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FLOOD THREATS ON LAND USES AND POPULATION IN LOKOJA, KOGI STATE, NIGERIA

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ABSTRACT

Flooding is a natural or man-made disaster that leads to voluntary or involuntary resettlement, which further causes population displacement and untold human misery. Lokoja, the capital town of Kogi State, Nigeria is prone to frequent flooding, posing significant threats to human settlements, infrastructure and economic activities. The study assesses the relationship between flood threat, land uses and population affected by flood in Lokoja metropolis. This research focused on flood occurrences of high to medium flood risk zones. Data were collected using both primary and secondary sources. 274 questionnaires were administered as sample sized to respondents across the strata of all the flood affected communities. Data were analysed using descriptive statistics (percentage distribution) and inferential statistics (Pearson's moment correlation) in assessing the relationships between minimum water levels, land uses and population affected by flood. Findings from the analysis show that there is a strong positive correlation between minimum water level and farmland and open space with the greatest correlation coefficient of 0.986. Also, commercial land uses has a slightly stronger correlation (0.899) with minimum water levels. The study therefore conclude that flooding had a significant impact on residential, commercial, and particularly agriculture and open spaces, inflicting widespread property and infrastructure damage. This research serves as a critical tool for policy makers, urban planners and stakeholders to priotize on flood risk management and coordinated physica development in Lokoja metropolis.4231.

KEY WORDS Urban flooding, vulnerability, disaster, climate change, Lokoja.

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1. INTRODUCTION

Floods remain the most devastating natural disaster globally, despite substantial investment in flood prevention and management in recently decades (Bubeck et al., 2017). In developed world, such as the United State of America, flooding is reported to be one of the most common and destructive natural disaster (Smith and Alexander, 2018). Georgakos et al., (1997) reported an estimation of flash flood potential for large areas in United State of America, upon which a methodology for determining the potential for flash floods in small basins, within large geographical area was presented. Geographical information system (GIS) technology was used to assimilate digital spatial data and remote sensing data. Similarly, Smith and Alexander (2018) examined the impact of 20 years flood frequency on land cover change type in Louisiana, Texas and Arkansas zones of United State.

In England, Flooding is the largest natural disaster risk and it is expected to rise even further with a changing climate (Surminski and Elderdges, 2017). A study by Kay et al., (2007) revealed that extremely large increase in winter rainfall is a major contributor of flood hazards in England. Centre for research on the epidemiology of disasters (CRED, 2011) reported the world's most disastrous flood in terms of the number of people who lost their lives occurred in the year 2004 in Haiti, Caribbean Island Nation. The report indicates that for fourteen days, there was continuous heavy downpour which caused swelling of rivers and subsequently overflowing of river banks claiming over 2,400 lives.

Ministry of Environment and forest (MOEF, 2005), reported that flood is a regular natural disaster occurring in Bangladesh, entailing huge damage to the economy. Brouwor et al., (2007) reported that Bangladesh is a highly flood prone country. Satterthwaite et al., (2007) reported that during the year between 1996 and 2005, floods had serious devastating effects on

the continent of Africa. Egbinole et al., (2017) reported that in 2007, most part of Africa experienced one of the worst and severe flooding events and more than one million people were affected in over 20 countries. In particular, Uganda, Ethiopia, Sudan, Burkina Faso, Togo, Mali, Niger and Benin were seriously affected. Amoako, (2012), reported the impacts and readiness of African cities dealing with urban flooding using Accra, Ghana as a case study. He reported that flood events can be attributed to overflow of rivers within the cities catchment, uncontrolled growth, poor waste disposal and rapid urbanization.

According to Anunobi (2003), Nigerian flood plains attracted settlements especially in the northern part of the country where the population is mostly agrarian. According to National Emergency and Management Agency (NEMA, 2009), floods affected 150, 000 people and displaced tens of thousands across the northern States which includes Kaduna, Gombe, Niger, Benue, Kogi, Adamawa, Taraba, Zamfara, Sokoto, Jigawa and the Federal Capital Territory, Abuja were worst affected. In 2012, the country experience the worst flooding in more than 40 years, 33 out of the 36 states in Nigeria were affected. An estimated seven million people were affected by the floods, about 363 people died and more than 618, 000 houses were damaged resulting in internal displacement of about 2, 157, 419 people (Egbinola, 2017).

