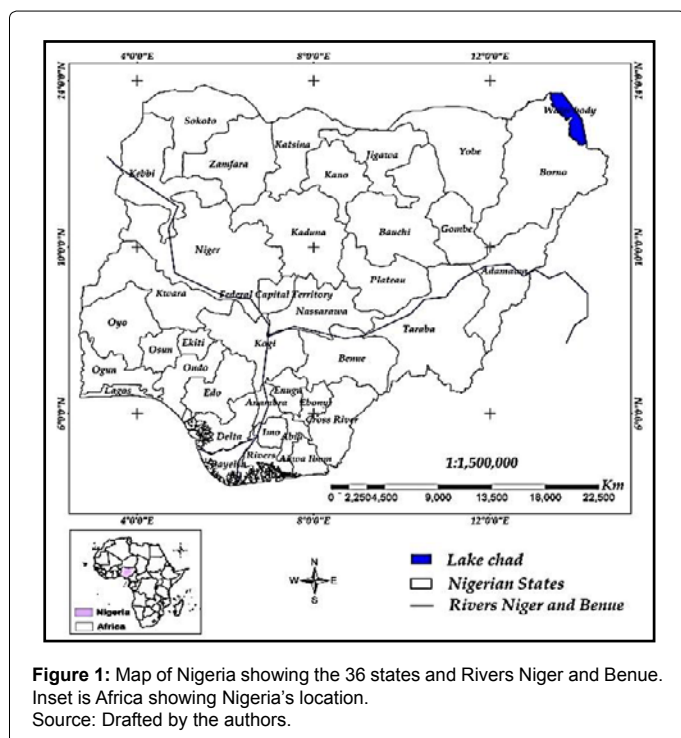


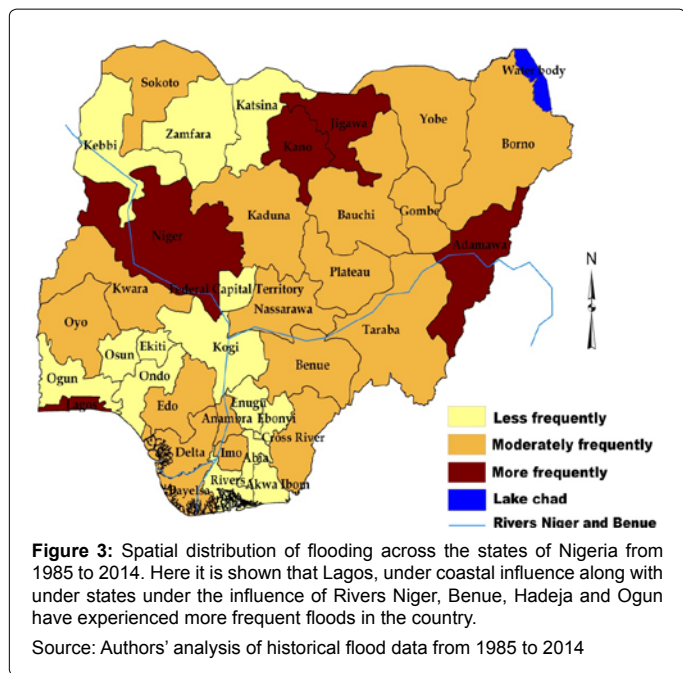
700 m, 11 m, 10 and 25 days respectively [53]. It is shown from EM-DAT database that most floods in Nigeria lasted up to 79 days. Thus based on these characteristics, the dangers posed to human lives and properties by flooding in Nigeria can be appreciated (Figure 2).

