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FLOOD PLAIN ENCROACHMENT AND LOKOJA FLOOD INCIDENCES

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Abstract

***Background**: Lokoja city is a confluence to two major rivers in Africa, river Niger and Benue. Flooding occurred in the city whenever neighboring countries: Guinea, Niger, Mali, and Cameroon release excess water from their dams. This study examine flood plain encroachment and flood incidences in Lokoja. **Method:** Cross sectional survey was adopted for the study. Both qualitative and quantitative data were used for the study. Geographical Information System was used to acquire spatial data and imagery of residential buildings that were sited on the flood plain of river Niger and its tributaries. 730 housing units along river Niger flood plain were sampled using 0.02% of the sample frame. Chi-square was used to examine the significant difference in the compliance of building to Physical Planning standards on river setback. **Results:** The prevalence of non-adherence to 45 meter Physical Planning standards on rivers setbacks was 63.1% on river Niger flood plain and 79.7% to ganaja stream. Chi-square statistic is $x^2=10812$, $P<0.005$. No statistical significant difference in the compliance of residential building to physical planning standards on rivers and streams setbacks. **Conclusion**: The study has demonstrated that central to Lokoja flooding are land use activities arising from urbanization, occupation of flood plain and metrological factors. Mitigation measures and initiatives were advanced in this paper to make the city more resilient to flood disaster.*

***Keywords:** Floodplain encroachment, Lokoja flood incidence, Flood Risk mitigation*.

INTRODUCTION

Lokoja city is a confluence to two major rivers in Africa, river Niger and Benue (figure 1). Flooding occurred in the city whenever neighboring countries: Guinea, Niger, Mali, and Cameroon release excess water from their dams. Flood in its simplest form refers to the overflow of water from its border or river banks resulting in submergence of its surrounding areas. It is a discharge which exceeds the channel capacity of a river and then proceeds to inundate adjacent flood plain

which is previously dry to threaten life and property [1]. Floods are most frequently related to climate. They are purely an environmental hazard of meteorological phenomena but very often induce by man's improper utilization or abuse of the physical environment [2] [3]. Excessively heavy and prolong rainfall is the commonest universal cause of flood [4] and [5] such rainfall when concentrated produces exceptional local floods. Apart from torrential rain rapid thawing of ice may cause rivers to rise considerably and flood over alluvia plain, which forms the greater part of a river valley. In addition some socio economic and anthropogenic activities have been found to induce or intensify flood condition in our environment [2] [3] and [5]. An accurate assessment of the havoc created by floods in Lokoja is difficult to obtain because of the paucity of official data. On account of these perennial devastation. This study seeks to documents flood incidences in Lokoja and advanced measures to mitigate flood disaster and make the city more resilient to flood disaster.

Encroachment can be described as the advancement of structures, roads, rail roads, utilities and other developments, the removal of vegetation or an alteration of topography into such natural areas as floodplains, river corridors, wetlands, lakes and ponds and the buffers around these areas [6]. The conversion of agricultural forest, grassland and wetlands to urban areas usually comes with a vast increase in impervious surface, which can alter the natural hydrological conditions within a water shield. The outcome of this alterations is further reflected in increases in the volume and rate of surface run off and decreases in ground water recharge and base flow. Which eventually lead to larger and more frequent incidents of local flooding [7].

A floodplain therefore refers to an area of land adjacent to a river which stretches from the banks of its channels to the base of the enclosing valley walls and which experience during a period high discharge. A flood plain is also an area of flat land alongside a river which gets covered in water when the river floods [8]. [9] Opined that there are two stages to flood plain encroachment. These are the pre – development phase and the development phase. The predevelopment phase involves the removal of the riparian vegetation on the floodplain by agricultural land user's activities and in some other climes, there is the common practice of channeling industrial water outlets along floodplains. These changes creates an alteration and causes an increase in the deposits of debris and sitting of river channel, thus increasing. The frequenting and time period of flood occurrence. The development phase of floodplain encroachment involve the transformation of the floodplain from initial intrusion of the pre – development phase into a full blown physical development whereby natural surfaces are replaced by more impermeable surface roads and concretized surfaces which have very low infiltration capacity. This type of development triggers an increase in the coefficient of runoffs thus leading to increased volume of run - off during rainfall episode with this, the capacity of the river channel to convey water is altered and the height of the water on floodplains increase [9]