Those involved in the fishing sector of the agrarian industry normally settle along the river banks and tributaries which are naturally flood prone. The reports of (Amagabra et al., 2015; Ebenta et al., 2015), on flood vulnerability assessment of Niger Delta states and Lokoja. They estimated that Nigeria suffered combined losses of more than \$16. 9 billion in damaged properties, oil production agricultural and other losses due to flood events in 2012 alone. Storbjork, (2007); Tran et al. (2009); Adedeji et al., (2012) reported about the threats of flooding to communal safety and natural development, due to lack of integrated

and sustainable flood risk management (FRM), system and practices in Nigeria.

Flood threat on land uses and population is generally acknowledged by many researchers to consist of three components: degree of exposure, susceptibility and resilience or response capacity of a population in particular area (Manandhar, et al 2015). Besides these components, vulnerable communities can be further evaluated through a variety of flood threat on land use determinant drivers such as physical, social, economic, environmental, agriculture, urban planning threats (Wisner et al. 2014).

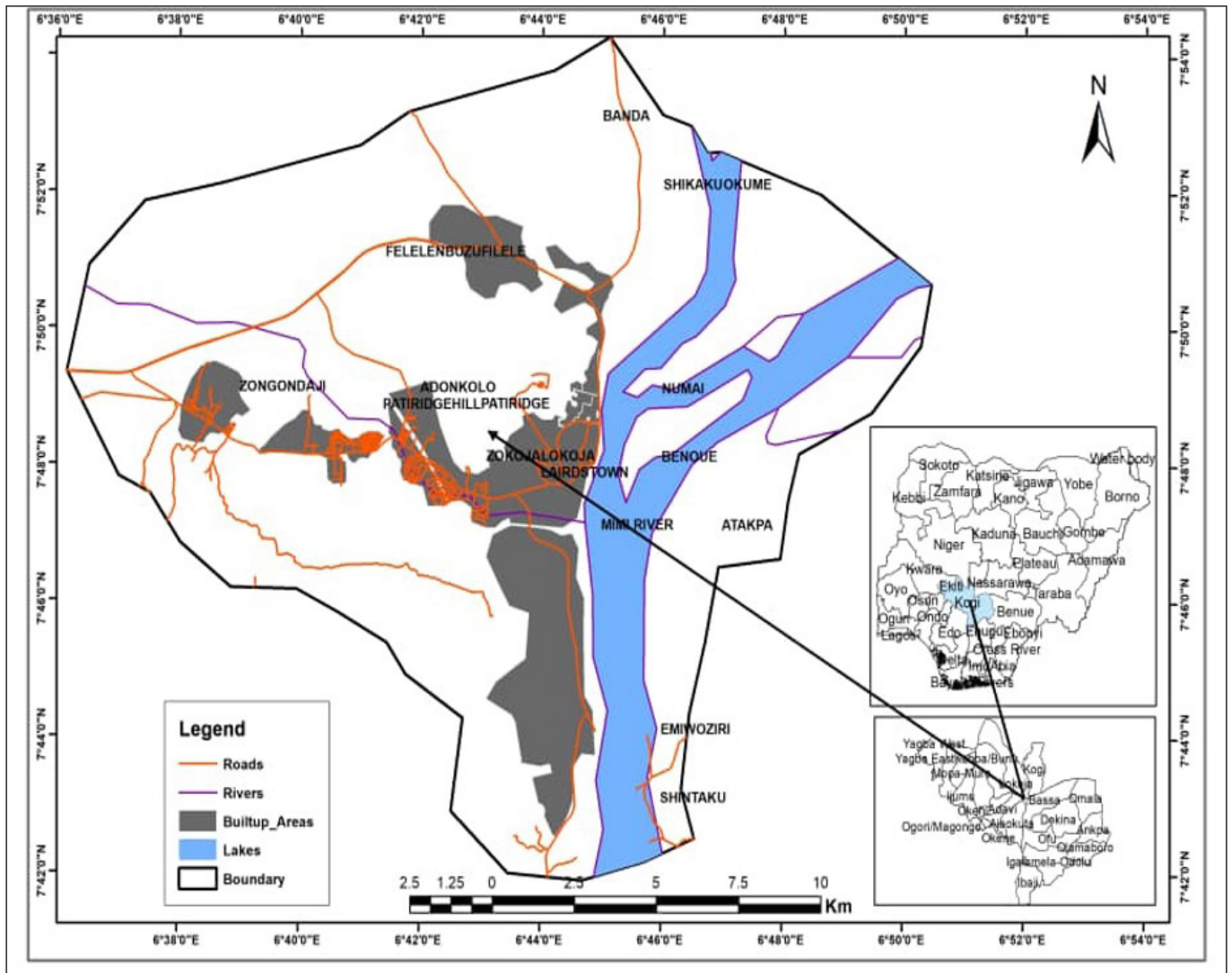
In view of the aforementioned physical and environmental challenges associated with flooding in the study area. Therefore this study focus on flood threat on land use and population in Lokoja metropolis, Kogi State, Nigeria. It can be stated that the study is meant to generate a flood threat database, reduce flood risk and promote sustainable urban development in Lokoja metropolis. The study will classify the environmental and physical elements at risk, determine the flood threat index and use the findings to prepare flood reduction, reduce flood risk and mitigation for Lokoja metropolis.