Paradoxically, relevant flood data which reveal widespread flood threats in Nigeria and how the situation differs from other places are lacking. Arguably, such dearth of flood data not only constrains investigations into gaining a better understanding of the spatial and temporal distribution of flooding across the states of Nigeria, but it also undermines efforts towards tackling the hazard. Although there is a large body of literature that highlights the gravity of flooding situation in the country, inconsistency of flood narratives in Nigeria has been overwhelming [59,90]. Undoubtedly, this inconsistency of flood narratives will undermine the general flood awareness which underpins more proactive ways of tackling the hazard in Nigeria. However, based on flood data from EM-DAT, CRED and Dartmouth Flood Observatory (DFO) databases, present investigations (which extend studies by [12,24,25,54,91]) relating to flood threats in Nigeria have been made.

Based on data on historical flooding in Nigeria from 1985 till 2014, the present study reveals that flooding is a common phenomenon for various states in Nigeria. Although Lagos state appears to have experienced most of the floods in the country, more frequent flooding are recorded in Niger, Adamawa, Kano, Oyo and Jigawa states. Whilst Lagos state flooding can be attributed to urban growth and coastal influence among other key factors, the influence of rivers such as Niger, Benue, Ogun and Hadeja may account for the rest of the states with more frequent floods (Figures 3 and 4).

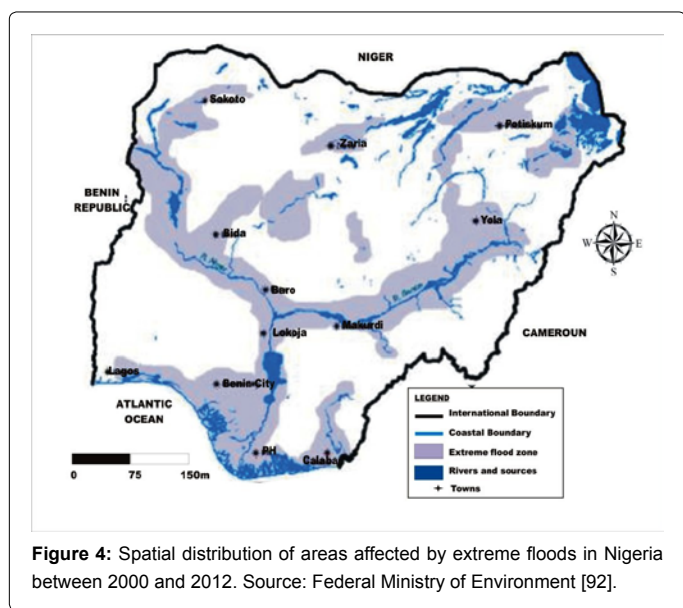
To understand where Nigeria stands in global and regional perspective since 1985, the 2012 flooding in Nigeria reputed as the worst in 40 years is compared with the most devastating floods in the world between 1985 and 2014. The result of this comparison shows that within the period under consideration, Nigeria may be ranked as third in the world, following peoples Republic of China and Soviet Union (Table 2). In Africa, the study shows that the country ranks topmost





S.No.	Country	Year	Mortality	Economic loss (billion US\$)	Affected Human Population (millions)
1.	Soviet Union	1991	N/A	60	0.04
2.	China	1998	3656	20	240
3.	Nigeria	2012	363	16.9	7.7
4.	Korea (P Dem Rep)	1998	405	15	5.2
5.	United States	1993	50	15	N/A
6.	Russia	2002	167	0.9	0.3
7.	Italy	1994	N/A	6	N/A
8.	Poland	1997	N/A	4.3	0.24
9.	United Kingdom	2007	30000	3.2	N/A
10.	Ecuador	2008	N/A	1	0.289
11.	Bangladesh	1998	3836	2	30
12.	Netherland	1998	N/A	5.3	0.02
13.	Argentina	1985	N/A	1.3	1
14.	Vietnam	1999	702	0.78	1.7
15.	Philippines	2012	1268	2.19	0.45
16.	Pakistan	1993	3084	1	6.184
17.	Afghanistan	1992	3000	N/A	N/A
18.	Colombia	2011	450	1.2	4.98
19.	Nepal	1993	1048	N/A	0.53
20.	Brazil	2008	246+	0.75	1.5

