Spatial Pattern of Landuse/Landcover and Flood Management Strategies by Vulnerable Communities in Kogi State, Nigeria

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Abstract

Flood is among the most recurring and devastating natural hazards causing colossal loss of lives and severe economic damages throughout the world. Kogi State in Nigeria, because of its confluence nature, experiences perennial flooding which this study seeks to examine. The objectives of this study includes to: identify and map landuse/land cover dynamics as they accelerate flooding, identify and examine the effects of flood risk on vulnerable communities, and examine the flood management practices in Kogi State. LandSat satellite images obtained from USGS Global Land Cover Facility website of different epochs (2000, 2005, 2010, 2015, 2020 and 2024) were used to model the variations in the spatial pattern of landues/landcover (LULC) changes. ENVI Remote Sensing Software was used to carry out digital image processing of the images and then classify the images into Crop, Settlement, Water and Island. ASTER elevation image data (DEM) of 30m Resolution was used to create terrain model of Kogi State to show regions of low lands that easily get flooded. The ArcGIS 10.5 was used to create the map layouts. The vulnerable communities to flood were geo-tagged using the Garmin 72+ handheld GPS. Using simple random sampling technique, a total of 418 copies of questionnaire sampled across the three senatorial zones of Kogi State: Kogi East - 197 (44.94%), Kogi West - 112 (27.89%), and Kogi Central - 109 (27.16%)) were analyzed using descriptive statistics, including graph and tables. 418 copies of questionnaires administered to residents were used to examine the impact of flooding on vulnerable communities at risk of flooding. The study reveals that the 2020 and 2024 images had scan and cloud cover errors; hence, they were excluded from further analyses. LULC change was considered to be partly responsible for flood in the vulnerable communities as most crop lands had been converted to settlements. The identified major vulnerable communities include Lokoja, Gadumo, Ganaja, Koton Karfe, Adankolo and Natako. These settlements fall within the lowlands of Kogi State. Flood impact on the communities includes loss of human lives (21%), loss of property (17%), displacement of people (13%), health risk (12%), disruption of economic activities (14%) and food insecurity (23%) during flood disaster in Kogi State. The identified flood management practices include flood vulnerability management (21%), flood plain management (20%), natural flood control system (19%), construction of flood barriers (15%), and early warning system (25%). This means that in most cases, before rainy season, early warning on flood vulnerability are received from relevant MDAs like NIHSA, NIMET and FEMA. The study, therefore, recommends, as a matter of urgency, the creation of Emergency evacuation route, *emergency evacuation/health centers, support coastal communities with fishing tools, timely and adequately response to flood affected communities to save lives, ensure public and environmental safety, and ecological security.*

Keywords: *Flood Management, Vulnerable Communities, Landuse/Landcover, Remote Sensing/GIS*

1. Introduction

Conceptually, flood is an overflow of a body of water that inundates land (Elekwachi, *et al.*, 2021). This occurs due to the volume of water within a body of water, such as Lake or River, exceeding the total capacity of the body, resulting in some water flowing outside the normal boundaries of the body. It can also occur in rivers, when the strength of the river is so high, that water flows right out of the river channel. Flood is an anticipated hazard in the coastal regions and when it occurs, it leaves loss and damage at its wake, giving rise to disasters. From time immemorial, flood has continued to be a threat to humans and their ecological buoyancy (Nkeki, Bello and Agbaje, 2022). The need for investigating and providing mitigating measures can never be over-emphasized as the presence and adherence to control measures, both structural and non-structural is key to avoiding loss and damage of properties (Elekwachi *et al.*, 2021). Statistically, every year, approximately 100 million people are affected by episodes of flood globally (Ndukson *et al.*, 2021).

Floods can be caused by anthropogenic activities which are human intervention in the natural processes which may include increase in settlement areas; population growth in low-lying plains prone to flood leading to alterations in the natural drainage and river basin system; deforestation and climate change and urbanization. Attempts by man to harness available water resources have resulted in the construction of dams and other water control structures. The failures of these structures have resulted in floods. The recent flood due to failure of dam in Maiduguri in Norther Nigeria is a case worthy of note. It was reported that more than 414,000 people are affected by the floods in the State, with some 37 deaths and 58 people injured as two major bridges in Maiduguri (Lagos Street Bridge and Bwange Bridge) collapsed (OCHA, 2024). Findings so far indicated that in support of Government efforts, the UN and partners are providing hot meals, water purification tablets, hygiene/dignity kits and cholera kits, as well as emergency health services, among other lifesaving interventions.

Literature ascribes flood danger to change in climate (Karley, 2009). Floods all over the world in recent time have been related to the occurrence and re-occurrence of prolonged heavy rains (Adetunji and Oyeleye, 2013). Climate change has been the resultant effect of prolonged heavy rain across the globe that usually results to floods. Climate Change is an attributed cause of flooding because when the climate is warmer it results to heavy rains, relative sea level will continue to rise around most shoreline, extreme sea levels will be experienced more frequently (Bariweni *et al.*, 2012). Most of the recent deadly floods have happened where the population has increased more. Due to population increase, there is also an increase in human settlements in flood plains (Douglas *et al.*, 2008). Human activities such as dam construction, irrigation, bridges and others have negatively impacted on free flow of water in the drainage channels, rivers and streams. Particularly at the urban centers, construction of roads, buildings, factories, manufacturing plants, bridges and culverts, farmlands and others have reduced drainage channels and erosion passages and diverted the natural courses of the flow of water (Aderogba, 2012). For instance, in Lusaka, the capital of Zambia, flood risk has strongly increased because of the fast growth of the city in flood prone areas (Nchito, 2007). This is also the case of Alexandria in Egypt (Klein *et al,* 2003), so many communities in Nigeria also experienced great damage in 2012 flood, the Senegalese capital, Dakar, and the Burkina Faso's capital, Ouagadougou, strongly affected by the 2009 flood. Poorest people, in particular, often have a limited choice and ended up living in high flood risk zones, such as riverbanks and coastlines, unaware of the risk and unprepared to react to floods (Lutz *et al.*, 2008). Also, Working on Spatial-temporal changes of exposure and vulnerability to floods in China, Wang *et al* (2014) acknowledged that disaster risk is a function between weather/climatic events, exposure, and vulnerability. Weather/climatic events are sources of disaster risks.