2. MATERIALS AND METHOD

2.1. The Study Area

Lokoja is the capital city of Kogi State in North-central Nigeria. It lies between Latitude 7o 45' 27.56"- 7o 51' 04.34"N and Longitude 6o 41' 55.64"- 6o 45' 36.58"E, with the total land coverage of 63.82 Sq.km Onuigbo et al, (2017) (Figure 1). It is situated on the Western bank of the confluence of River Niger and River Benue at an altitude between 45-125 metres above sea level towards the North-South at the foot of 1349mm of Mount Patti Ridge, which reaches its altitude of 411 metres above sea level Onuigbo et al., (2017).

Figure 1: Map of Nigeria showing Kogi State and the Study Area



Source: Kogi State Urban Development Board (2019)

2.2. Data and Analysis

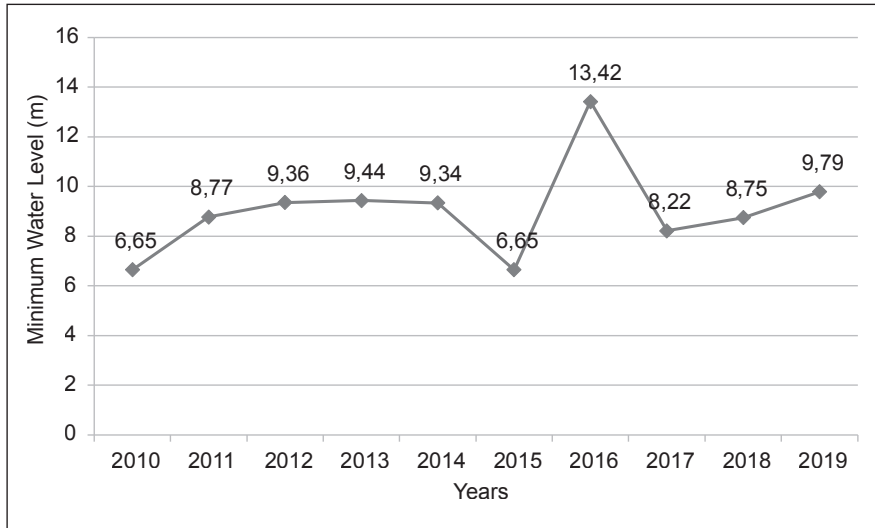
The study used quantitative research methods. Data for this study were gotten from both primary and secondary sources. The primary data was collected from Kogi State Urban Development Board with the aid of a structured questionnaire as a research instrument. Also, another set of targeted population of study is the general occupants of residential buildings which were estimated at 643,000 residents of about 9663 structures affected by flood disasters in Sarkin-Noma, Kabawa-Adankolo axis, Phase I-Old Poly quarters axis, Gadumo and Ganaja communities, from 2010-2019, in Lokoja Metropolis. The sample for the survey was distributed within the declared urban area of 16km radius of Lokoja Metropolis by the state government. Survey questionnaires were distributed using a convenient sampling method to reach out to residents in the area. Several avenues were employed to send out questionnaires such as emails, personal messages and other social media channels. This helped to increase the number of respondents as well as enhance the external validity of the study. Descriptive statistics via percentage distribution was used to summarize data collected, specifically, for analyzing minimum water level, extent of land uses affected by flood and number of structures affected by flood throughout the study period. Inferential statistics, specifically the Person's moment correlation was used to analyse the relationship between land uses, population affected by flood and minimum water level in the study area.

