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Flooding Conceptual Review: Sustainability-Focalized Best Practices in Nigeria

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Abstract: Nigeria's 196 million people is the third fastest growing population in the world; the interactions of this build up has left an indelible mark on the landscape and environment. Urbanization, deforestation, flooding, desertification, over population and all levels of pollution are resultant effects of this interaction with the environment. These changes directly relate to a seemingly endless desire for food, shelter, recreation and infrastructural facilities and urbanization in general. This has placed enormous pressure on ecosystem stability and environmentally sound living conditions. Flooding has become an annual event for Nigerian cities—where it consistently causes economic problems in the rainy season. Effort made by the government and residents to forestall this problem has produced sub-optimal results. There is a need to adopt more proactive, standard and reliable procedures that can offer sustainable outcomes and restore the socioeconomic growth of urban areas. Frequency of flooding is due to a number of factors relating to differing climatological patterns of precipitation, urban growth and increase in paved surfaces. The aim of this review is to utilize a conceptual framework to assess and identify areas within Nigeria prone to flooding and examine possible means of alleviating damage and harm.

Keywords: flood risk awareness; disaster mitigation; preparedness; environmental sustainability; Nigeria

1. Introduction

Flooding is one of the most common natural environmental hazards in the developing world. In Nigeria, a wide range of natural and human induced flood events, often relating to communal violence, continues to force displacement and fatalities [1]. Flooding is a general temporal state of partial or fully submersed inundation from overflows of inland or tidal waters or from infrequent and rapid accumulation of runoff [2,3]. It is one of the most widespread and destructive natural perils, affecting approximately 250 million people worldwide and causing US$ 40 billion in losses on an annual basis [4]. They affect all types of settlement, including: small villages, midsized market towns, service centers, cities and greater metropolitan areas. In many parts of the world, people moving from rural areas to cities, or within cities, often settle in areas that are highly exposed to flood, thereby making them highly vulnerable if no flood defense mechanism is setup [5]. The pursuit for survival and control over the environment has partially enabled human beings the capacity to grow in terms of urbanization, industrialization and development in general. This development, however, has not occurred without environmental backlash, that is, human activities that contribute to the continuous environmental deterioration and counter-response manifested in the form of nature-based resistance and resurgence. The result or implication of this development is a closer proximity, or encroachment, on natural

climatic phenomenon, including: flooding, erosion, wildfires, hurricanes, tornadoes, volcanic eruptions, earthquakes, tsunamis and any other geologic process. In addition, examples of non-geologic processes, such as pollution, deforestation and cementification of urban areas play a major role in this reactive backlash. In general, environmental problems have been better managed in developed countries and urban centers.

This review focuses on challenges and prospects of flooding within the nation of Nigeria. Across the world, floodwaters pose immediate dangers to human health, causing about one third of all deaths, injuries and damage from natural disasters [6,7]. Records of these devastating flood impacts are bountiful throughout Africa, with a significant amount occurring in West and Central Africa.

2. Flood Impact in Nigeria

In Nigeria, flooding displaces more people than any other natural disaster with an estimated 20% of the population at risk [8,9]. This perennial problem consistently results in death and displacement of communities. The number of flood-related fatalities has varied significantly from flood-to-flood with the percentage of displaced versus killed persons not conclusive in the literature. Groundwork into verifying the correlative connection between the two would require an in-depth data mining check on fatalities and an analytical breakdown of each flood occurrence to date. Using this method, we performed a preliminary calculation of 34 floods and found results ranging from 0.0% to 2.8% for larger-scaled floods versus 0.0% to 42.8% for smaller-scaled ones. In about half of the flood events no fatalities occurred. The higher smaller-scaled percentages related to examples like the event from 7 August 2005 in Jigawa State in which 7 persons were displaced and 3 died. On the other hand, at the larger-end of the scale, in 2012 for example, flooding caused more than two million to be displaced with hundreds of fatalities—resulting in more deaths, but at a much lower percentage. In any case, flood fatalities warrant further research, beyond the scope of this review; they alarming pose a real threat to citizenry and stress the continued need into best practices nation-wide.

Equally concerning, flooding has become increasingly severe and more frequent throughout the country. Unfortunately, impacts are felt more by the urban poor where recovery is unlikely without external aid [10]. As a result, the urban poor are most vulnerable since they often build homes along a floodplain. Flooding in various parts of Nigeria have caused four notable problems: (1) forced millions to relocate, (2) destroyed businesses, (3) polluted water resources and (4) increased risk of disease [11,12]. In the last few decades, high annual seasonal rainfall prediction (SRP), conducted by the Nigerian Meteorological Agency, affirm irregular flooding and consequential suffering for many parts of the country. The national response to SRP has been anything but communicative or comprehensive. Flood management, by in large, is a reactionary aftereffect with relief provided to unfortunate victims. Management is limited to waiting for an event to occur with limited SRP mass communication, hazard prevention or associated risk reduction efforts [3,13]. The notion of flood risk reduction largely depends on the amount of available information and regional knowledge affecting ongoing events. A lack of accurate hydrometeorological data affects the uncertainties associated with flash flooding and relating tidal wave hazards. There is, therefore, an urgent need to introduce mitigation measures to ensure that these areas are protected so flooding can be minimized. Demands for the use of modern day techniques identify steps that will help government and relief agencies identify flood prone areas and help with future flood prevention.