Table 2: 20 most devastating floods in the world between 1985 and 2014. Source: Compiled by authors



S/No	Country	Year	Mortality	Economic loss (billion US\$)	Affected Human Population (millions)
1.	Nigeria	2012	363	16.9	7.7
2.	Algeria	2001	921	0.3	0.045
3.	Mozambique	2000	800	0.419	4.5
4.	Ethiopia	2006	705	0.32	N/A
5.	South Africa	1987	506	0.765	0.065
6.	Burkina-Faso	2009	N/A	0.15	0.15
7.	Malawi	1991	472	0.024	0.15
8.	Kenya	2006	114	N/A	0.723
9.	Egypt	1994	600	0.14	0.16
10.	Sudan	2007	N/A	0.3	0.56

Table 3: 10 most devastating floods in Africa since 1985. Source: Compiled by authors

(Table 3), overtaking Mozambique and Algeria in terms of economic loss. This reality highlights the need for more proactive efforts towards tackling flooding in the country [92].

Apart from China which presently reputed as the most flood prone country in the world, characterized by recurrent perennial floods due to among other things, the influence of population growth and mainly the River Yangtze [93]. The fact that other countries with known extreme flooding experience (for examples: Netherlands, the US, Brazil, United Kingdom and many other European countries) may be ranked below Nigeria in terms of devastating floods within the period considered suggest among other things the significance of flood risk reduction measures which are presently in place in those countries.

The Netherlands with more than half of the country at or below sea level experienced a severe flood in 1953 that devastated majority of

the nation's economic and human infrastructure. The estimated impact of the flood was 1835 deaths and 1 billion Dutch guilders (US\$ 558 million). That flood challenged various stake holders, particularly the general public and local communities and Dutch government towards more effective strategies of mitigating the threats of flooding. The reduced impacts of flooding in the country in recent times validates these efforts. Similarly, recent floods in the US have lesser impacts compared to the flood of 1972 which caused 238 deaths, 357 injuries and destroyed about 1335 homes with estimated fiscal loss of over 800 million US\$. In the UK, although there have been devastating recent floods, the 1947 floods were considered the worst in recent history with overall impact estimated at about £4.5 million (USD\$ 6.81 million) at current value, with millions of displaced human populations, farm animals and agricultural products [94]. For Brazil, the floods of 2010 have reduced impacts compared to the floods of 1967 which was considered the deadliest in the country's history, claiming about 610 lives with economic loss amounting to about US\$ 1.2.

Efforts towards tackling flooding in Nigeria

The threats of flooding in Nigeria have been tackled through a

number of specific and general actions including physical intervention, legislation and policy formulation, creation of awareness of flooding, urban renewal and development, engineering structures such as dams, bridges and drainage systems, relocation of human populations during flooding and assisting flood victims with basic humanitarian needs [40,78,95]. To simplify discussion regarding these efforts, the present study simplifies and groups these actions into institutional approach, actions by local communities and the general public, action by humanitarian agencies and actions by research institutions and the media.

Institutional Approach

Institutional approach towards addressing the threats of flooding in Nigeria dates back to the early 1960's with the establishment of federal and state ministries of works [96]. However, the increasing frequency and severity of floods across the country prompted the establishing of the Federal Environmental Protection Agency (FEPA) as a unit in the Federal Ministry of Works and Housing in 1988 [26] and the Federal Ministry of Environment (FME) in 1999 [92]. Among other things, the key roles of FME towards flooding risk reduction in Nigeria is to assess the flooding potentials as well as design, determine, develop and/or authorize the development of appropriate flood reduction measures for the country [92].

With the FME comes various ministries and agencies for tackling flooding in Nigeria which include: Federal Emergency Management Agency (FEMA), National Emergency Management Agency (NEMA), State Emergency Management Agency (SEMA), Local Emergency Management Agency (LEMA), National Orientation Agency (NOA), National Commission for Refugees (NCR), National Environmental Standards and Regulations Enforcement Agency (NESREA) which by 2009 Nigerian Acts supersedes the FEPA, Nigerian Meteorological Agency (NIMET), Nigeria Hydrological Services Agency (NIHSA), NEST (Nigeria Environmental Study/Action Team) and Building Nigeria's Response to Climate Change (BNRCC).

