

# MANAGING FLOOD RISK IN NIGERIA: ISSUES, SOLUTIONS, AND MANAGEMENT STRATEGIES

Peter Mafimisebi

Department of Environmental Engineering and Hydrogeology, Geoearth Project Ltd. Nigeria  
mafimisebipeter2023@gmail.com

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## ABSTRACT

In Nigeria, flooding has become a significant danger in recent years because of increasing population, fast urbanization, and severe weather occurrences. This research presents an in-depth evaluation and description of managing flood risk strategies in Nigeria, focusing on identifying existing flaws and potentials, and offering suggestions for both implementation and future study. Suitable keywords were used to systematically search and extract academic literature databases on a variety of FRM topics. A systematic examination of the literature was conducted, and multiple previous flood occurrences and the responses to them were examined as examples. Present practices of flood risk management are defined by lack of integrated systems, not having inter-agency coordination, poor infrastructure, insufficient drainage network, urban poverty, low literacy rates, cultural obstacles, and weak institutions. The research suggests using a comprehensive strategy for developing urban infrastructure, beginning by evaluating current and future infrastructure systems and projects to enhance their FRM capacities without compromising their original goals. It was also suggested to empower additional entrepreneurs in the development and delivery of FRM solutions and include FRM concepts and practices in the country's educational curricula. Nigeria requires a diverse platform to create successful strategic policies and effective operational mechanisms for FRM.

**Keywords:** Flooding, Population, Climate Change and Urbanization.

## I. INTRODUCTION

In general, a flood is when a large amount of water spills or erupts over land that is not typically underwater [1]. It is a severe weather occurrence that occurs because of the increasing global temperature, leading to intense rainfall, the warming of the ocean, and melting glaciers, ultimately leading to an increase in sea levels and the inundation of coastal regions. Flooding results in the flooding and damage of plants, animals, humans, buildings, and infrastructure [2]. Nonetheless, flooding is a worldwide phenomenon that has impacted individuals, resulted in property damage, and caused the extinction of various species in the ecosystem. Flooding poses a danger to the environment's overall quality. Flooding is considered a key factor in determining the environmental quality of residential neighborhoods. Additional environmental dangers comprise prolonged dry spells, the advancing of deserts, the degradation of soil, and massive sea waves known as tsunamis.

In Nigeria, flooding has emerged as a significant risk in recent years. In 2012, Nigeria experienced total losses exceeding \$16.9 billion from flood events, including damage to properties, oil production, agriculture, and other sectors [3]. The continued high vulnerability of the people, combined with a lack of capacity to cope and more frequent flood events, are putting numerous lives and properties in danger. Stakeholders are becoming more worried about the risks of flooding to public safety and overall national progress. A sustainable FRM system should consider ecological factors, infrastructural development,

institutional behavior, and other techno-socio-economic characteristics of the environment.

At the same time, it has been noted that there is a lack of sufficient literature on key aspects of flooding and flood risk management in Nigeria. Adelekan et al. [4] note that flooding is a recurring phenomenon in Nigeria, causing significant economic losses and human displacement. In particular, it is necessary to discover FRM methods and systems used in other places and how to modify them for Nigeria (5).

This study aims to analyze and describe FRM in Nigeria to identify existing weaknesses and opportunities. This will help the stakeholders, community leaders, and government take the necessary actions to prevent loss of life and destruction of infrastructure around the high flood risk-prone areas across Nigeria.

## II. LITERATURE REVIEW

Correia et al. [6] evaluated the potential for flooding and strategies for controlling it. Their research predominantly centered around assessing the comprehension of individuals and their reactions to natural disasters in Setubal, Portugal. They tried to figure out how the knowledge could be incorporated into the planning and management of flooding. Their research was based on conducting numerous interviews to gather information. They noted that the involvement of the public in flood management is crucial to the success of flood management efforts. For example, when individuals are prepared to participate in flood control, methods that will encourage

management will be advocated. Community involvement in drainage development and following development regulations and provisions may be required.

Adebayo et al. [7] assessed the flood risk in Lagos State, Nigeria, and evaluated the current management strategies, revealing that poor drainage and inadequate flood forecasting exacerbate flooding impacts.

Yusuf et al. [8] analyzed the community roles in flood risk management in Nigeria, stressing that community engagement and education are crucial for effective flood risk reduction.