Several researchers have examined the utilization of remote sensing and geographic information system (GIS) data in regards to flood risk [7,13]. Ologunorisa and Abawua [14] applied GIS within a flood risk assessment analysis to a wide variety of countries around the world. Their research formulated risk assessment into five categories: (1) meteorological parameters, (2) hydrological parameters, (3) socioeconomic factors, (4) combination of hydrometeorological and socioeconomic factors and (5) GIS predictive testing. In reference to the latter, Okoduwa's [15] research utilized and identified specific GIS itemized variables (e.g., land use, land cover and soil strength) correlating with varying areas of flood prone probability (i.e., low, medium and high levels). This predictive research

overlay focalized urban flooding within Benin City, Nigeria and created a digital database for land relief mapping. To date, for Nigeria as a whole, there are limited flood risk maps; two example maps of flood prone areas in Nigeria built in GIS can be found in Figure 1.

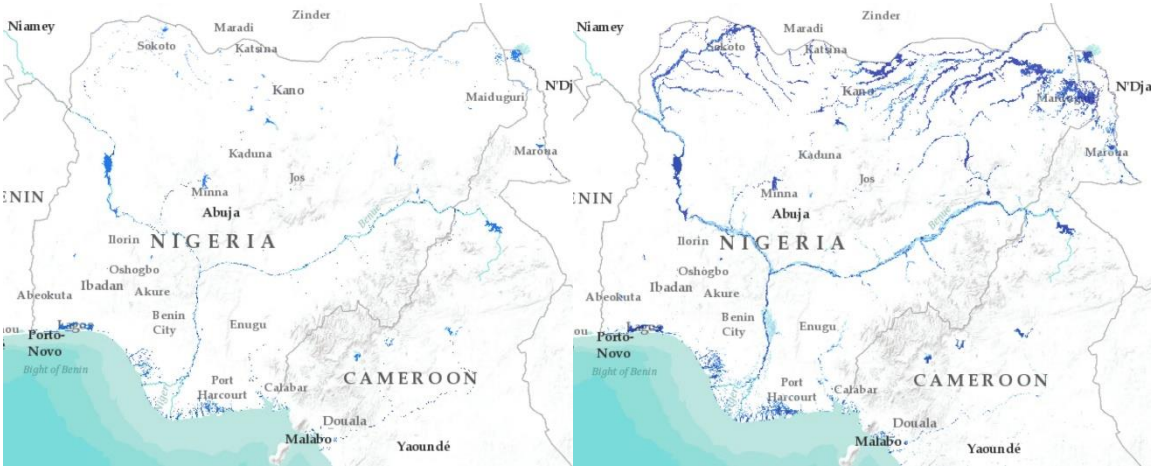

Figure 1. Examples of flood mapping within Nigeria. (**Left**) 2001; (**Right**) 2014 (Adapted from ESRI [16]).

3. Statement of Problem

In 2010, approximately 1550 people died and 258,000 displaced by 19 flood events [17]. Two years later in 2012, floods claimed 361 lives and displaced 3.8 million inhabitants [18], recording a monetary loss of approximately US$ 6.5 billion in damages despite an effort, the years before, to make the environment more habitable [18,19]. Nigeria's National Emergency Management Agency (NEMA) stated the flooding events from 2012 caused an estimated loss equivalent to 4.1% gross domestic product. This type of disaster has had a ripple effect on the livelihood and activities of communities where people literally were washed away and drowned, properties destroyed and socioeconomic activities suffered [20]. While this type of natural disaster could be avoided, or limited, there seems to be a cause-and-effect to the kind of havoc citizenry face—especially in the southern parts of the country.

Research and development are gathering nationwide information to aid with flood inundation, encroachment and flood prone areas. Methodologies have not adequately assessed flood hazards, in all of the flood prone areas, however, a lack of application within small urban watersheds, focused on generating rainfall and runoff data in urban areas, often correlate where no major rivers exist. Two reasons for this flood-complexity are development practices used in urban areas and a lack of advanced technological methods for capturing geographical data [21,22]. As a consequent, the risk of overflow from the Niger River, spanning much of West Africa, funnels via southern Nigeria and all its minor tributaries (Figure 2). As a result, flood-complexity research must take this into account for forward minded thinking, preparedness and economic, sound development.