NEMA is basically a coordinating body for disaster management in Nigeria. Actions towards addressing the threats of flooding which the agency coordinates include but not limited to policy formulation, leasing with and assessing the state of preparedness of all other relevant agencies, data collation from relevant agencies, education of the general public on flooding and interaction with SEMA towards the distribution of relief materials to disaster victims within states and local government areas. Recently, a memorandum of understanding was signed with NESREA and NOA to intensify efforts towards flood risk management in Nigeria [13].

The protection and development of the environment, a measure that helps keep check flooding, is the key role of NESREA, the agency which enforces all environmental laws, guidelines, policies, standards and regulations in Nigeria, as well as enforcing compliance with provisions of international agreements, protocols, conventions and treaties on the environment to which Nigeria is a signatory.

Whilst the provision of humanitarian needs such as shelter, clothing and floods for internally displaced persons is anchored by NCR, the importance of local communities being aware of flooding and actively participating in discussions and decisions which might increase their resilience and adaptability to the hazard highlights in the roles of NOA, which re-orientates and keeps Nigerians informed about ways of taking part in issue that affects them. The poor perception of flooding in the country should be the concern of this agency.

NIHSA provides reliable and high quality hydrological and hydrogeological data on a continuous basis for the for the purposes of assessing the status and trends of the nation's water resources including its location in time and space, extent, dependability, quality and the possibilities of its utilization and control. Since 2013, the agency has been creating awareness of flooding through the "flood outlook" initiative. Other activities of NIHSA include; provision professional advice to various levels of government in Nigeria on all aspects of hydrology, collaborates with NIMET to issue flood forecast and contributes towards creating awareness of flooding among local communities. NIMET furnishes the country with weather report, and other meteorological information, issues alerts and early warning and forecast on impending flood disasters within the country.

Issues relating to flood insurance are coordinated by FEMA, the agency which makes federally funded insurance protection policy available for property owners in Nigeria. Policies relating to assisting flood victim at state and local government levels are coordinated by SEMA and LEMA. As climate change is complicit with other factors that influence flooding in Nigeria, BNRCC's key role is to collaborate with other agencies to promote the capacities of the generality of human populations within the country to cope with all effects of climate change. NEST undertakes continuous research required for enhancing decisions and robust measures towards addressing flooding in Nigeria [97,98].

Action by local communities and the general public

The peculiar attitude of Nigerians towards issues they probably have no solution to is to find a possible natural means to adapt. Although such attitude has cost many lives and properties, however, it is arguably a significant potential for Nigerians and has severally favored them in emergency situations. Families in Nigeria co-habit and this offers a comparative advantage in the event of flood disasters. In many flooding incidences in Nigerian cities, the general public has often offered assistance to victims, assisted in evacuation of those displaced and in protecting property from further damage. Many IDPs easily find shelter and other humanitarian needs from families and friends while awaiting intervention by authorities. Although anti-social behavior, such as looting and sexual harassment of some of the internally displaced victims often arise, however the civilized attitudes of the general public, which may be comparable to those in the developed world such as the US following the hurricane Katrina of 2005 [99] has been commendable.

Action by humanitarian agencies

Humanitarian response to flooding in Nigeria dates back to the early 1980s following the Ogunpa, Sokoto-Rima, Banguada flood disasters [100]. Almost in all cases of flooding in Nigeria victims have received humanitarian supports with most notably the International Federation of Red Cross (IFRC), United Nations, World Bank, Foreign countries including UK, the United States, China, Japan, France as well as religious organizations including the Catholic, Anglican and Pentecostal churches and missionary societies. Although this study has not provided an empirical evidence of supports received so far in view of flooding in Nigeria, recent records by OCHA [60] indicate that such supports have been considerable. The 2012 flooding saw humanitarian response amounting to over US\$70 million [60]. These supports which seem to indicate solidarity for Nigeria as a whole and the people affected by flooding within the country in particular have been evidently considerable.