Developing countries especially in the African continent are vulnerable to flood disasters due to the weakness of state infrastructure and absence or lack of implementation of appropriate policies guiding disaster reduction and prevention (Cirella and Iyalomhe, 2018). Nigeria is one of the most disaster-prone countries in Africa, and floods are the most common and recurring natural disaster, with the frequency, severity, and spread of these floods increasing. The most devastating floods in the history of the country occurred between July and October 2012, affecting 25 of the 36 states. The impact was very high and unprecedented in terms of human, material, and production loss: 363 people killed, 5851 injured, 3,891,304 affected, and 387,153 displaced (FGN, 2013; Ndukson *et al*., 2021).

In Nigeria, flood causes loss and damage to properties, distortion of sources of livelihood and displaces more people than any other disaster. The 2012 overflow of the River Niger and the subsequent flooding of some parts of Nigeria historically represent the most devastating natural disaster in the country. It is recorded that in 2012 alone, flood caused a loss of a significant amount of money which exceeded $19.6 billion, destroyed more than 590,000 houses, and claimed the lives of more than 360 people according to the Nigeria Emergency Management Agency cited in the work of Said *et al* (2021). This is a common environmental problem, but hazardous, causes psycho-environmental as well as socio-economic effects to the people affected by it. In a developing country like Nigeria, more people are living in unhealthy areas as a result of poverty and poor governance which are aggravating the effect of natural disasters, and its consequences (Olorunfemi, 2011).

Flood events and impacts in recent times have arguably been unprecedented and affected the lives of hundreds of millions of people across the world. These impacts have been shared by both developed and developing countries with rapid urban expansion taking place in many flood-prone areas. Concerns for flood and the associated human impacts are clearly of global significance, especially when aligned with the fears of climatic change and associated changes in rainfall events and sea level rise. The rapidly growing urban environments in many areas correspond with a lack of urban planning strategies, the deterioration and lack of capacity of urban drainage infrastructure and an increased rate of development on flood plains. Additionally, the increasing densities of populations particularly in the urban areas of most developing countries such as Nigeria, alongside the poor level of awareness and the limited efforts of many stakeholders towards flood risk reduction are critical issues undermining possible efforts towards addressing the hazard such as flood (Elekwachi *et al*., 2021). Nkwunonwo and Ugonna (2016) in their work on a review and critical analysis of the efforts towards urban flood risk management in the Lagos region of Nigeria, maintained that flood events and impacts in recent times have arguably been unprecedented and affected the lives of hundreds of millions of people across the world. These impacts have been shared by both developed and developing countries with rapid urban expansion taking place in many flood-prone areas. Concerns for flooding and the associated human impacts are clearly of global significance, especially when aligned with the fears of climatic change and associated changes in rainfall events and sea level rise.

Orimoogunje *et al* (2016) acknowledged in their study that accelerated urbanization especially built-up areas that are spreading across Africa and increasing much in rural-urban migration due to droughts, demographic processes and globalization are playing a role in increasing society's exposure to weather and climate-related damage through factors such as deforestation, housing developments in areas vulnerable to flooding and other environmental risks. In a developing country like Nigeria, more people are living in unhealthy areas as a result of poverty and poor governance which are aggravating the effect of natural disasters, and its consequences creating a vicious spiral of poverty-natural disaster vulnerability. In other words, disasters occur when hazards and vulnerable systems intersect. Over the years, flood incidences in different communities and settlements in Nigeria showed that certain areas are more vulnerable to flood. The impact of inundation and antecedent of flood called for serious attention. Therefore, concentrated action is needed by all the stakeholders to avoid severe impacts on human life and property. According to Orimoogunje *et al*., (2016), the assistance and aids on the flood disaster mitigation in the developing countries should be operated from a multidisciplinary perspective including sociology, economics, agriculture, environmental, science, engineering and education.

When floods occur as natural incidents away from human populations, they have numerous benefits. However, when it occurs in areas of significant human development, especially in densely populated areas, a natural incident becomes catastrophic. Immediately after floods, there is poor hygiene and an increased risk of disease outbreaks, especially among displaced people. Potable water may be contaminated by pollutants from overflowing sanitation facilities, resulting in increased risk of waterborne diseases such as typhoid fever, cholera, leptospirosis and hepatitis. Often poor people are more vulnerable and most affected as physical damage, social, economic and health impacts of floods are well beyond their capacity due to poor resilient. There is no consensus as to the precise meaning of vulnerability. For instance, social scientists view vulnerability as that which represents the set of socio-economic factors that determine people's ability to cope with stress or change, while climate scientists view vulnerability in terms of the likelihood of occurrence and impacts of weather and climate related events (Abdulganiyu, 2014). IPCC Third Assessment Report has two definitions of vulnerability: In the first definition, vulnerability is defined as "the degree to which a system is susceptible to or unable to cope with, adverse effects of climate change, including climate variability and extremes. Flood events may not be considered a natural hazard unless there is a threat to human life and property. The most vulnerable landscape for floods is low level coast and deltas, and small basins subject to flash floods (Zarma et al., 2020). Empirical researches have highlighted the basic consequences of flood as; loss of human lives, submerging of residence and streets, inflow of sewage, municipal pollution and health hazards, traffic obstruction, aesthetic discolouring, clean-up cost and disruption of services, infrastructural damage, and economic loss.