The aim of assessing the nature and cause of floods, throughout Nigeria, relates to a provision of reliable and sustainable solutions that connects ongoing problems with flood occurrences. Four objectives need to be considered: (1) factors responsible for flooding; (2) identification of flood prone areas; (3) assessment of significant impacts of flooding; and (4) control and management measures of flood hazards. Typical areas of research that explore the physical geography of a region in relation to flood occurrence and mapping can show various flood prone area records (i.e., their trends). Mapping inputs include recorded past events and the use of predictive, future-based modelling.

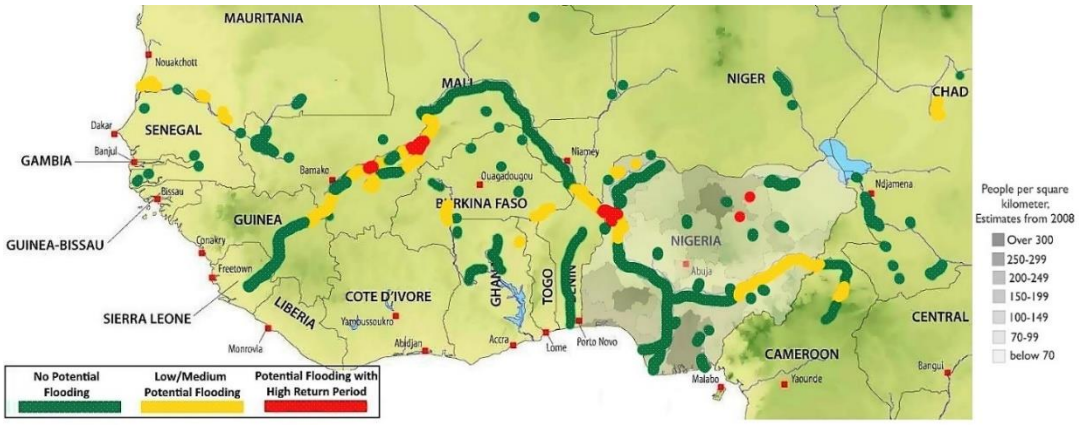

Figure 2. Risk of overflow of the Niger River in Sierra Leone, Mali, Benin and Nigeria [23,24] and overlaid population density map of Nigeria (Adapted from Wikipedia [25]).

4. Methodology

The methodology of the research is primarily based upon the review of literature. The methods to identify and assess was conducted systematically using the following electronic journal databases: Science Direct, Web of Knowledge, Scopus, Science Direct, ProQuest, Sage, Directory of Open Access Journals, Google Scholar, and Google. We specifically searched for the following English language keywords including "flood + Nigeria", "natural hazard + Nigeria", "flood risk management + Nigeria", "disaster mitigation + Nigeria", "preparedness + Nigeria" and "environmental sustainability + Nigeria". Once the literature was compiled, publications were systematically analyzed so as to identify those that presented specific findings that presented an overall review of the flooding circumstances within the country, using strategic and critical reading methods [26]. From this original compilation of the literature we then identified and analyzed the identified literature and relevant information regarding different flood reports and data. Due to a very limited amount of information, a number of tables and figures have been adopted and updated accordingly. Overall, we identified more than 500 articles, reviews and grey literature in our initial literature review. To better focus our review, we filtered out articles published before 1989 and omitted articles on that did not discuss the nexus between flooding and Nigeria, leaving us with approximately 20 publications that included literature published in the form of books and technical reports.

5. Conceptual Framework

The conceptual framework is divided into six components and has been derived from an accumulation of methods and practices within the scope of Nigeria's past flooding events. Nkwunonwo et al. [27] conceptualized flood risk within the Lagos region of Nigeria, depicting a breakdown of four key components of urban flooding: climate and meteorological events, poor urban planning, urbanization and anthropogenic activities (Figure 3). These components illustrate a first-hand relationship to improving, comprehending and setting up an urban flood management plan.

The risk is conceptualized on the basis of three integral components frequently implemented during flood damage estimation. These components include: the probability of flood hazard, level of exposure and vulnerability [27,28]. The conceptual framework of flooding is broken down as follows: (1) definition, (2) cause, (3) impact of climate change, (4) urbanization, (5) prediction and (6) occurrence. This review focalizes on the problems and prospects of flooding in Nigeria and links it to Nkwunonwo et al.'s [27] study on flood risk.