The rapid growth and expansion of urban centres and the need for land space for different uses have often resulted in the encroachment of the floodplains thus increasing human vulnerability to flood disaster. [10] also asserted that urban encroachment into floodplains alters the integrations of surface run off with the main channel, reduces surface water storage and conveyance

capabilities, reduce water quality of receiving water and adjacent land, in additions other secondary effects such as depletion of water resources and pollution of downstream surface waters.

[11] Suggested that increasing urbanization along river floodplain has led to the problem of flooding. This has highlighted the need to understand the consequences of urban developmental activities on the geomorphology of rivers and the propagation of flood wave along the river channels. [12] Argues that the hydrologic effects of urban development often, are greatest in small stream basins where prior to development much of the precipitation falling on the basin would have become subsurface flow, recharging aquifers or discharging to the stream network further downstream. He therefore affirms that structures which encroached in the floodplains such as bridges, can increase up stream flooding by narrowing the width of the channels resistance to flow. Urban areas in Nigeria are particularly vulnerable to flooding due to inadequate drainage system; changes in eco system through the replacement of natural and absorptive soil cover with concrete; deforestation of hill sides which has the effect of increasing the quantity and rate of runoff through soil erosions and the silting up of drainage channels [7].

Geographic Information System (GIS) have been deployed in the flood monitoring and risk disaster management in studies conducted across regions and countries. In particular, GIS techniques have been applied in the analysis of flood related issues in Nigeria, a number of studies exist on the application of GIS to flood monitoring and risk disaster management .[13] focused on the application of remotely sensed data and GIS techniques for terrain analysis for flood disaster vulnerability assessment of Niger State. They created and classified Digital Elevation Modeling (DEM) of the state into four: Niger valley, plains, uplands and highlands areas using ArcGIS 9.3 software. It was revealed that the Niger valley and the plain terrain of the state, which are classified as “highly vulnerable” and vulnerable respectively to flood disaster, collectively cover a land area of 58.43% of the state land area.

Flood Risk Mitigation and Adaptation Measure

[14] Affirmed that land use and territorial planning are key factors in risk reduction. The environment offers resources for human development at the same time as it represents exposure to intrinsic and fluctuating hazardous conditions. Population dynamics rivers demands for location and the gradual decrease in the availability of safer lands, mean it is almost inevitable that humans and human endeavor will be located in potentially dangerous places [14]. Where exposure to events is impossible to avoid, land use planning and location decisions can be accompanied by other structural or non – structural methods for preventive or mitigating risk [15]. Flood risk reduction, as identified by [16] includes structural and non – structural measures. According to them these measures -should be integrated parts of both the overall development process and relief and recovery activities, in response to floods or other disaster.

[17] Discuss three main approaches for managing storm water with the primary goal of preventing property damage from flooding the conventional storm water conveyance systems: This measure focus on the design of the conventional storm water conveyance system. The goal of the conveyance system is to effectively collect, convey and discharge storm water runoff. The design approach adopts “end – of – pipe control” method by sitting the storm water management controls

at the most downstream point of the entire area. This approach is highly contextual and works best at maintaining the peak runoff rates for a particular design storm event at pre – development level. The low – impact development hydrologic design. It is a distributed control approach which, in comparison with conventional storm water management, has the objective of retaining the post – development excess runoff volume is discrete units throughout the site to emulate the predevelopment hydrological regime [17]. The approach is to manage runoff of the source rather that at the end of pipe. This design approach aims at learning as many undisturbed areas as practical to reduce runoff volume and runoff rates by maximizing infiltration capacity. The hydro - logically functions landscape. In addition to the low – impact development hydrologic design, this approach goes further to incorporate integrated management practices by disturbing integrated storm water management controls throughout the site to compensate for the hydrologic alteration of development. The approach of maintaining areas of high infiltration and low runoff potential in combination with small on lot storm water management facilities creates a "hydrological functional landscape" [17].