3. RESULTS

3.1. Minimum Water-Level of Floodable Areas in Lokoja Metropolis (2010-2019)

The trend of minimum water level of floodable areas measured in hectares in the study is presented in Figure 2. The finding revealed an averagely increasing pattern of minimum water level trend throughout the decade. The trend pattern shows a relatively flat curve between 2011 and 2014 and a drop in the year 2015. The curve revealed a sharp increase of 13.42m minimum water level in 2016, which is the highest minimum water level in the decade. The curve then continues to increase steadily between 2017 and 2019 from 8.22m to 9.79m minimum water level.

Figure 2: Minimum Water-Level of Floodable Land Uses in Lokoja Metropolis (2010-2019)



Source: Kogi State Urban Development Board, (2019)

3.2. Land Uses Affected by Flood in Lokoja Metropolis (2010-2019)

The research finding revealed how floods influenced various land uses between 2010 and 2019 (see Table 1). Residential areas witnessed a rise in flood-affected land, rising from 39.32 hectares in 2010 to 65.44 hectares in 2019, with major peaks in 2016 (81.43). Commercial areas maintained a similar upward trend, growing from 4.87 hectares in 2010 to 8.12 hectares in 2019, with the largest increase being between 2015 and 2016, from 3.23 to 10.15 hectares. Public areas were less badly affected, increasing from 1.34 hectares in 2010 to 3.83 hectares in 2019, with highest of 4.38 hectares in 2017. Except for slight increases of about 0.1 hectares in 2016 and 2019, industrial areas were relatively not affected. Farmland and open spaces were the hardest hit, starting from 2084.32 hectares in 2010 and changing over time, with highest at 3542.13 hectares in 2016 and 2933.71 hectares in 2019. These findings indicate increased flood susceptibility in the study area, where almost all land uses constantly experiencing the impact.

Table 1: Land Uses Affected by Flood in the Study Area

Land Uses	Years / Land Area (Ha)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Residential	39.32	42.34	52.23	59.49	61.01	47.22	81.43	55.34	53.56	65.44
Commercial	4.87	5.33	6.45	6.71	7.6	3.23	10.15	6.92	7.21	8.12
Public	1.34	2.31	3.34	3.41	3.82	2.87	4.38	3.98	3.18	3.83
Industrial	0	0	0	0	0	0	0.1	0	0	0.10
Farmland/ Open space	2084.32	2562.12	2662.43	2683.78	2676.12	1912.73	3542.13	2408.43	2518.21	2933.71

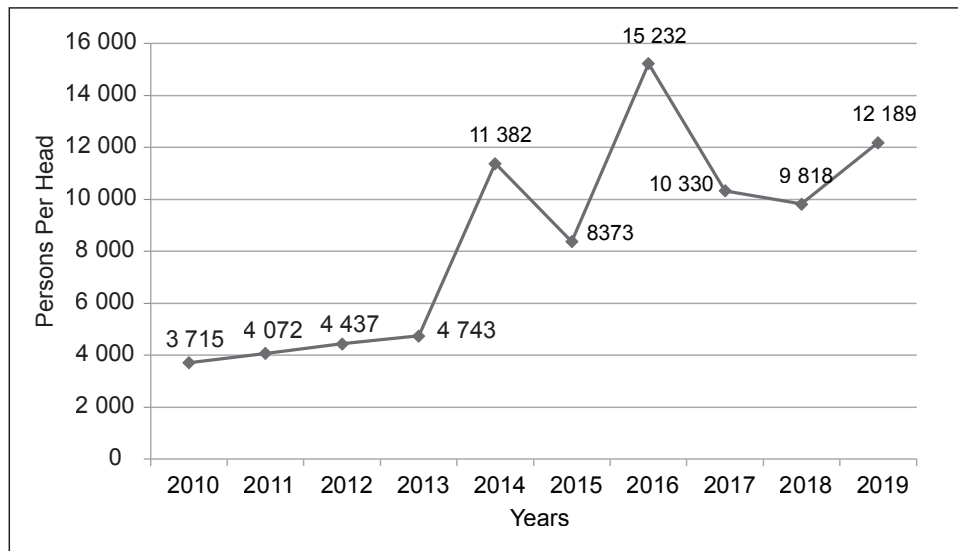
Source: Kogi State Urban Development Board, (2019).