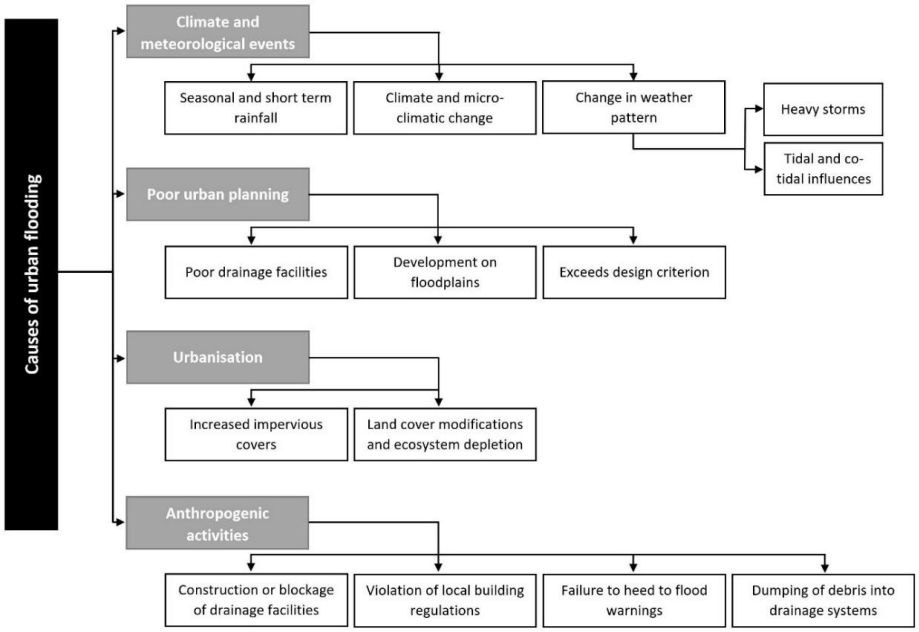

Figure 3. Four key components of urban flooding: climate and meteorological events, poor urban planning, urbanization, and anthropogenic activities (Adapted from Nkwunonwo et al. [27]).

5.1. Definition of Flooding

Flooding is the temporary inundation of all or part of the floodplain or temporary localized inundation occurring when surface water runoff moves via surface flow, gutters and sewers [29]. It may be referred to as a comparatively high flow of water that overtops the natural or artificial banks in any reach of stream. Flooding is also regarded as an overflow or inundation that comes from a river or other body of water and causes or threatens to damage [30,31]. Its occurrence is usually due to the increase in volume within a water body which causes it to exceed drainage channel capacity and overflow its bounds [32]. Due to the nature of flood occurrence, full analysis of the effect of a flood requires correlative research linking physical hazard and socioeconomic impact. The most effective form of evaluating effects of any flood event—including most environmental disasters—involves the assessment of such impacts within a past, present and future context.

5.2. Causes of Flooding

Flood is a result of many conditions working singly and in synergy. These conditions are mainly natural and anthropogenic. Natural causes of flooding are generally a result of heavy rain and downpour. Anthropogenic causes of flooding are enhanced by human activities [33,34]; that is, flooding in terms of environmental hazard is not totally a physical phenomenon. Floods only become a hazard when they impinge unfavorably upon human activity, mostly due to built-infrastructure along floodplains and coastlines. Based on this understanding, flood hazards also create socioeconomic phenomena and socio-psychological conditions of stress. Major causes of flooding have been linked to human interaction with the environment (e.g., urbanization and agricultural activity). As urbanization intensifies, natural surfaces are replaced by buildings, paved roads and concrete surfaces, which do not readily allow water to percolate into the ground. The effect is, therefore, a large proportion of rainfall, which normally should infiltrate into soil or be intercepted by vegetation, is immediately converted into surface runoff. Attempts to harness available water resources have resulted in the construction of dams and other water control structures. However, the failure of these structures, infrequent as they may be, have also resulted in floods (e.g., the collapse of the Bagauda Dam near Kano in 1988).

The encroachment of buildings on floodplains through towns and cities and the depositing of waste materials creating blockage can facilitate flooding. In combination, poor city planning and

management, in addition to natural rain-induced causes, can be detrimental in an urban setting. Six general causes of flooding specific to Nigeria, include: (1) heavy rainfall (i.e., a tropical climate combined with a relating wet season); (2) soil nature (i.e., poor infiltration of rainwater flow and soil percolation); (3) deforestation (i.e., increased forest and vegetation removal, especially within lowlands and valley beds); (4) climate change (i.e., attributed by NEMA, including the worst flood disaster in 2012 and indirect aggravation of flood patterns in flood prone areas [27]); (5) poor waste disposal (i.e., blockage of drainage channels, especially in urban centers); and (6) poor land use policy planning and management (i.e., improper sitting of buildings, structures, road and drainage construction and land use ordering [35], as well as available control tools to oversee development standards). It is unfortunate Nigerian authorities lack proper planning and orderly conduct when it comes to sound promotion of flood prevention [36].