Structural measures like embankment can provide protection against many type of flooding. Flood control alone, however often does not provide a robust, long term solution for addressing flood risk. Such efforts at food control in both urban and rural contexts have produced limited solutions sometimes even exacerbating flooding problems, when applied in isolation from overall policy in the floodplains. [18]. However, such structure may offer solutions to critical aspects of the flooding problem if they are used in conjunction with other non – structural measures are planned and implemented with the participation of local people with an understanding of possible negative consequences and are integrated in the overall development policy.

Study Area

Geographical Location

Lokoja is located on the intersection point of longitude 7^0 49'E and latitude 6^0 44'N on a map of Nigeria (fig.1.). Lokoja is presently the administrative capital of Kogi State created in 1991. Lokoja occupies an area of about twenty square kilometres. It lies on the right-hand side of kilometrer seventy-six of the Okene-Abuja Road. It is a town situated on the slope of a range of hills called Mount Patti. The town in its growth, runs down the slope and expands into the Niger River valley (fig.1).

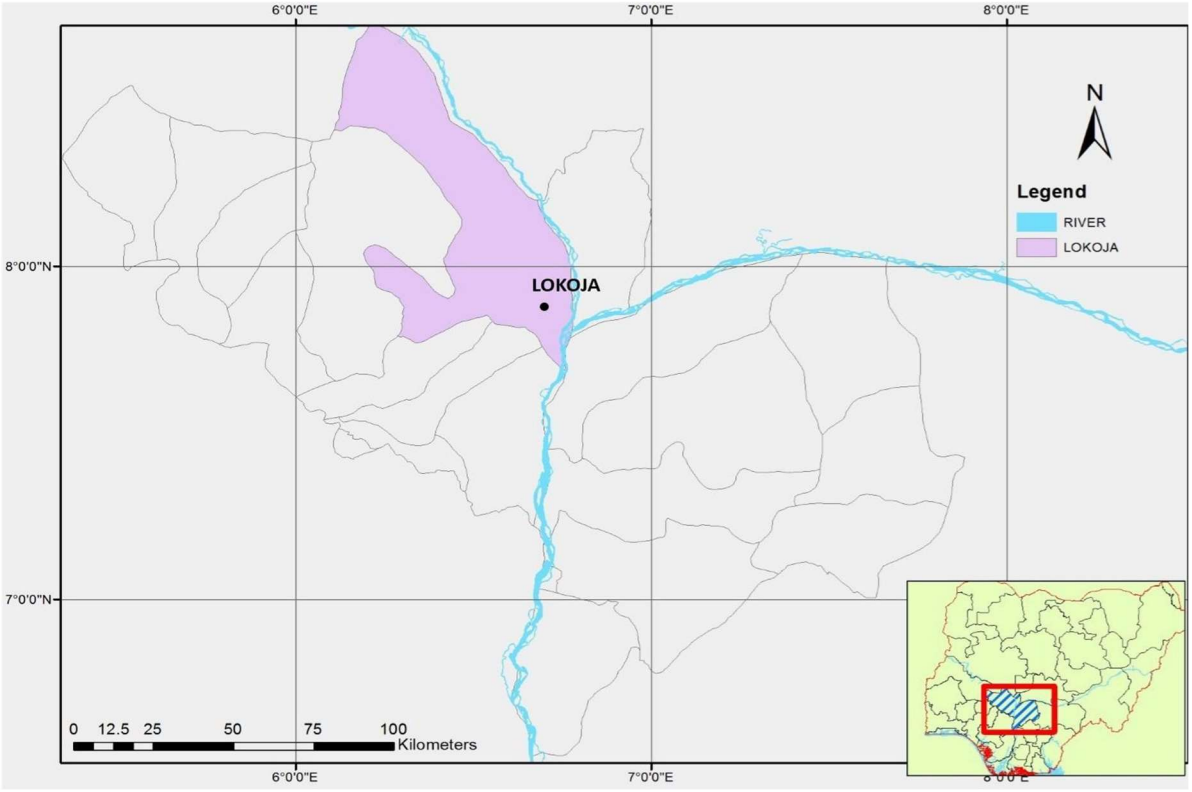

Figure 1: Lokoja in the context of Kogi state and Nigeria.
Source: Kogi State Ministry of Environment and Physical planning, Lokoja. 2023