3.3. Estimated Population of Affected Persons in Lokoja Metropolis (2010-2019)

Figure 3 shows the estimated population of flood-affected residents in Lokoja Metropolis from 2010 to 2019. The graph shows that flooding has had a major and varying influence on the local population during the past decade. These fluctuations in the population affected by floods may indicate shifting flood intensities, urban development into flood-prone areas, or variances in flood control efforts throughout the decade. In the early years of the decade, the number of persons affected by the floods gradually grew, from 3,715 in 2010 to 4,743 in 2013. This constant trend could signal increased flood intensity or the expansion of settlements in vulnerable locations. However, a substantial increase happened in 2014, when the affected population jumped to 11,382, more than doubling the previous year's total. This sharp rise is most likely due to either a severe flood event in 2014 or a significant increase in population exposure to flood-prone areas.

Following this, the number of people affected fell to 8,373 in 2015, indicating that temporary flood control measures or less severe flooding conditions were implemented. However, the situation worsened again in 2016, with the number of flood victims rising at 15,232, the highest in the previous ten years. This peak indicates an extreme flood occurrence or a combination of conditions, such as poor drainage infrastructure or inadequate urban planning, which contribute to greater susceptibility. In the following years, the flood impact fluctuated, with 10,330 individuals affected in 2017, a little decrease in 2018 to 9,818 persons, and an increase to 12,189 in 2019.

Figure 3: Estimated Population of Flood Affected Persons in Lokoja Metropolis (2010-2019)



Source: Kogi State Urban Development Board, (2019)

3.4. Flood Affected Structures from 2010-2019

Table 2 shows the number of flood-affected structures in five Lokoja localities between 2010 and 2019. Flooding affected a total of 9,663 structures. The Kabawa-Adankolo Axis in Lokoja has the most affected structures with 3,681 (38.09%) properties. This is followed by SarkinNoma neighbourhood with 2,183 (22.59%) structures affected. Gadumo reported 1,764 (18.26%) damaged structures, indicating significant damage, whereas the Ganaja area had 1,448 (14.98%) affected structures. These data indicate the broad nature of flooding in several neighbourhoods. In contrast, the Phase 1-Old Poly Qtrs Axis has the fewest affected structures with 587 (6.07%) of structures. This lower percentage may indicate improved flood management measures or geographic advantages that lessen risk. Example of damage caused by flood in Lokoja during the study period is shown in Plate 1.

Table 2: Flood Affected Structures from 2010-2019

S/No.	Areas (Axes)	Total Structures Affected	Percentage
1	SarkinNoma	2183	22.59
2	Kabawa-Adankolo Axis	3681	38.09
3	Phase 1-Old Poly Qtrs Axis	587	6.07
4	Gadumo	1 764	18.26
5	Ganaja	1 448	14.98
Total	Five (5) Communities	9663	100

Source: Kogi State Urban Development Board, (2019)

Plate 1: Extent of Flood Disasters on Physical Infrastructure and Environment.



a. Submerged Residences in Gadumo Qtrs



b. Old-Poly Qtrs Flood Disaster



c. Galilee-Kabawa Road Affected By Flood



d. Submerged Ganaja Road

3.5. Relationship between Flood, Affected Land Uses and Population of Persons in Lokoja

The findings in Table 3 look at the relationship between minimum water levels and the various land uses in the study area. The correlation coefficients show substantial interactions that indicate how rising water levels affect various land types, emphasising the importance of good flood management techniques. The lowest water level has a substantial positive link with farmland and open space, with the greatest correlation coefficient of 0.986. This suggests that as water levels increase, farming and open spaces will be adversely affected. Residential areas have a significant link with minimum water levels, with a value of 0.895. This substantial correlation suggests that rising water levels are likely to cause significant floods in residential areas, affecting housing and residents’ safety. Commercial land uses has a slightly stronger correlation (0.899) with minimum water levels. The impact on commercial properties may result in economic losses and disruptions in the urban economy.