5.3. Impact of Climate Change on Floods

Climate change refers to long term change in climate due to natural variability [37,38]. A major factor that influences flood is the climatic condition of a particular geographic location manifested in the form of amount, duration and intensity of precipitation (i.e., rainfall). The combination of precipitation and high temperature affect soil moisture content (i.e., percentage saturation), liquid limit and infiltration rates. One of the consequences of climatic variability is when humid environments increase and alter rainfall patterns [39]. There is no doubt the effects of climate change alter the precipitation patterns of distribution, intensity and duration of extreme rainfall events and a higher frequency of strong precipitation. In the case of Nigeria, due to higher temperatures and drought, land has become more susceptible to runoff, intensifying flood events. Changes in rainfall intensity and distribution influence river morphology (i.e., erosion of banks and fast sedimentation in riverbeds) introducing augmented dynamic flood shift patterns [40].

5.4. Urbanisation and Floods

A significant amount of research over the past two decades has shown a strong relationship between urban areas and local micro-climate. The "urban heat island" (UHI) effect is now well-established, whereby urban areas have higher temperatures than surrounding regions [41]. In many cases, UHI increases rainfall in the vicinity of cities. A number of studies have found an increase in rainfall in regions downwind of urban areas, with some cases recording increases as high as 25% [41,42]. In urbanized areas, huge amounts of anthropogenic waste heat is emitted due to human activities; the increase of energy consumption is causing environmental problems and temperature rise in the urban atmosphere [43]. Hence even without long term climatic changes, urban extreme rainfall intensities may be increasing with severe impacts on society at large.

In Nigeria, the rehabilitation of rivers, channels and sewers lags far behind the development of municipal construction. Consequently, the existing drainage capacities are insufficient in draining runoff discharge, increasing flood risk. Moreover, there is a lack of adequate infrastructural provision, especially within Edo State. Over the last decade, Benin City and other parts of Edo State have witnessed rapid territorial expansion, in which successive administrations until recently have failed to match growth with infrastructural development—particularly in the expansion of its drainage network [44]. Currently, with an annual urbanization rate of 5.5%, the highest in the world, Nigerian cities face numerous problems, including: deterioration of the environment, urban decay, un-cleared refuse, flooding, erosion and pollution [45,46]. At present, it is easy to acknowledge casual factors of urban flooding and gully erosion are multifarious.

5.5. Flood Prediction

The prediction and forecast of floods depend greatly on the consistency of available meteorological data. The development of the hydrological operational multipurpose sub-programs (HOMs) has been a top achievement in its field. Improvements on the HOMs forecasting and

information dissemination is ongoing. The potential benefits are immense for communities under its management. The network of instruments, digital data and other meteorological flood prediction devices can be employed, coupled with appropriate modelling to forecast real-time, onset and other features of phenomena in question [46,47]. Development of hydrological forecasting systems has been installed in a number of countries and has resulted in a substantial saving of life and reduction of damage.

Installation of similar systems, throughout Nigeria, would also reduce vulnerability to some areas and promote early evacuation when needed. However, problems have been identified in relation to evacuation procedures due to a lax resistant population that is overly exposed to flood events. Pfister's [48] research observed a significant factor in the lack of response to an evacuation order in New South Wales, Australia, noting the effect of false alarms as a major factor that might make future evacuation more difficult if not impossible. In two studies, Olowu and Sako [49] and Olowoyo and Lion [50], looked at a number of developing countries including Nigeria, and found that limitation of infrastructure, absence of appropriate legal and policy framework and sometimes inadequate resources particularly render areas more vulnerable to the consequences of flooding and other natural disasters.

5.6. Flood Occurrences

It is difficult to determine the extent of flood damage and to compare in a satisfactory manner one flood with another, mostly due to the relative tendency to overestimate flood damage, particularly at the time of the event [51]. Flooding in Nigeria occurs in three main forms: river flooding, urban flooding and coastal flooding [52]. In Nigeria, flood occurrence can cause panic nationwide. Flood events have caused astronomical price hikes in food crops, resulting to an estimated 2% rise in rate of inflation [53]. By far, this is the worst environment-induced economic disaster Nigeria faces. Flood impacts are often felt all over most parts of the country. In 2012, the government spent approximately US$ 300 million on relief materials for flood victims [54]. In the face of flood disaster, predominately affecting about one quarter of the country's cities, many Nigerians are of the opinion flood events will not end, or get better anytime soon, leaving the general population with hope of government mitigation and adaptation resolve. Poor and unavailable flood prediction, flood control systems and techniques are seen as major causes that aggravate flood disaster nationwide.

6. Discussion: Flood Control and Management

In Nigeria, flood control measures need to be better understood, complimented and harmoniously matched up with the forces of nature, instead of simply trying to eliminate them [53]. A compiled list of the main flood occurrences recorded in the country has been updated in Table 1.