Magami et al. [9] evaluated the effects of flooding in Nigeria. It was disclosed that flooding in some Nigeria states is caused by dam malfunctions, major rivers overflowing, coastal storms, disregard for warnings from the Nigerian meteorological agency, a slow response to assess flood victims, and people residing in flood-prone areas like riverine and coastal areas. They also noticed that climate change, unusually heavy rainfall, and the ongoing discharge of surplus water from man-made reservoirs were also contributing factors to the flooding. It was also mentioned that improper upkeep of drainage channels and careless waste disposal cause flooding in Nigeria.

Afolayan et al. [10] analyzed the effectiveness of flood risk management strategies in Nigeria, emphasizing the importance of integrating traditional and modern approaches to enhance flood resilience.

Umoh et al. [11] assessed the flood risk in Calabar Metropolis, Nigeria, and evaluated the current management strategies, revealing that poor drainage and inadequate flood forecasting exacerbate flooding impacts.

Rufa'I [12] evaluated the level of readiness of households for potential flood risks in Nigeria. He observed that more rainfall triggered by climate change leads to floods. Although the number of floods in Nigeria is rising, household readiness has been neglected. His research focused on analyzing previous studies that indicate households are experiencing losses of property, lives, and other assets due to floods. Flooding has been recognized to have negative effects on human livelihoods because of its destructive nature.

Oyedepo et al. [13] analyzed importances of Nigerian government policies in flood management in Nigeria, highlighting the need for effective policy implementation and enforcement to mitigate flood risks.

### III. NIGERIAN FLOOD SYSTEMS

#### 3.1 Occurrence of flooding in Nigeria

Flooding is a recurrent and severe natural disaster in Nigeria, significantly impacting the socio-economic landscape of the country. Seasonal flooding, primarily during the rainy season from April to October, disrupts lives, damages properties, and hampers economic activities. Flooding in Nigeria started in 1963 when the

Ogun River flooded Ibadan City, resulting in casualties and destroying properties. Similar events were also recorded in 1978, 1950, and 2011. The flood of 1980 resulted in significant losses of lives and properties, highlighting the potential for disasters from the river. This led to various flood risk management measures being implemented, including the Ogunpa channelization project, educational radio and TV ads on FRM practices, and relocating structures from flood-prone areas [14].

Around twelve human activities were found to have contributed to the heightened level of destruction seen after the 2011 Ibadan flood. Although responses to previous floods have been fragmented, with the main emphasis on addressing short-term needs like reconstructing what was destroyed.

#### 3.2 Areas in Nigeria that are prone to flooding.

With the rapid urbanization happening in Nigeria, the number of flood prone communities and assets is growing. Figure 1 shows regions that are susceptible to flooding occurrences. The major flooding locations and causes can be classified in the following way.

With the rapid urbanization happening in Nigeria, the number of flood-prone communities and assets is growing. Figure 1 shows regions that are susceptible to flooding occurrences. The major flooding locations and causes can be classified in the following way:

1. Coastal cities and towns: Nigeria has a coastline that spans more than 853 km (530 mi) and includes vast low-lying regions, along with heavily industrialized areas that are at risk of flooding. Lagos, the primary business center of West Africa, as well as Warri and Port Harcourt, where Nigeria's petroleum facilities are located, are facing a growing risk of ocean flooding [15].

2. Towns and villages are located around the rivers, which run through the country (Fig. 1). Research has indicated that flooding impacts urban and rural areas near the River Niger and its tributaries the most.

3. Communities are located downstream of dams and along the shores of large rivers. As an example, Ilorin, a city in the north-central region, has experienced serious flooding from the River Asa, which flows within the city [15].

Considering these problems, it is necessary to address the following inquiries. How many urban areas, villages, and communities within these flood-prone areas are in danger? What are the population size and demographic features of the at-risk regions? What are the primary economic activities and industries in these flood-prone regions, and what are the consequences and potential impacts of a significant flood event?