Public spaces also have a strong correlation coefficient (0.708) with minimal water levels. This shows that, while public places are affected by flooding, the consequences may be less severe than those on residential or commercial buildings, possibly due to the design and types of structures used. Industrial land uses have the lowest relationship with minimum water levels, at 0.507. This implies that these land uses may be less affected by rising water levels, either due to improved flood defences or geographical advantages.

Table 3: Relationship between Flood and Affected Land Uses in the Study Area

	Minimum water level	Residential	Commercial	Public	Industrial	Farmland and open space
Minimum Water Level	—					
Residential	0.895	—				
Commercial	0.899	0.889	—			
Public	0.708	0.868	0.750	—		
Industrial	0.713	0.766	0.688	0.507	—	
Farmland and Open Space	0.986	0.878	0.927	0.687	0.754	—

The findings in Table 4 examine the relationship between minimal water levels and the affected population in the study area. The correlation coefficient of 0.603 suggests a moderate positive relationship between rising water levels and the number of persons affected by flooding. This implies that as minimum water levels rise, so does the population affected by floods, emphasising the susceptibility of populations to flooding disasters.

Table 4: Relationship between Flood and Affected Population of Persons in the Study Area

	Minimum Water Level	Population
Minimum Water Level	—	
Population	0.603	—

4. DISCUSSIONS

The findings in this study revealed an averagely increasing pattern of minimum water level trend throughout the decade. The trend pattern shows a relatively flat curve between 2011 and 2014 and a drop in the year 2015 and the highest minimum water level in 2016 with 13.42m minimum water level. The finding also revealed that most land uses including residential and commercial are affected by flood in the decade of study. Although, farmland and open spaces were the hardest hit throughout the period, starting from 2084.32 hectares in 2010 and 2933.71 hectares in 2019. This aligns with the findings of Kayode et al. (2017) where flood event was evident in the wanton destruction of private properties and shared community infrastructure such as roads and power supply facilities, the loss of farmlands and the general disruption of social and economic lives of the people. Similarly, Agenzia, (2012) reported that flooding directly affects farming, transportation and housing, and also infrastructures that can support the welfare of the people are been damaged.

Finding of this study also revealed the estimated population of flood-affected residents in Lokoja Metropolis from 2010 to 2019. The trend pattern shows that a substantial population affected by flood in 2014 with 11,382 numbers of persons affected. The pattern shows a fluctuated curve with 10,330 individuals affected in 2017, 9,818 affected in 2018 and 12,189 affected in 2019 respectively. This is in agreement with the findings of Adelekan (2010) in which 91 per cent of the sampled population reported to have been displaced or severely affected by floods. The implication of this displacement has placed huge impact on their physical interactions with their original environment and social interactions, such as security, family ties, cultural cohesions and health issues. Similarly findings were also shown in the previous studies (Kayode et al., 2017; Adelekan, 2010).

The study shows that a total number of 9,663 structures were affected by flood in five Lokoja localities between 2010 and 2019. This significant effect of floods on structures would have significant impact on the living condition of urban residents as earlier argued by Heryanti, (2012) who suggest that risk perception which affects disaster preparedness and consequently the severity of the impact of a flood event is directly related to the socio-economic characteristics of households and individuals. The study also found a significant relationship between minimum water levels and the various land uses and also minimum water levels and population of persons affected by flood in the study area. This is in line with the argument of Agenzia, (2012) and Kayode et al. (2017) where both land uses and population of communities are threaten by flood reoccurrence.

5. CONCLUSION

Lokoja metropolis had suffered series of flood disasters in last few decades. In conclusion, this study revealed a progressive increase in minimum water levels over the decade of study (i.e. 2010 to 2019), with significant impact on land use and population of people in Lokoja. Flooding had a significant impact on residential, commercial, and particularly agriculture and open spaces, inflicting widespread property and infrastructure damage. Floods had a significant impact on the Lokoja Metropolis population, displacing or severely affecting many individuals. Floods also ruined thousands of structures, deteriorating urban living conditions even more. The study finds a significant relationship between rising water levels and the amount of land and population affected, emphasising the need for better flood management techniques to prevent future hazards.

6. CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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