Action by research and the media

Arguably, much of what is known about flooding in Nigeria can be attributed to efforts by research and media. In the literature, undoubtedly, considerable attention has been given to flooding in Nigeria. Presently there are more than five hundred publications indexed in the Google scholar that relates to flooding and means of tackling it in Nigeria. In addition, the country has a number of country-wide research-based groups such as the NEST (Nigeria Environmental Study/Action Team), BNRCC (Building Nigeria's Response to Climate Change) and university-based research groups that focus on flooding within Nigeria. Similarly, the Nigerian media has been given the credit of providing qualitative information regarding the widespread flooding in Nigeria [59].

Gaps in Flood Risk Reduction in Nigeria

The fundamental idea of flood risk reduction is to build the resilience of human populations to flooding [44]. In the US, UK and Netherland, it can be argued that this idea is underpinned by much profound measures for tackling flooding. For Nigeria, there are potential efforts for tackling flooding but in the light of best practices in flood risk reduction, there are gaps and limitations which the present study identifies and discusses as follows:

Poor attention to flood modelling and assessment of vulnerability to flooding

The crucial gap in flood risk reduction in Nigeria is poor attention to flood modelling and assessment of vulnerability to flooding. The present study has shown that flood risk reduction under the idea of living with floods integrates structural and nonstructural approaches which are underpinned by flood modelling. Flood data is fundamental to tackling flooding in Nigeria, but the dearth of such data is overwhelming. Similarly, assessment of vulnerability to flooding aides the understanding of variations in human sensitivities, exposures and lack of capacities to cope with floods. These approaches are poorly considered in efforts at tackling flooding in Nigerian.

Weak institutional framework

Despite the seeming organized nature of Nigeria's institutional approach to flood risk reduction, the approach has been acutely flawed [12,24,97]. Although key roles within the approach has consisted of facilitating the evacuation of victims affected by floods and providing them with urgent humanitarian needs, the level of dissatisfaction and agitations from large numbers of the flood victims, especially the IDPs, queries the effectiveness of institutional approach in Nigeria. Although it is unjustifiable to claim that the weakness of this institutional approach in Nigeria probably leads to more frequent flooding in the country, however, it can be argued that whilst that such measures have not improved the country with regards to the idea of "living with floods" is clearly acknowledged [27,35,98].

Arguably, institutional framework with a complex chain of action which characterizes Nigeria is not ideal for a country with urgent needs to address the threats of flooding. The widespread flooding in Nigeria requires less complex framework with reduced chain of action and increased authority and responsibilities towards flooding and ways of managing its threats, as is the case in the United States, UK and Netherlands where a centralized authority such as FEMA, Environment Agency (EA) and *Rijkswaterstaat* respectively operates within the framework of institutional approach with more abundant resources towards addressing the challenges of flood risk.

Poor human responsibility

The vulnerabilities of local communities to flooding in Nigeria may indicate among other factors an overwhelming level of irresponsibility towards flooding and ways of addressing its challenges. Although a number of actions by the people towards flooding is commendable, some actions which characterize a cross section of Nigerian such as the failure to comply with environmental laws and regulations and to adhere to weather warnings and alerts are possible situations where lack of responsibilities of the general public is highlighted [53]. Poor perception of flooding among local communities is a major issue which underscores the current activities of NOA within Nigerian institutional framework [18,62]. The indifference towards research questionnaires and surveys most likely constrain research effort at tackling flooding in Nigeria. In Nigeria there seems to be a gap between efforts by the government and activities by the people such that it appears difficult to know the peoples' responsibilities towards addressing the challenges of flooding. The government claims the people are sabotaging its efforts. Whilst this claim is hard to substantiate, the attitude of a considerable population of Nigeria towards environmental management, regulations and rules in the country shows irresponsibility towards the threats of flooding.