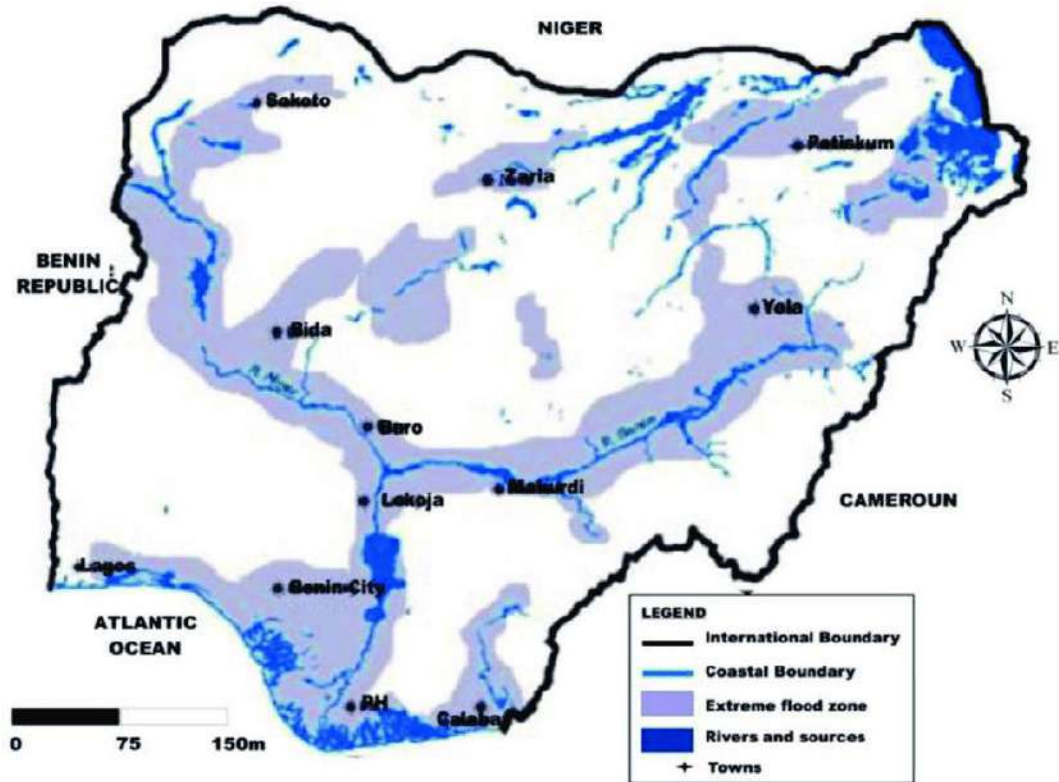


Figure 1. Flood prone states in Nigeria [15].

**IV. ATTRIBUTES OF FRM SYSTEMS IN NIGERIA**

The main flooding factors in Nigeria are both natural and anthropogenic. The Niger and Benue Rivers, the major water bodies in the country, frequently overflow their banks during heavy rains, leading to widespread flooding. Coastal areas, especially Lagos, face severe flooding due to a combination of sea-level rise and inadequate drainage infrastructure. Urbanization has led to the paving over of natural drainage areas, further exacerbating the risk of floods. Additionally, deforestation and poor land use practices in rural areas contribute to soil erosion and reduced water absorption, making these areas more vulnerable to flooding.

*4.1 Lack of coordination between urban development and FRM*

It is noticeable in many Nigerian urbanization cases that there is a gap between FRM systems and other aspects of the urbanization process. Limited coordination among government agencies has hindered the success of FRM, in addition to technical and financial challenges. Typically, FRM systems are created without adequate coordination with other development systems like power infrastructures, water supply systems, transportation networks, recreational facilities, and more. One instance

is when the public works department carries out road construction projects without sufficient coordination with other departments like water resources, environment, or agriculture. There have been multiple instances where road construction companies have caused damage to important water pipes that serve as regulated outlets for dams. This leads to a compromise in the flood safety features of the dams, resulting in the flooding of areas around and below the dams. There have been situations in which road contractors dig borrow pits during dry periods without proper regard for potential flooding. The projects ultimately harm the ability of the surrounding environment to resist erosion by eliminating the ecosystem's natural flood defense [16].

A comprehensive and interconnected strategy for development where flood management receives significant emphasis is seen as the sole long-term solution for flood risk management. This development strategy necessitates significant coordination and integration among the different branches of the Nigerian government. Coordinating different agencies and integrating them, especially in the context of Flood Risk Management (FRM), will enable the examination and utilization of the connections that exist among urbanization processes and systems in a cohesive way. For example, when addressing

transportation challenges, water channels constructed for flood prevention can be planned to serve as water routes for improving transportation in locations such as Lagos. By installing numerous wind turbines along the offshore coast of Lagos, we can meet the power supply needs and lessen the impact of coastal waves/storms by utilizing the kinetic energy from the storms to power generators. This could offer a better and more efficient defense, compared to building basic concrete walls, and help with energy generation and FRM issues.