Accordingly, the prescriptive and normative response to vulnerability is to reduce exposure, enhance coping capacity, strengthen recovery potential and bolster damage control (i.e. minimize destructive consequences) via private and public means. Cutter *et al,* (2003) perceived it as broadly associated with the potential for loss of property or life from environmental hazards. Similarly, Bizimana (2015) analyzed the social vulnerability of groups in Rwanda to malaria using a composite index method and GIS while Williams (2018) used the framework with GIS to analyze the social vulnerability of Nigeria's Katsina-Ala local government area to malaria. It was further noted that developing countries are prone to more social stresses than the developed ones.

The thrust of this research is to identify regular flood risk and vulnerability evaluation of communities along flood plain areas for proper and effective environmental planning towards achieving the 11th goal of the Sustainable Development Goals (SDGs) which is to make cities and human settlements safe, resilient and sustainable. Most of the victims of floods in the developing countries are the poor and marginalized, particularly those living on marginal land, flood plains or improperly planned and developed neighbourhoods (Adeleye and Popoola, 2019). While many may be vulnerable, some, especially those residing in better planned and developed neighborhoods of the cities, are usually not affected, particularly where the flood is described as a flash flood. However, the authors viewed vulnerability as a concept that is a function of exposure to some identifiable risks (location relative to hazard). Varieties of vulnerability indicators have been identified and include individual, social, economic, ecological and urban, among others. The common baseline is that vulnerability of whatever form is dependent on the existence and exposure to some form of risk or harm as a consequence of some external shock. Muller *et al* (2017) said with regard to flooding, vulnerability indicator is described as resulting from the social and physical conditions that make parts of an urban system susceptible to experience damage from an after-flood event. This implies that particular neighbourhoods of the cities, by their physical and social circumstances (exposure factors), are vulnerable to flood. In many instances of flooding, the elements commonly at risk are usually the poorest segment of the population, improperly or poorly built housing and civil engineering structures, and public infrastructures.

The SDG goal 2 aims to end hunger in all its forms by 2030 (Gil *et al.*, 2019). The food and agricultural sector is key in eradicating hunger but this important sector is heavily impacted by flood in Nigeria (Osabuohien and Urhie, 2018). Food security is the assured way of eradicating hunger and involves making food available and easy to access especially the staple foods but Nigeria is far from achieving food security. This is despite its vast fertile land. Nigeria remains the biggest importer of food in Africa (Matemilola and Elegbede, 2017; Osabohien and Urhie, 2018). The level of preparedness and the capability to reduce vulnerability to disaster largely depends on the developmental stage of a country or a community and the balance between the strengths and imperfections in the functioning of its sectors, structures and institutions.

Kogi State is a peculiar State because the two major Rivers in the country (Rivers Niger and Benue) meet in Lokoja, the State Capital. Perennial flooding in the state is very common and the spatial nature of landuse/landcover as well as identifying the communities at the risk of flood, and strategies in managing flood form the core of this study.

2. Materials and Method

2.1 Study Area

Kogi State is located in North-Central Region of Nigeria (Figure 1). It is popularly called the confluence state because of the coming together of Rivers Niger and Benue at its capital city, Lokoja. The State which lies between latitude 6° 30´N and 8° 45´N of the Equator and longitude 5° 20´E and 7° 53´E of the Greenwich Meridian occupies a total land area of 29,165km^2 (Aderoju *et al.*, 2014). Kogi State has 21 LGAs and was created in 1991 from parts of Kwara and Benue States. It is bordered by Federal Capital Territory (FCT) to the North, Nasarawa State to the Northeast, Benue State to the South, Enugu State to the Southeast, Anambra State to the south, Edo State to the Southwest, Ondo and Ekiti to the West, Niger State to the North and Kwara to the Northwest. Kogi State has a typical climate of the tropical zone because of its location. It is characterized by wet and dry ***Aw*** type of climate going by Koppen classification scheme. It has annual rainfall of 1016mm-1524 mm, of which 90% falls between April and October with mean annual temperature of 27.7°C (Ifatimehin *et al.*, 2009).