Lack of detailed plan

We argue that the lack of detailed plan and strategy for disbursing funds and inaccurate information relating to those who have been affected by flooding most probably undermine humanitarian support in Nigeria. The disbursement of these funds and relief materials, although unjustifiable to argue that it highlights the level of corruption and financial mismanagement in Nigeria has been argued to indicate the weakness of institutional framework within the country [12]. Humanitarian actions in Nigeria are generally for post-disaster and emergency situations suggesting some limitation based on what can be achieved through financial support. Given that most local communities in Nigeria consist of poor human populations, it is arguably a top-bottom approach to concentrate humanitarian supports in the event of crises rather than prioritizing improving the living condition of these people which will not only ultimately reduce their chances of being vulnerable to flooding and assist in minimizing financial mismanagement, but also it will boost the credence of humanitarian supports towards natural disasters in general and flooding in particular in Nigeria.

Insufficient research and Skewed focus of local education and publications

Considering what has been done globally in research (mostly in China, India, UK, the US, Bangladesh and Netherlands) the specific situation of Nigeria regarding research in terms of flooding is arguably weak. The study of science and technology in Nigeria are yet to embrace environmental education and this has been identified [58]. Whilst flooding and climate change are passive subjects in education curriculum of studies in Nigerian schools, current key issues in flood research such as flood modeling, uncertainty analyses, early warning systems and flood forecasting, vulnerability assessment and climate change models are lacking in the country. From the literature search conducted in this study, it is clear that perception of flooding in Nigeria has only received little attention, and this seems to undermine possible efforts as assessing the level of perception and public awareness of flooding in Nigeria. A number of researches relating to flooding in Nigeria seem to recycle issues that are well known such as causes and

impacts of flooding. More scientific investigations are few probably due to lack of funds and the indifference of political leaders.

Poor media reporting

The inconsistency in media reporting in Nigeria which was identified in [90] highlights some disconnect between the media and agencies tackling flooding in the country particularly the NEMA. The standard of media reporting in Nigeria following recent flood incidences has been very poor. This is compounded by the irregular power supply in the country which overwhelms the chances to take advantage of information gadgets such as radio and TV. A large number of the population seems to rely on Facebook pages, which also has its own challenges based on internet accessibility. This situation seems to have caused a general lack of confidence in the media generally such that a growing parlance among researchers in recent times regarding flooding is “of what relevance is what the media have to say?” Whilst this situation undermines the professionalism in Nigerian media industries in particular, a key question that lingers with regards to widespread flooding in the country is “how would the media industry contribute to addressing the challenges of flooding Nigeria?”

It is possible political factors and market competition to a large extent influence media reporting, but it also appears the importance of piloting the perception and awareness of flooding in the general public and local communities as well as sensitizing them on issues relating to flood alerts and early warning has been compromised.

Recommendations

Based on the findings of this study, lessons learned from other countries' experiences of flooding and “best practices” in flood risk reduction [100,101], the authors argue that the following key issues are fundamental to the success of efforts towards addressing the challenges of flooding in Nigeria. Firstly, the understanding and demonstration of the roles more scientific approaches such as flood modeling, can play in flood risk reduction within the context of Nigeria. Secondly, the need to align the focus of flood risk reduction in Nigeria to the objectives of such task in more developed countries such as the US, UK and the Netherlands, and thirdly, the need to promote awareness of flooding among local communities and the general public and to delineate more suitable locations for relocation of human populations during flooding events. For this reasons, the study makes the following recommendations:

1. Following the European Union framework, which requires all constituting States to prepare flood hazard/risk maps [102], a strong legislation that requires each state of Nigeria to produce a flood hazard/risk map, is recommended for Nigeria. This will to a large extent strengthen existing institutional framework and stimulate increased responsibility towards flood risk reduction among the states in the country.