Geology, Hydrology and Drainage

The geology of Lokoja comprises two main rock types, namely, the basement complex rocks of the Precambrian age in the western half extending slightly eastward beyond the lower Niger valley and the sedimentary rock in the Eastern half. The river Niger is an important river system in Nigeria with River Benue's confluence at Lokoja at an average flow rate of 137.9km^2/year. The rainy season water level of the river Niger fluctuates between 8-10m above sea level while the dry season water level ranged from 3-5m. The drainage of Lokoja is the River Niger with extensive river bed floodplain that are used for all year-round agricultural activities. Aside the River Niger drainage system with extensive floodplain. Among them is the Ganaja stream which drains into the River Niger.

Lokoja is especially vulnerable to flooding because of its location.. It is a city located at the foot of a hill- Mount Patti. Whose growth extended to Niger River valley (fig 1) Settlement located along flood plains and river set backs are more vulnerable to flood disaster in Lokoja. Recorded flood occurrences in Lokoja dates back to 1902 when river Niger overflowed its banks and flooded Lokoja cantonment of the city about 25 houses had their foundation submerged. In 2011 river Niger also overflowed and drown the houses of residents along its banks and cut off all roads leading to FCT, Abuja, by 2022 river Niger and its tributaries in Lokoja sacked about 425 houses and subsequently, the flooding problems recurred in 2011, 2012, 2022 respectively with more devastating ad unprecedented losses and damages to residents. The flood profile of Lokoja is

shown in Table.1. Most of the recorded flood occurred between August and first week of September which mark the second peak of annual rainfall in the Tropical continental climate.

Table 1 Profile of flooding in Lokoja between 1900 and 2022.

Date	Depth of Associated Rainfall mm	Description	No of Affected building	Major Affected River
1902	-	Flooding of Lokoja cantonment	25	River Niger, Benue.
1924	-	River Niger overflowed its bank	66	River Niger, Benue Ganaja stream
1956	161	Niger and Benue flood which rendered many homeless and destroyed properties.	76	River niger and Ganaja stream
August 28th 1960	170	River Niger flood disaster destroyed over 85 houses	85	River Niger
August 30th 1963	258	River Niger overflowed it bank again causing disaster to many homes	92	River Niger and Benue
August 31st 1980	250	River Niger flood disaster, the most devastating ever in the history of Lokoja. It killed about sixty five people and destroyed properly worth millions of naira	121	River Niger and lower tributaries of River Benue, and Ganaja Stream
August 26, 2011	1275	Affected all the major highway leading to Abuja. Destroyed life and properties	105	River Niger Ganaja stream Meme stream
July 14, 2012	164	Roads and bridges were washed away destroyed life and properties	125	Lower Niger Valley, River Niger
September 10th 2022	150	Houses were submerged while road and bridges were also washed away	425	River Niger, Ganaja stream and Meme stream

Source [19], [20] and Authors field work 2022.

Materials and Methods

This was a cross sectional survey design. Both qualitative and quantitation data were used for the study. Geographical Information System was used to acquire spatial data of community residential buildings sited alone the flood plain of river Niger in Lokoja Nigeria (Fig.2). [20] Opines that larger population permit smaller sampling ratio for equally good sample. Hence for this study a

sample size of 730 housing units along flood plain of river Niger and its tributaries were selected using 0.002% of the sample frame. Chi-square was use to analyze the data collected for the study.

Figure 2. Lokoja Satellite Imagery Showing residential building on river Niger Flood Plain Sources: Field Survey, 2023

Results and Discussions

Table 2 presents the percentage of residential building that adhered to the stipulated setback from stream/river. Only 36.9%of the residential building had to river Niger in Lokoja, while 33.3% of buildings had a minimum setback of 45 meters to river Benue. This implies that 63.1% of the building do not observed 45 meters to river Niger from the last limit of flooded area. While (23.3%) of the building complied with the 15 metres setbacks from Ganaja stream. The study also demonstrated a very low compliance to setback to meme stream only 30.4% of the residential building adhered while the total of 69.6% of the building encroached into the meme stream.