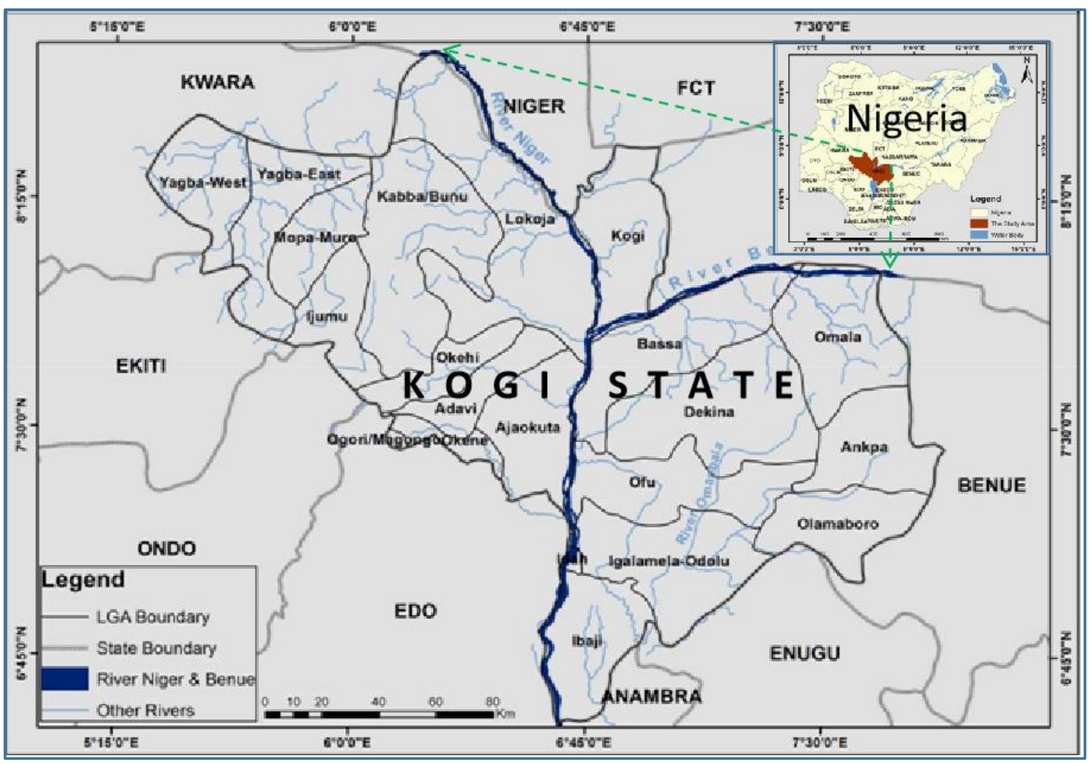

Figure 1: Location of kogi State, Nigeria

The land areas in Kogi State rises from about 300metres along the Niger-Benue confluence, to the heights of between 300 and 600metres above sea level in the uplands. Agbaja Plateau, which ranges from 335 to 366metres above sea level, and the much higher Okoro-Agbo hills at Ogidi in ljumu LGA are some of the predominant landforms of the state. The general terrain is undulating and characterized by high hills, plateaus and numerous inselbergs and elongated ridges (Aderoju, 2014). All the above charateristics play significant roles in the nature of flood when it rains or when dams at the upper course of the two major rives are open for water to flow. When such happens, there is bound to be attendant consequences on the impact of flood in communities at risk of vulnerability (Ehizemhen, Igibah and Sadiq, 2018); hence, this study.

2.2 Methodology

LandSat satellite images of different epochs (2005, 2010, 2015, 2020, 2024) obtained from the United State Geological Survey (USGS) Website: www.earthexplorer.usgs.gov were used to model the variation in spatial pattern of landues/landcover change over the years in the study area. As a result of the scan lines and cloud cover errors (poor image quality) in the 2020 and 2024 images, they were discarded to avoid introducing errors to the results being analyszed. Digital image processing using ENVI Remote Sensing Software was used to classify the images into Crop, Settlement, Water and Island respectively, while ArcGIS 10.5 Geographic Information System (GIS) mapping software was used to map the changes and create layouts. Communities at risk of vulnerability to flood in terms of spatial spread were identified using Garmin 72+ handheld GPS receiver. ASTER elevation data (DEM) image of 30m Resolution and Geographic Information System (GIS) technology were used to model flood risks based on terrain elevation and create map layouts respectively. The LULC change was considered to be partly responsible for flood in the vulnerable communities.

The total sample size for this study was four hundred and eighteen (418); hence, same copies of questionnaire were administered and 386 which constitutes (92%) were completed and returned by the respondents. The projected population of Kogi State for 2024 as estimated from the 2006 National Population Commission of 3,314,043 at 3% growth rate is 5,641,936. The flood impact assessment questionnaire were sampled using the simple random sampling techniques. The Simple random sampling is the randomized selection of a small segment of individuals or members from a whole population. It provides each individual or member of a population with an equal and fair probability of being chosen. Collated feedback from the retrieved questionnaires were analyzed using descriptive statistics including graphs and tables. Based on the Statistical Package for Social Sciences (SPSS) software used to analyze the questionnaires, the descriptive statistics deals with presentation, interpretation and analysis of data generated from the questionnaire obtained from field survey.

3. Results and Discussion

3.1 Spatial Pattern of Landuse/Landcover of the study area and Flooding

Figure 2 shows the elevation pattern of Kogi State, the study area. The elevation ranges from 1 (very low) to 674m (very high) above mean sea level. This variation is understandable in view of the fact that the state has several highlands with rock outcrops and many other mineral deposits. The study shows that the vulnerable areas are within the low lands, especially riverine areas with major vulnerable hotspot (high risk communities) within the confluence where River Niger and River Benue meet in Lokoja. Areas between 1-96m are considered extremely vulnerable, 96-197m are highly vulnerable, and 197-297m are moderately vulnerable. Although other areas are vulnerable too, the severity are very low, and also dependent on the local differences in terrain and the general watershed morphometry of a given study area (Bello, Adzandeh, and Rilwani, 2014; Taofi et al., 2017). Thus, the Landuse/Landcover results presented here are those that fell within the extremely, highly and moderately vulnerable areas in Kogi Sate, the study area. The spatial pattern of changes that occurred in the study area can be seen over the years, as shown in figures 3, 4, and 5. The study reveals that the crop land cover in the year 2000 were more. By the year 2015 there was increase in settlement areas and corresponding decrease in crop land areas due to the activities of man over the years. The study further reveals that perennial (annual) rainfall affects the level of water especially during the rainy seasons with peak period around late September and early October every year. Most people in the highlands are safer but far away from accessing River Niger water. Irrigation and wetland farming is predominant though with periodic washing away of farmlands during wet (rainy seasons). The study also revealed that accelerated run-off during the rainy seasons and the release of water from Lagdo Dam in cameroon are the major drivers of flooding in Kogi State.