An examination of the flood record reveals Oyo, Lagos and Rivers—in that order—top the country in terms of highest amount of flood occurrences per State; these three States, however, were dwarfed by Edo's 2012 one-off event that halted the nation and semi-collapsed the economy. Correspondingly, the States of Kano, Niger, Delta, Bayelsa, Anambra and Ogun—which have had far fewer flooding occurrences than the top three—have also had huge one-off events that surmount to or similarly total the top level of affected population. Contradictory to the top three, these other States have suffered far more damage and structural devastation which, most likely, is related to lack of preparedness, inexperience in flood management and mitigation practices and lack of knowledge and governance in terms of flood relief. It would be fair to say the top three States, due to historical and seasonal flooding, have grown more accustom to flood events and arguably top the state-of-the-art when it comes to sustainability-focalized best practices in Nigeria. Flood prone areas and main flood occurrences when superimposed over the States and federal capital territory (FCT) of Abuja and main waterway systems illustrates this correlation (Figure 4).

Table 1. Main flood occurrence record in Nigeria (Data updated from Oluwaseyi [20]).

State	Flood Disaster	Other Disasters	Associated Hazards	Affected Population	Year
Oyo	Ogunpa flood, Ibadan flood	-	500 houses demolished, properties destroyed, bridges collapsed; 300+ houses destroyed in 2017	50,000 displaced; 300+ in 2017	1948, 1963, 1978, 1980, 1982, 1985, 1987, 1990, 2011, 2017
Lagos	Lekki flood	-	buildings collapsed, markets submerged, properties destroyed	300,000+	from the early 1970s to date
Kano	flood	windstorm	schools, houses, farmlands, animals destroyed	300,000+ displaced in 1988; 20,445 in 2001	1988, 2001
Zamfara	flood	-	building submerged, farmlands destroyed, properties damaged	12,398	July 2001
Yobe	flood	fire, drought	houses and farmlands submerged, houses razed, animals affected	100,000+	April and September, 2001
Sokoto	flood	fire, windstorm	houses and farmlands destroyed	16,000+	July 2001
Taraba	flood	-	80 houses swept away; 410 houses extensively destroyed	50,000+ displaced	August 2005
Osun		rainstorm	houses and schools destroyed	17,000+	April 2001
Ondo		rainstorm	houses and schools destroyed	800	April 2001
Niger	flood	rainstorm	houses, schools, animals and farmland affected	200,000+ displaced	1999, 2000
Kogi	flood	rainstorm	houses, schools and farmland destroyed	1500 displaced	March and May 2001
Jigawa	flood	windstorm	houses, farmlands and animals destroyed	35,500 displaced in 1988; 450,150 displaced in 2001	1988, March, April and August 2001
Imo	flood	windstorm	1000 houses; 150 electric poles; 40,000 oil palms destroyed	10,000+ displaced	April 2001
Ekiti	flood	rainstorm	public schools, 890 houses	2100 affected	April 2001
Edo	flood	rainstorm	560 houses destroyed in 2001; State-wide devastation in 2012	820 affected in 2001; 3.8 million affected in 2012	March 2001, 2012
Delta	flood	rainstorm	houses, schools, markets and farmlands submerged	425,839 affected between all 3 incidences	1999, March and April 2001
Bayelsa	flood	-	houses, schools, markets and farmlands submerged	273,266 affected in 1999; 382,000 affected in 2001	1999, March 2001
Akwa-Ibom	flood	rainstorm	367 houses washed away	4000	March 2001
Adamawa	flood	rainstorm	houses and farmlands destroyed	500	April 2001
Rivers	flood	rainstorm	residential houses, churches, public and private facilities	350+ affected year-in-year-out	2006, 2012, 2013, 2017
Cross Rivers	flood	rainstorm	entire communities, public and private facilities	25,000+ affected	2017
Anambra	flood	-	residential houses, farmland, public schools and market places destroyed	500,000+ affected in several communities	2012, 2017
Ogun	flood	rainstorm, windstorm	residential houses, public and private buildings collapsed, market places destroyed, farmland washed away	350,000+ affected in several communities	2012, 2017