2. The Environment Agency in United Kingdom is adequately empowered to coordinate, among other things, research which drives current approaches of addressing the challenges of flooding [83]. Thus, it is recommended that Nigeria's NEMA be reviewed in terms of its research activities, how relevant they have been and how they can be further strengthened to promote more scientific researches towards ways of addressing the challenges of floods and other environmental challenges in Nigeria.

3. The importance of a centralized institution having all the powers and resources to manage the challenges of flooding

highlights the success of flood risk reduction in the Netherlands, the US and UK [103]. The roles of NEMA in Nigeria are acknowledged, but improvement is required. Lack of adequate resources especially accurate data clearly undermines the effectiveness of the agency in disaster management. Thus, we recommend improvement in resources allocation to NEMA, but also acquisition of data should be the agencies top priority.

4. Hurricane Katrina, among other major disasters in the US showed the unique roles of security personnel in managing emergencies and securing victims of disasters. In Nigeria, the victims of flooding live in apprehension of theft and sexual abuse. These dimensions which if addressed can restrict the impacts of flooding on human populations, are often overlooked by security personnel in the course of duty. For this reason, we recommend training for rescue and evacuation operations during for the civil defense corps and other military and paramilitary personnel, including the police, immigration and road safety commission.

5. Flood risk reduction under the “living with floods” idea is multi-disciplinary indicating that various industries can assist in reducing the impacts of flooding. In UK, evidences of collaboration from various companies and institutions towards addressing flood challenges are undisputable [83,101,103]. Thus, the need for multinationals and banking industries in Nigeria to sponsor research and promote sustainable development within Nigerian cities, as well as augment humanitarian supports to improve the living standards of local communities whilst reducing their vulnerabilities and building their resilience is should not be ignored.

6. Flood insurance is a non-structural approach which many property owners have benefitted from in developed countries following flood disasters. To support the roles of flood insurance in Nigeria, it is recommended that the role of FEMA in this regard should be extended to states and whilst encouraging insurance companies to commence sensitization exercises for properties owners to take positive step in this direction.

7. Enforcement of environmental standard and laws is often a key factor towards containing adverse effects of climate change including flooding. Indiscriminate waste disposal, production of Carbon monoxide, construction along flood plain, felling of trees and indiscriminate car parking, among other anthropogenic activities which influence flooding in Nigeria are illegal. In view of addressing these matters, NESREA should embark on arrest, prosecution and proportionately fine Nigerian who violate these rules.

8. The flooding of 1953 is historic in the Netherlands, which with its half at or below sea level is reputed as the top in the world in terms of flood management [81]. Such activities in the Netherlands described as imperfect but pragmatic is built on a strong commitment to resist any attempt of a repeat of history. The people are committed, and so is the government implying that collective efforts underlie success towards addressing the challenges of flooding. The old English adage “*God created the world, but the Dutch created Netherlands*” is often used to highlight the commitment and responsibilities of people in the Netherlands towards flooding and its challenges. It is claimed that flood defense in the Netherlands cost each person a few hundred Euros each year and the people rarely flinched at the responsibility [81]. The high level of adherence to regulations and rules shown by British citizens is highlighted in the conservation of nature and high environmental standards within the country. Such positive attitude is also exhibited towards weather reports, disaster warning and alerts

informing a significant level preparedness which appears to influence reduced damage following flooding event. Against this background, Nigerians need to know that the role of protecting the country is a collective one. Thus a change of attitude towards flooding its management in which the people should participate in matters relating to flooding which most largely affects their lives. This can be done by asking relevant questions, seeking to know and willing to adapt to individual actions which can potentially influence flood risk reduction within the country. Individuals in politics should ensure that laws which underlie the enforcement of environmental standards and regulations are made. Equally, the general public and local communities in Nigeria should support research through positive and accurate responses to questionnaire and surveys.