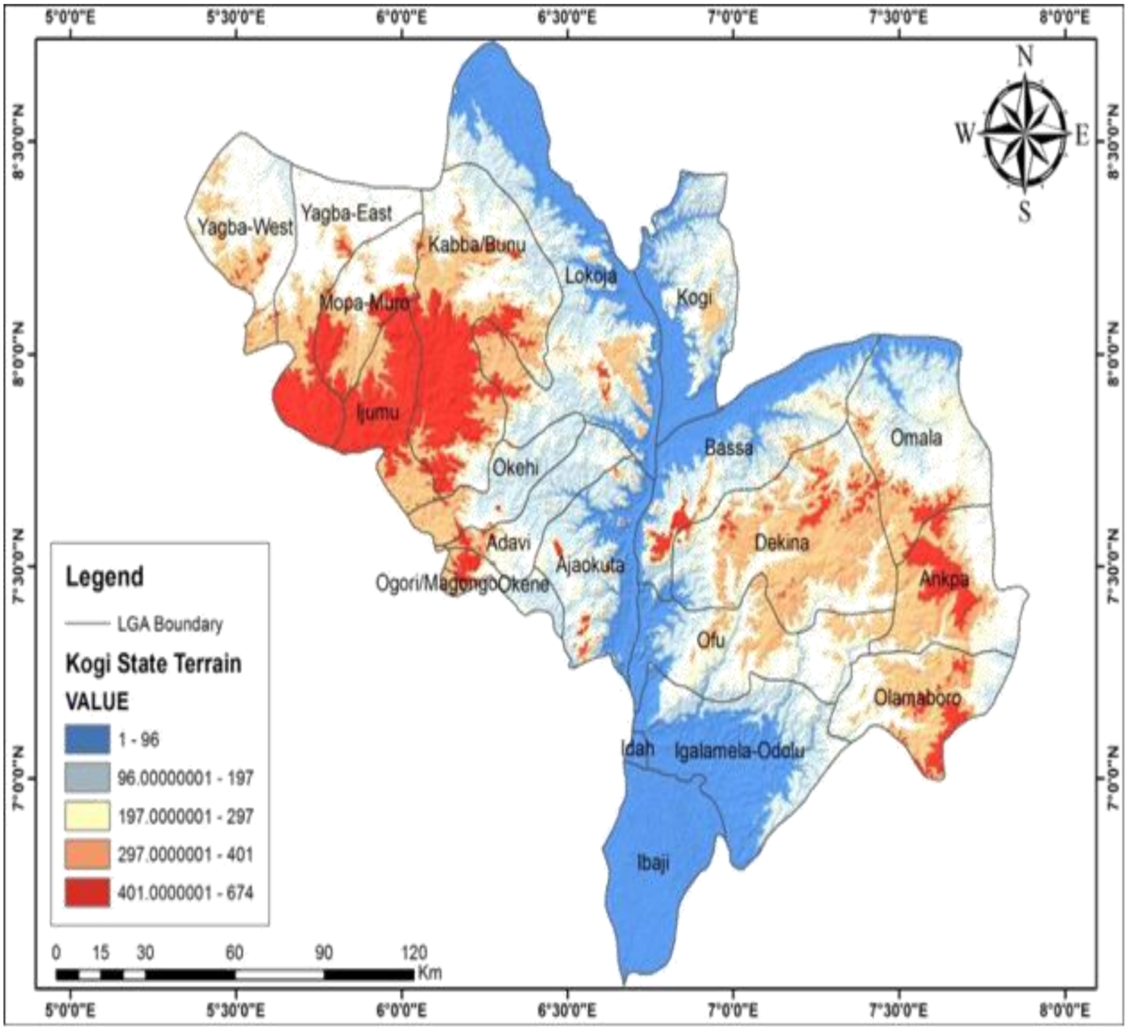

Figure 2: Terrain model of the Vulnerable areas

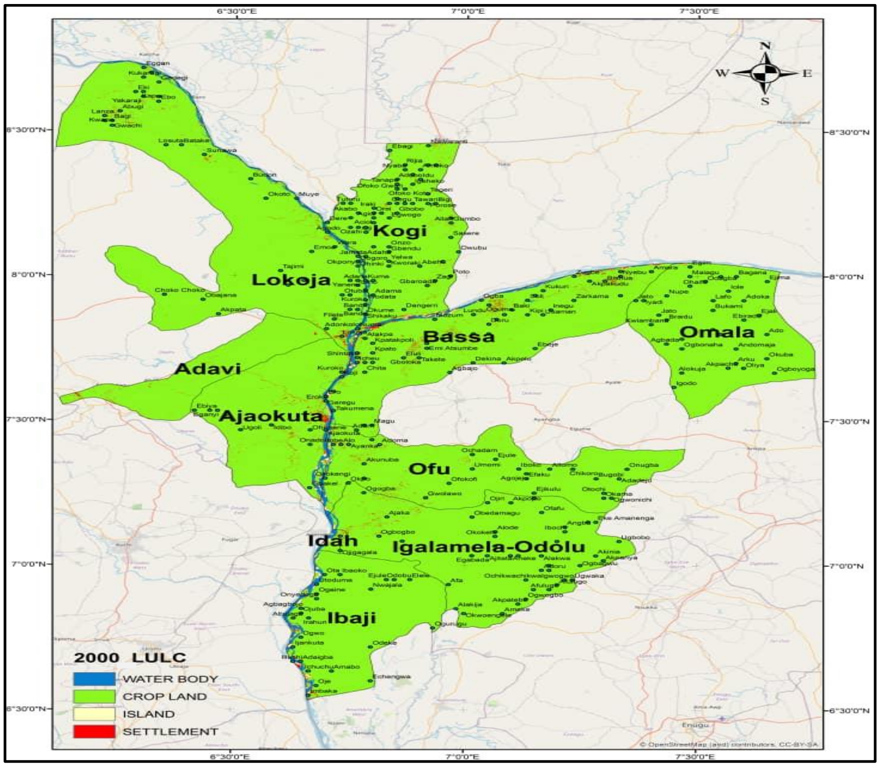

Figure 3: Lanuse/Landcover of vulnerable areas in 2000

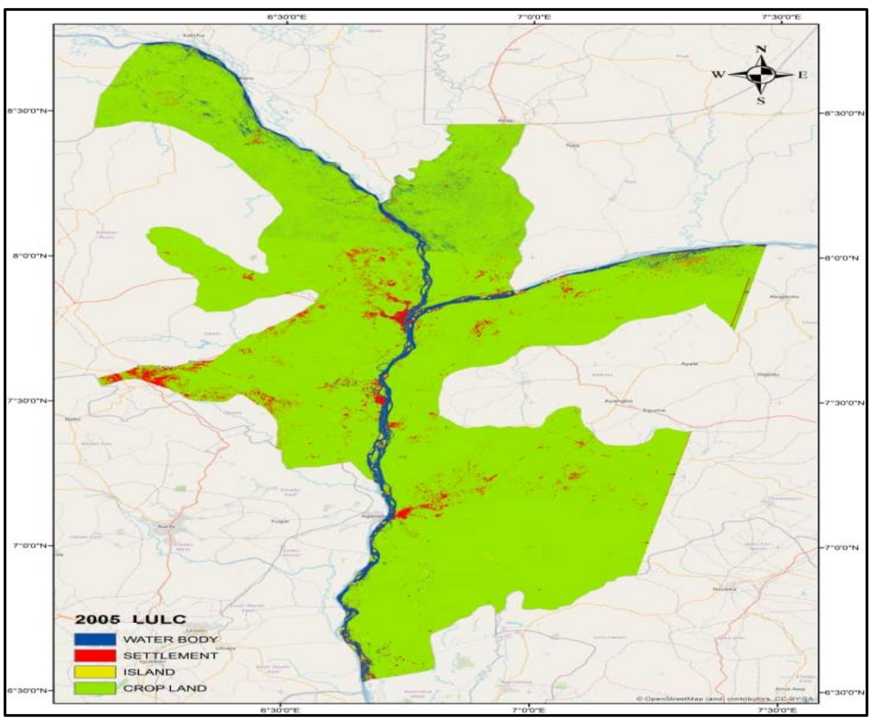

Figure 4: Lanuse/Landcover of vulnerable areas in 2005

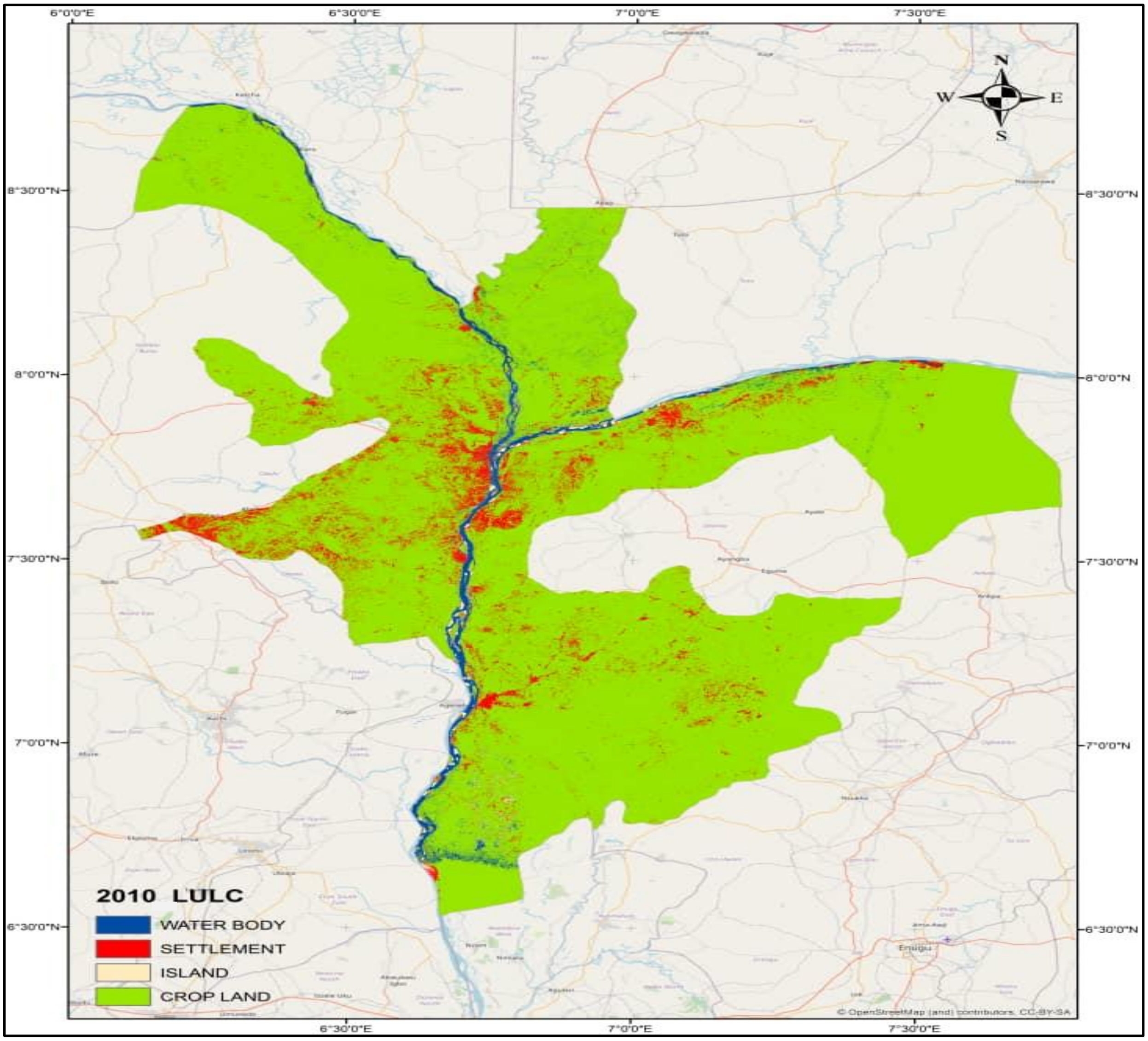

Figure 5: Lanuse/Landcover of vulnerable areas in 2010

Thus, the periodic flooding in Kogi State has become a great threat to the survival and socio-economic buoyancy of the local residents. It is important to note that those mostly affected by flood are those withing the riverine areas (Figure 7) who mostly engages in fishing activities, sand mining and rice farming.