Yet, the lack of cooperation among agencies and the failure to integrate solution systems in the urbanization process in Nigeria currently hinder holistic approaches. Besides the central government, there exist 36 independent state governments, more than 750 local authorities, numerous private organizations, businesses, NGOs, and individual property owners carrying out different flood risk management solutions independently without proper coordination and collaboration. Frequently, these organizations implement FRM strategies that are not ideal for their local areas, potentially leading to increased harm or flooding elsewhere. Reported instances exist in which dams, channels, and structures constructed for the purpose of safeguarding a specific area, community, or private property result in the diversion of runoff water towards neighboring communities downstream [17].

*4.2 Emphasize on implementing structural FRM measures*  
When addressing flood risk in Nigeria, the primary emphasis has been on structural solutions along with excessive reliance on foreign expertise and technologies. The tendency to allocate funds for constructing additional flood defenses, canals, embankments, culverts, and bridges without adequately assessing cheaper and more eco-friendly non-structural alternatives is clear in the country's budget. Regrettably, foreign contractors and experts typically manage these structures, but their knowledge of the local situation is limited, which hinders knowledge transfer to indigenous experts [17]. These constructions, often mirroring solutions from faraway places and different social-ecological contexts without proper adjustment to the local situation, lead to additional socio-technical issues. Projects without the appropriate balance of soft components such as advocacy, education, involvement of stakeholders, and consultation do not create a feeling of shared responsibility and ownership in the project. For example, some flood canals and drainages have become garbage dumps just a few years after being put into use. It has been demonstrated that these expensive concrete buildings and civil projects do not often provide

sufficient or long-lasting protection against flood dangers. This aligns with widespread floods in the UK and reports of the breakdown of recently constructed expensive flood barriers in various regions. It is clear that the defense against floods in affected UK communities relies more on non-structural measures, institutional preparedness, and coping capacity. People in Nigeria are gradually acknowledging the importance of investigating non-structural FRM measures [17].

## V. FACTORS THAT CAUSE FLOODING HAZARDS IN NIGERIA

There are multiple reasons in Nigeria that cause and worsen the effects of flooding.

### *5.1 inadequate infrastructure led to flooding*

The interconnections among different parts of the contemporary built environment system offer a reliable foundation for comprehending the unique complication of flood risk management in Nigeria. Although Nigeria has invested significantly in infrastructure like roads, bridges, and modern facilities for its increasing population, there has been a lack of thorough system thinking in the planning, designing, and construction of these projects. Additionally, a lack of proper management, corruption, and incompetence lead to many facilities deteriorating and failing well before their projected lifespan [16].

For instance, if a poorly constructed bridge or section of road collapses during the rainy season in Nigeria, it often results in debris and concrete blocking or limiting the flow of the channel. This will ultimately lead to artificial flooding of the neighboring area located upstream from the bridge that has collapsed. When a road section becomes unusable because of inadequate civil work, drivers will reroute traffic to other roads, causing congestion on those routes. For example, truck drivers who drive heavy vehicles must cross bridges and roads with limited capacity, leading to more bridges collapsing and creating a continuous cycle. Regrettably, it is often difficult to identify the original cause in many cases, especially when the impacted infrastructures are under separate authorities [18]. Additionally, substandard infrastructural systems like high voltage power lines, bridges, unsecured construction sites, and unfinished buildings, easily collapse during floods, leading to an increase in the number of fatalities and injuries.

Due to the lack of a trustworthy drinking water system, most homes in Nigeria rely on shallow wells and streams near sewage facilities for their water supply. During flood events, the water supply system can easily become contaminated, resulting in additional health and water supply problems.



Figure 2. Landslide contributing to flooding hazard.



Figure 3. Road cut contributing to flooding hazard.

### 5.2 Inefficiently organized and controlled urbanization process

Poor management has been observed in the growth and expansion of urban communities in Nigeria. Urban development in Nigeria is characterized by inadequate spatial planning, ineffective land use management, and lack of strong corporate governance [19]. The outskirts of major cities like Ibadan are infamous for this. Town planning officials in numerous cities have been influenced in a way that residents, businesses, government agencies, and NGOs change the design and usage of buildings without the necessary approvals. Unexamined environmental impacts can lead to potential flooding from activities such as dump

sites, borrow pits, trenches, water dredging, and sand filling. The utilization of geotechnical studies and other preliminary design assessments to determine if an area is not common to be suitable. The lack of adequate urban development planning has led to significant disruption of ecological systems and has particularly harmed floodplains in low-lying cities, as stated by Salami et al [20]. The harmful changes to the ecosystems involve replacing the natural soil cover with concrete and clogging drainage channels. For example, the clearing of trees on hillsides has led to more runoff and erosion, possibly causing more mud and landslides during floods in Nigeria in recent years