9. Arguably, it appears research globally is proportional to success towards tackling flooding. From a routine Google scholar search, literature relating to flooding in Nigeria appears insignificant compared to those of the US, Netherlands, UK, etc. This is a strong pointer and indicator that more research is required for the country. Equally, the universities and research agencies should be empowered to include in their curriculum studies and programmes tailored towards improving flood awareness and management. Flood alert and flood early warning systems should be introduced and utilized at all levels of flood disaster management. More research should be directed towards developing bespoke hydrologic and hydraulic flood models for simulating flood hazard and other hydrological parameters in Nigeria.

The government should play more active parts in this regards. Research is capital intensive and many Universities and research agencies are constrained by this factor. Indeed, many universities have benefitted from the Tertiary Education Intervention (TETFUND). However, due to limited funds available, accessibility by a number of academics has been poor. Thus we recommend improvement on funding and acquisition of high accuracy input data like LiDAR (Light Detection and Ranging) and SAR (Synthetic Aperture Radar) for flood modeling within the country.

Conclusion

Flooding has been devastating for Nigeria with large scale threats on people, critical infrastructure and economic activities. The hazard which has been generally linked to climate change and poor urban planning has received the attention of government at all levels, local communities, humanitarian agencies and research. However, efforts so far at tackling the hazard seem limited mostly due to lack of data relating to flooding and other factors which are yet to be identified. Although flood hazard is widespread in the country, its knowledge in the wider population is poor.

To attempt towards solving the challenges of flooding in Nigeria, the present study reviews flooding and ongoing efforts at tackling the hazard in the country over a period 1985 till 2014, the present study reveals considerable impacts of flooding, arguing that such impacts have not been accompanied by corresponding efforts to address them. A number of limitations and gaps which needs to be addressed were identified with those ongoing efforts and they include poor attention to flood modelling and assessment of vulnerability to flooding, weak institutional framework, poor human responsibility, etc.

It is argued that flood modeling and vulnerability assessment, have both been relevant to all aspects of flood risk reduction [39,104], as they provide information about flooding and also serves as the bases for evaluating the susceptibilities of social systems to the hazard. Efforts

towards addressing the challenges of flooding in most places for example the US and Europe include these more robust operations to achieve the three-tier risk management cycle, which includes mitigation/prevention, preparedness, response and recovery. Unfortunately, the implementation of these operations in Nigeria has been inadequate.

Across the world, there are many predictions of the worsened threat of flooding in the future, which in turn is stimulating research into finding solutions. There seems to be some increased interest in preparing for future uncertainties with regards to exposure and vulnerabilities of social systems flood risks. For example in Europe, the EU adopted a directive in 2007 which requires all member States to carry out flood hazard and risk mapping in their territory, in order to support the transition from traditional flood defense strategies to a flood risk management approach at the basin scale [76]. In the US, despite the high level of flood events, based on available records, it can be argued that the country seems to have contained the degree of impacts on social systems at least for the present [4]. This may be as a result of various on-going initiatives especially in flood modeling (for example: HEC-1, HEC-RAS, and HEC-HMS). Given the proliferation of models existing at present for simulating flood hazard along with recent development in remote sensing and computer technology, it is now possible to undertake flood forecasting and flood early warning systems in many places [105].

However, looking at these developments vis-à-vis Nigeria, one wonders and asks "how prepared are the government and the people in this present and future fight against flooding?" If perhaps the situation with Nigeria is that of unpreparedness and limitations with regards to addressing the threats of flooding, then much apprehension should abound bearing in mind that the country has one of the fastest growing urban areas and population density in the world [9], and knowing that the risks of flooding will capitalize on those factors leaves more to be desired. It is not productive to attribute blame as to why flooding occurs, yet responsibility is required to mitigate the extent of damage and disruptions to economic activities. It is in view of this responsibility, which is often defined by awareness, and positive action that the present study has made a number of recommendations hoping that Nigeria will join her counterparts in various parts of the world to become more proactive in finding lasting solutions to the threats of flooding.

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