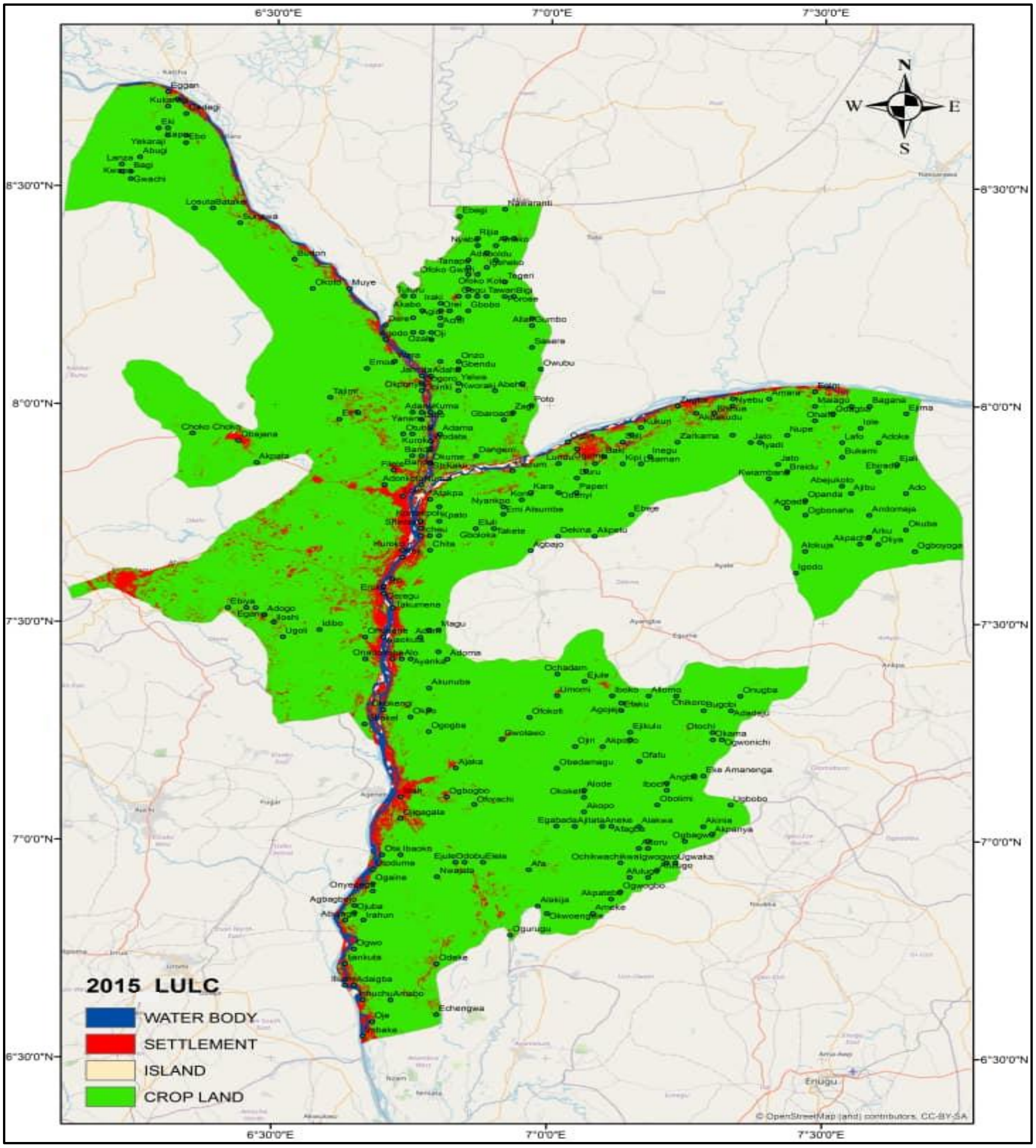

Figure 6: Landuse/landcover and Settlement at risk in 2015

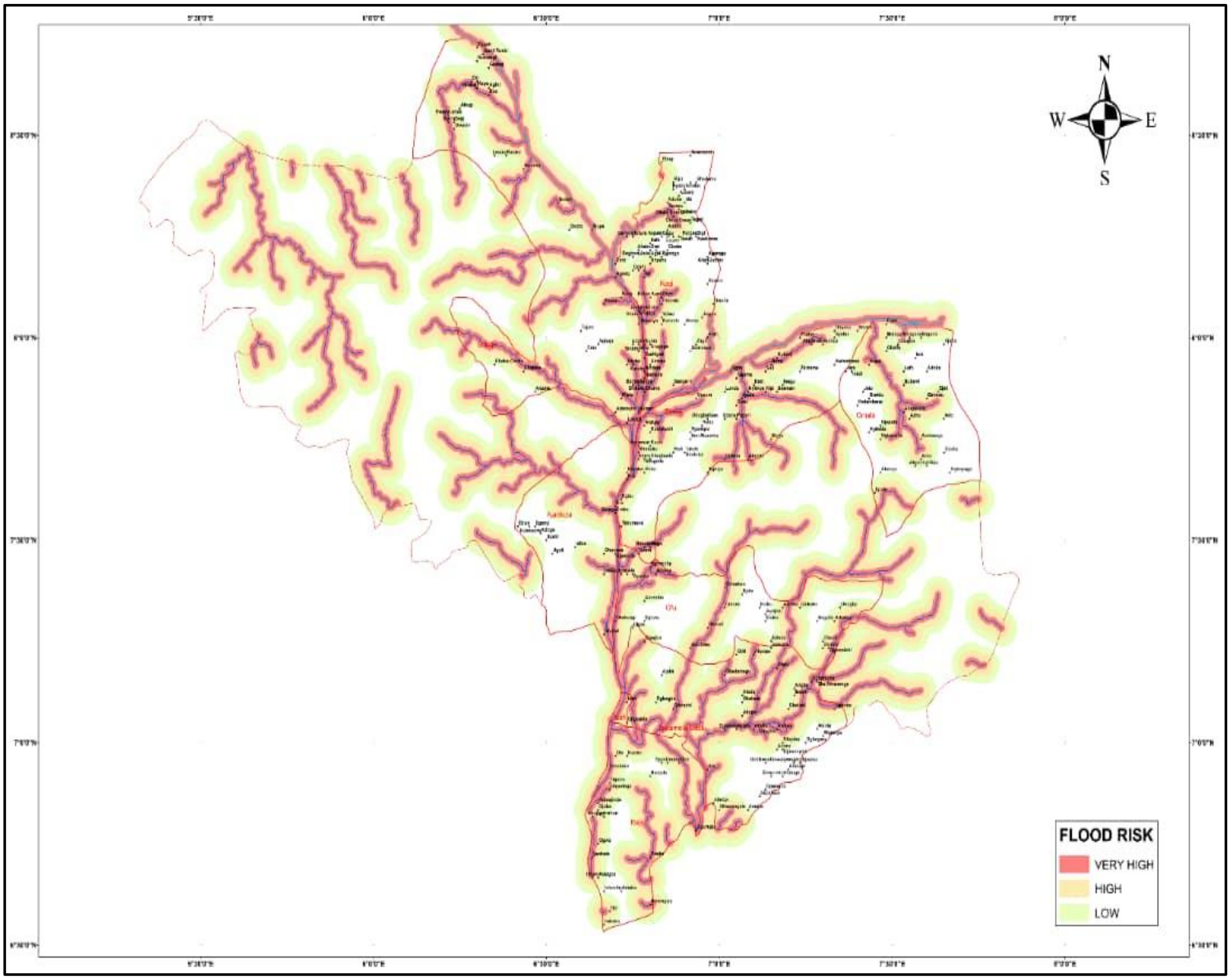

Figure 7: Modeled flood risk vulnerable areas in Kogi State in 2024

3.2 Impact of flood on vulnerable communities in Kogi State

The identified major vulnerable communities include Lokoja, Gadumo, Ganaja, Koton Karfe, Adankolo and Natako. The impact of flood on vulnerable communities in Kogi State are tabulated in Figure 8. A typical flooded federal road incidence in October, 2023 at Koton Karfe, kogi State is shown in Plate 1. The responses from the respondents reveals that loss of human life constitutes 21% of damage caused by flood disaster, followed by loss of property (17%), displacement of people from the habitats (13%), health risk constitutes (12.6%), food insecurity (22%), and disruption of economic activities including fishing and farming (14%).

The implication of the above result is that there is severity of food insecurity during flood disaster in the study area. This ultimately leads to increase in food rices and rise in water-born diseases diseases and loss of lives, damages and eventual loss of properties due to flooding as shown in Figure 8.

Figure 8: Impact of flood on vulnerable communities in the study area
Source: Field Survey, 2023

Plate 1: Flooded road and houses at Kotonkarfe, Kogi State: Canoe to the rescue

The impact of flood on vulnerable communities as revealed in Figure 8 and Plate 1 further indicated that flood affects various aspects of man's environment; this includes his economic activities, settlements (including road network) and lifestyle. Several threats to livelihoods ranging from the physical threats to social and economic activities, therefore, exist. Flood also causes land pollution, epidemics and infections. A lot of emotional and social costs have been attributed to flooded regions. These costs include: the loss of personal valuables, displacement from homes, and the insecurity caused by the experience. This study corroborates the findings of Ajodo and Olawepo (2021), and Bello and Ogedegbe (2015) in previous studies of similar case scenarios.

3.3 Socio-Demographic characteristics of the respondents and Flood Knowledge