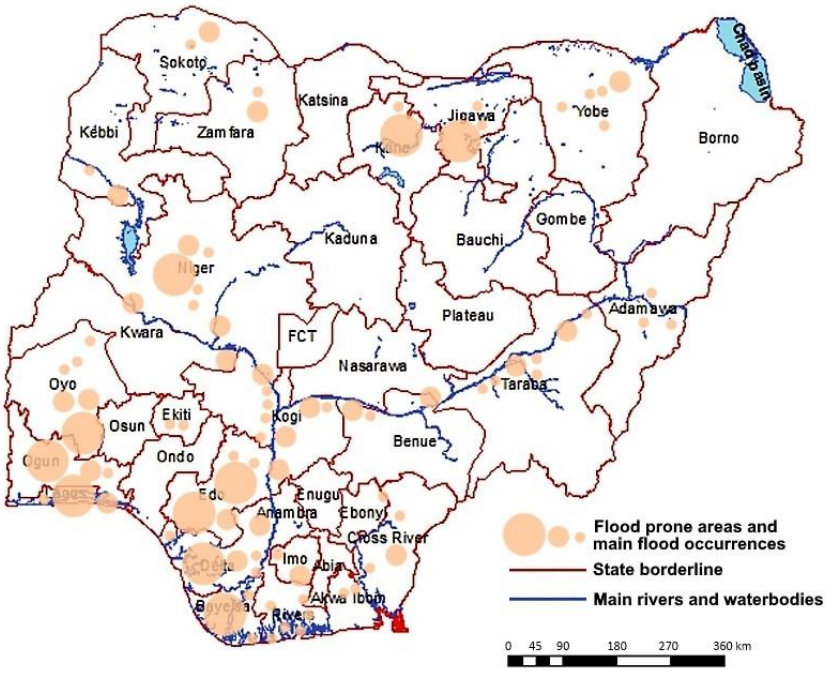

Figure 4. Flood prone areas and main flood occurrences superimposed over the States and main waterway systems in Nigeria (Adapted from Ekpo et al. [55]).

It is important to note that a significant and crucial factor in saving lives includes trying to control flood occurrence or, at the minimum, to minimize vulnerability within affected areas. It is clearly known that control and management may not provide the ultimate panacea for flood hazards, but it will provide a perspective to improve its impacts on human activities, lives and property. Specific to Nigeria, Adekola and Lamond [22] and Olowu and Sako [49] state infrastructure and an absence of appropriate legal controls is crucially needed. As a result, inadequate access to resources particularly renders the country more vulnerable to the consequences of flooding and other large-scale disasters. Recently, researchers have pointed out one method of studying and understanding flood behaviors, by examining the extent of floods with flood risk mapping, since they use and overlay spatial planning and land management information [13,56]. There is also research that looks at integrated GIS-based assessment that integrates population and agricultural vulnerability with flood events [57,58]. Comprehension geographic information can be very critical in making important decisions due to the spatial coverage of most disasters. Flood risk mapping can also determine the area at risk and can be the basis for flood damage reduction and subsequent action-based management.

Spatial planning according to Nkwunonwo et al. [34] and Isma and Saanyol [13] suggest the support of early warning systems, risk assessment and mapping as an optimal basis of flood management. Burton [59] categorizes alternative measures of reducing flood loss into two groups: (1) corrective measures and (2) preventive measures. The corrective measures are divided into two parts: flood control and other methods. The preventive measures are: flood regulation and other preventive methods. Flood control measures involve the construction of reservoirs, levees and walls, channeling of streams and construction of drainage systems. The provision of flood insurance could also assist with compensative efforts of affected occupants however insurance research is still tentative. We believe these linkages between the six-point conceptual framework compliment Nkwunonwo et al.'s [27] key components of flood risk (i.e., climate and meteorological events, poor urban planning, urbanization and anthropogenic activities). This overlapping review affirms the need for further methodological research, expertise, government and community commitment as well as social and economic knowhow.

International Flood Management Practices: Sustainable Flood Prevention, Protection and Mitigation

A number of principles and approaches from an international perspective reinforce the connection between flood prevention, protection and mitigation. A brief internationalized state-of-the-art of flood management practices puts into perspective flood strategies that integratively promotes coordinated development and management of actions regarding water, land and related resources. From this viewpoint, such practices consider different kinds of flooding (i.e., hydrological circumstances) and environmentally-focalized conditions that contribute to the problem. Flood management practices from around the world are briefly examined and commented upon from a Nigerian backdrop.

In accordance with the Water Directors of the European Union (EU), the EU Floods Directive 2007/60/EC and the United Nations and Economic Commission for Europe (UN/ECE) Guidelines on Sustainable Flood Prevention eight notable practices are described: (1) integrated river basin approach; (2) public awareness, public participation and insurance; (3) research, education and exchange of knowledge; (4) retention of water and non-structural measures; (5) land use, zoning and risk assessment; (6) structural measures and their impact; (7) flood emergency; and (8) prevention of pollution [60]. There has been a number of European-centric working groups which have expanded upon the Water Framework Directive 2000/60/EC and EU Floods Directive 2007/60/EC that focus on flood risk management information-based systems. Key deliverance has focused on securing basic resource needs for better integration and coherent management approaches for natural water retention methods, improved ecosystem quality and reduced, overall, continent-wide flooding [61]. At present, authorities throughout Nigeria significantly lack utility in all eight of these practices. From a European standpoint, the country insufficiently conducts background controls and has limited pathways for extensive implementation.