Table 2. Observed and Expected Minimum Standards

River	Expected minimum standards (M)	Foot (F)	Number of building that met the standard
Niger	45.0	150.0	421 (36.9%)
Benue	45.0	150.0	52 (33.3%)
Ganaja	15.0	15.0	153 (20.3%)
Meme	15.0	15.0	104 (30.4%)

Source: Field Survey, 2023.

To ascertain the statistical significance differences of the level of compliance of encroachment to approved space standards for residential building to rivers and Streams, Chi-square analysis was adopted. The hypothesis states that, there is no significant difference in the compliance of building to physical planning standards on river/stream setback. The result of this test was presented in Table 3, the value of the chi-square statistics is (X^2 = 10, 812) the computed p-value was less than 0.005. This shows that there was a significant difference in the compliance of residential building to stream/river setback standards. The unit implies that there was high level of encroachment into stream/river valley.

Table 3. Chi-square analysis

+	Value	Df	Asymptotic significance sides	E-fact sig. (2-sides)
Pearson chi-square	10.812	4	.000	
Likelihood ratio		4	.000	
Fisher's exact test				.014
N of valid cases	730			

Source: Authors Fieldwork, 2023

By jurisdiction and legal mandate, the Kogi State Ministry of Land and Physical Planning and Development Control of the Kogi State are involved in the management of flood plain in Lokoja. The enforcement of river/streams setback is partly guided by the Bureau of Land and Physical

Planning and Development Control of the Kogi State Ministry of Land and Physical Development. However, the institutional structure for the management of river corridors and flood plains is fraught with irregularity and inconsistency [22]

As illustrated in Table 2 the stipulated setback by the ministry of Land and Physical Development ranges from 15m to 45m taken from point of last flood limit. In other words the minimum setback for any stream in Lokoja is 15m while 45m for rivers despite the standards, there are cases of flood plain encroachment.

The increasing sprawling expansion of the city in Lokoja into flood plain had further increased the rate of contravention leading heading to the encroachment of flood plain. Greater encroachment were noticeable along river Niger valley. This is connected to many factors ranging from ignorance poverty, and scarcity of land for development.

Summary, Conclusion and Recommendation

The study examined flood plain encroachment and flood incidences in Lokoja. The study reveals that uncoordinated urbanization, structures along floodplain and silting of drainages and river channel were implicated as factors that exacerbate flood disaster in Lokoja. The city of Lokoja has witnessed a huge cost over the years as a result of damaging flood disaster. Having examines the flood plain encroachment and flood incidences in Lokoja the following recommendation were made.

The dredging of major rivers in Lokoja to desilt the mouth of the river Niger. Although, the administration of Late President Musa Yar' Adua started the dredging of river Niger but it was latter abandon by his successors, such dredging could reduce perennial flooding, ensure all year navigation of river Niger.

Removal of encroachment along flood plain. Although it has been argued that removal of encroachment does not necessarily eliminate flooding but it can reduce damages and lost.

Building of dam at the upstream of river Benue in Adamawa state to accommodate the release of excess water from Loggo dam from Cameroon during the second maxima rainfall in September, this will reduce the annual flooding of the city.

Structural flood control measures such as embankments in the bank of rivers.

There should be public awareness system on the effects of flooding and early warning signal from metrological Agencies on impending flooding.

Land use regulation is a measure involving allocating the flood prone areas to uses that will gain what is lost in floods; for examples agriculture and recreation activities.

Laws are expected to effectively guide the urban land use practice for example, urban and Regional planning laws made it mandatory for protection of wet land. A stab ac of 45m to the last level of flooding a major rivers and 30m setback to a stream. These law have to be strictly adhere to. Finally community participation in flood disaster management is critical in providing support to flood victim. Change in land use. Land area located on the flood plain should be converted from residential area to passive recreation site.