Figure 4. Poor water drainage network



Figure 5. Lack of proper drainage

**VI. APPROACHES AND TACTICS FOR MANAGING AND REMEDYING FLOOD CONTROL.**

In Nigeria, the threat of floods has been rising recently. Proactive and preventive alternatives related to both structural and non-structural strategies must be put in place to address and reduce the impact of floods. Structural measures like check dams, levees, flood walls, and proper drainage systems will assist in managing periodic flooding in flood-prone areas in the following manners:

(a). Building irrigation structures and diverting surplus water for inter-basin transfer offers an alternative solution to managing excess water in Cameroon.

- (b). Check dams to help decrease high water volumes.
- (c). Levees and flood walls restrict the movement of water to specific pathways.
- (d). Satisfactory drainage systems can lower flood peak stages and divert extra flow.
- (e). In areas with high stormwater flow rates, it is important to ensure there is embankments to divert stormwater and prevent flooding. These barriers can either be long-lasting or temporary, like when sandbags are used to prevent flooding. Nevertheless, relying solely on structural measures could result in subpar floodplain development and could potentially result in increased

damages during storms that surpass the structures' design limits, as evidenced by the Bagauda dam collapse in Kano. As a result, the following non-structural measures could be implemented to address the problem of flooding in Nigeria.

(i). Managing floodplains is considered as the most effective method. To solve flooding with this method, start by creating a flood-frequency curve using past data and analyzing vegetation to estimate the frequency of floods of a specific size in a specific location. While this method doesn't predict flood timing precisely, it does provide an estimate of their frequency using historical data. It can be done by banning specific buildings or activities in flood-prone areas, raising or flood-proofing buildings in designated floodplains, and building a floodway to safely divert floodwaters.

(ii). In developed countries like America and Europe, there is consistently a dedicated task force assigned to addressing snow issues as winter approaches. Similarly, the Nigerian government should be proactive by establishing a permanent task force to address flood concerns before the rainy season arrives.

(iii). The strict enforcement and adherence to town planning laws will greatly help in controlling the problem of floods. The Nigerian government must always prepare in advance for the population to prevent unplanned houses and cities. As a result of blocking these natural drainage channels, stormwater will have no paths to flow through, leading to natural disasters in susceptible areas.

(iv). Every road needs to have sufficient drainage facilities included during construction.

(v). Regular inspections and monitoring of drainage systems are essential to identify any failures and promptly carry out necessary repairs. Additionally, measures should be taken to prevent sedimentation and litter from clogging drainage systems, and trees with roots that can cause damage to the system should be removed.

(vi). The culverts located directly downstream should be cleared of sediment and properly positioned to maintain efficient drainage and self-cleaning.

(vii). Nigerians need to understand that "For every action, there is an equal and opposite reaction". In order to prevent blockages in drainage channels, it is important for people to dispose of their waste properly and not throw it into the drains. This waste, like discarded plastic, footwear, and clothes, can clog drains, especially at narrow points.

(viii). People commonly impacted by floods need to be better informed about environmental best practices.

(ix). Rewrite the subsequent text using the same source language and maintain the same word count: Concerted action is needed to focus on proper city planning, creating policies, boosting public awareness programs, incorporating environmental planning and education into school curricula, and building capacity to address climate change through adaptation and mitigation.

(x). Government at every level must guarantee the appropriate and efficient utilization of the ecological fund; and promote the inclusion of environmental disaster insurance to address the consequences of flooding.

(xi). Establishing partnerships between local communities, NGOs, voluntary groups, and local and international donors is necessary for managing floods.

## VII. CONCLUSION

This study examined flooding and the management of flood risk in Nigeria. Some traits and difficulties were talked about. It was observed that the rise in flood occurrences has led to greater awareness and increased activity in the management of flood disasters in Nigeria, but there is a lack of coordination and integration among key FRM systems and processes. FRM strategies and actions usually focus on optimizing specific sub-sectors or sub-regions. Urban system planning and development lacks holistic or systemic thinking. Inefficiency and ineffectiveness in FRM systems result from the absence of integration with other built environment subsystems. Despite significant resources and investment being dedicated to various structural FRM measures, there has been minimal implementation of these technologies in the Nigerian socio-technical context and a lack of necessary knowledge transfer to local experts.

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