In the USA, flood management practices are predominantly updated by the Federal Emergency Management Agency (FEMA); at present, FEMA has 56 legislative floodplain management publications, with its NFIP Floodplain Management Guidebook 5th Edition stating six practices that make up the management scheme: (1) floodplain management concepts; (2) mapping and map revisions; (3) the National Flood Insurance Program (NFIP); (4) floodplain management at the local level; (5) NFIP floodplain development standards; and (6) flood hazard mitigation [62]. In addition, ongoing reports included FEMA's National Flood Insurance Program Community Rating System: A Local Official's Guide to Saving Lives, Preventing Property Damage, and Reducing the Cost of Flood Insurance FEMA B 573/2018 highlight flood mapping and regulations, damage reduction and preparedness [63]. Nigeria's authorities have published a very limited number of government reports and publications, with a very limited amount of conceptual management, mapping and, basically, no proper insurance-oriented program. American management practices within Nigeria would be beneficial however not feasible due to the expensive nature of implementing such a scheme.

In Canada, recent flood management practices prioritized three flood risk management initiatives: (1) data and shared understanding; (2) homeowner and education awareness; and (3) proactive cross sector collaboration [64]. In Australia, the national publication entitled Managing the Floodplain: A Guide to Best Practices in Flood Risk Management in Australia extensively references 58 manuals and handbooks specific to Australia's environment [65]. Similarly, New Zealand has published Meeting the challenges of future flooding in New Zealand stating four fundamental actions: (1) active and engaged risk management by central and local government collaboration; (2) risk reduction embedded within the policy framework; (3) appropriate resources, including sufficient information, guidance and funding, made available to promote good practice in the daily management of flood risk; and (4) central and local government monitoring to understand the levels of flood risk and inform future policy and management practices [66]. Additionally, coastal flooding attention looks at: storm, tides and sea level preparedness; landform characteristics; and flood hazard preparedness [67]. Other countries with noteworthy flood management practices include: the United Kingdom, Japan, Singapore and China. In retrospect of these management practices, Nigeria would benefit from Canadian-style initiatives that prioritize on community and societal level involvement. In both Australia and New Zealand, the pure volume of research and development exemplify the extent of how flood management practices are prioritized and integrated into high level governance interlacing academia and institutions alike with government. Unfortunately, Nigeria, as in many developing countries, research and development in flood management practices is limited and lacks support from the top-down. This briefing demonstrates well developed flood management practices that exist and offers potential ideas for policymakers from Nigeria, and other lesser developed countries, a pathway forward. The international perspective also sets a standard for sustainability-focalised best practices and comparative development.

7. Conclusions

Flooding has become an annual event for Nigerian cities where it consistently causes economic problems in the rainy season. Effort made by the government, community organizations and residents to anticipate the problem has generated substandard outcomes, largely due to tremendous changes in built environment. These changes to the urban landscape, without equal precautionary measures for flood, relate to seasonal effects on people and the environment itself. Hitherto, human activities have exacerbated flood related problems by cutting down trees, digging up vegetation and exposing soil, thus increasing soil erosion and flooding. Cultivation has decreased water retention force of soil and increased runoff. If deforestation could be controlled using stringent policy and regulation, then flood levels along rivers, streams and even the ocean could be improved in cities and adjacent floodplains. Ongoing fieldwork conducted by the authors contest that flood throughout Nigeria continues to cause the federal government relief concerns for affected persons; it correlates with the intervention strategies being put in place by the national emergency management agency and relating communities.

The common understanding of flooding during the rainy season, which is from May to September, is especially concerning within the states that contain or run adjacent to the Niger or Benue river systems. Our own flood prediction research tentatively points to a worsening situation as reoccurring flood phenomenon remains high. Rainfall patterns in the last 30 years also suggest that rainstorms are getting more intense. This, in turn, means that there is a higher rate of downpour on the days that there is rain, which indirectly correlates with an augmentation of rain storms in cities and increasing threat of flooding. Further flood research will be critical to bettering management practices. This should include local and international intervention as well as early warning and rapid response systems, proper urban and spatial planning, flood data gathering, modelling flood emergency preparedness and political will.

Land use planning and controlled sustainable development must be prioritized to better manage rapid urban growth and infrastructural demands. In a swiftly urbanizing country, proper land use policy, regulation, construction and development by-laws are essential to keep developers in check. A stringent program to monitor landscape changes and urban development is a critical starting point. Key to best practices in the country will need to focalized efforts on the high flood prone States of Oyo, Lagos and Rivers with additional attention going to Edo, Kano, Niger, Delta, Bayelsa, Anambra and Ogun. Nigeria's government agencies, authorities, planners, environmentalists, practitioners of the built environment, non-governmental organizations and communities alike must work in synergy to advance a comprehensive approach that would emphasize more on the means of reducing flood damages over the long term. This process would rely on both indigenous and advanced techniques to abating flood problems throughout the country and, in particular, its urban centers.

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