Post – flood community Recovery processes should provide better understanding of the local economy to determine how different intervention may affect it. Relief materials should be administered to flood victims rather than cash gift to prevent local inflation.

References

1. Monkhouse, F. J & Small, J. (1978). *A Dictionary of the Natural Environment.* Edward Arnorld Ltd
2. Oriolola E.O (1994) Strategies of combating urban flooding in a Developing Nation. A case study from Ondo Nigeria. *The Environmentalist*. Vol 14 (1) 57 – 62.
3. Oriolola E.O (1998) Anthropogenic Activities and flood inducement in Urban Environment: The case of undo state Nigeria in S.O Ojo and J.E Ukeje (eds) Africa processing's of sustain Africa Vol 5 PP 1-4.
4. Olaniran, O.J (1983) flood generating mechanism at Ilorin Nigeria Geo Journal 7 (3) PP 2710.
5. Babatolu, J.S (1997). The June 24th 1995 flood in Ondo. Its Antecedent and Incident. *Iffe Research Publications in Geography*. Vol.6 (1and2) Hoyt A and Langbein W.B (955) Floods. The Ronald press N.Y
7. Omirin, O.J (2020). *Flood plain Encroachment and incidences of flood in Ibadan*. Department of urban and Regional planning, faculty of environment design and management, university of Ibadan.
8. Kates, R. (1985) *Hazard Assessment; Art and Social Science and Ideology*. Neat View press, London
9. Sani, A.S (2005) Analysis of flood plain Encroachment pattern and management in Kaduna Metropolis M.S.C. Dissertation submitted to the Department of urban and regional planning, faculty of environmental design, Ahmadu Bello University Zaria, Nigeria.
10. Emeribeole, A (2015) Managing Flood Disaster in Nigeria Cities issues and Strategies towards meeting challenges in the modern world. A case study of oweri metropolis Imo state, Nigeria.
11. Alayande, A.W. Aganwamba, J.C (2010). The impact of urbanization in Kaduna River flooding *Journal of American science* 6(5): 28 – 35.
12. Konrad C.P (2016). Effects of urban Development on flood plains, *US Geological survey fact sheet.* 076 – 3. Retrieve from Https//puts/usgs.gpv/fs/fs07603
13. Lavel, A, (2003). *Local level Risk management concept and practice.* Quito CEPREDENAC UNDP.
14. Ikusemoran, M. Kolawole, M.S. Adegoke, M. (2014). Terrain Analysis for flood Disaster Vulnerability Assessment: A Case study of Niger state, Nigeria.
15. United Nations (2009). *2009 Global Assessment Report on Disaster Risk Reduction: Risk and Poverty in a Changing Climate*, UNISDR, Geneva, 207pp, Available at http://www.preventionweb,net/net/english/hydro/gar/pid3&pil:1
16. ALNAP and Prevention (2008). Flood disasters learning from previous relief and recovery operation available at www.alnap.org/publications/(Retrievesinjune.2012).

17. Prince George's County (1999). Low-Impact Development Hydrologic Analysis. Department Environmental Resources, Prince Geordes County, Maryland
18. ADPC and UNDP (2005) Integrated flood risk management in Asia. Bangkok – Asian Disaster preparedness centre and united Nations Development programmes. Available at www.adpc.net/maininforesource/udrm/floodprimer.pdf(Retrivedinjune2012)
19. Nigerian Metrological Agency (NIMET) (2012) Nigerian climate Review Bulletin, Abuja, NIMET.
20 Nigerian Environment Study and Action Team (NEST) (1991). Nigerians Threatened Environment: A National profile. Ibadan NEST.
21. Neuman, W.L (1994) *Social Research Methods Qualitative and Quantitative Approaches*. Second Edition, Boston, London, Toronto, Sidney, Tokyo and Singapore: Adyn andBacon.
22. Wahab, B. and Falola .O. (2016). The consequences and policy implication of urban encroachment into flood – risk areas. The case of Ibadan. *Environmental Hazards* 16 (1) 1 – 20.