To better understand and appreciate the quality and impact of flood in the study area, it became important to have requisite information on the respondents because they constitute the direct recipient of the flood disaster. They are, therefore, fundamental to drawing conclusions on the impact of flood in the study area. The study shows that from Table 1, about 208 (53.8%) of the respondents are male, while 178 (46.2%) are female. The implication of this is that male respondents were available and ready for the investigation under review. Similarly, the study also revealed as tabulated in Table 2 that 27.4% of the respondents fall within the age range of 20-29years, 31.2% falls within the age range of 30-39 years, 34.7% falls within the ages of 40-49 years, while the remaining 6.7% fall within age range of 50 years and above.

From the above result, it is deduced that most of the respondents were within the age range of 40-49 years and have requisite knowledge on the effects of flood on socio-economic activities in the study area. This age group of respondents are better informed on the direct impact than anyone else because they reside within the area for long and have been experiencing the disaster for a long time too. They complained that they, however, finds it completely difficult to permanently relocate due to the survival resources in the water such as fishes (for fishing) and sands (for sand mining). They also use the wetlands for growing crops like rice which they use to feed and earn income too. About 47.2% of the respondents are married (Table 3). In addition, the study also revealed as shown in Table 4 the distribution of academic qualification of Respondents.

Table 4 categorically showed that 42 respondents representing 10.8% have non-formal education, 66 (17.1%) of the Respondents have primary education, 117 (30.3%) have secondary education, 139 (36%) have tertiary education while 22 (5.7%) were holders of other forms of learning qualifications.

In essence, the study shows that most of the respondents have tertiary education and can at least read and write and comprehend simple text as contained in the questionnaire and issues under study.

Table 1: Sex Distribution of Respondents

Sex of Respondents	Frequency	Percentage
Male	208	53.8
Female	178	46.2
Total	**386**	**100**

Table 2: Age Distribution

Age of Respondents	Frequency	Percentage
20-29 years	101	27.4
30-39 years	115	31.2
40-49 years	128	34.7
50 years and above	25	6.7
Total	**369**	**100**

Table 3: Marital Status of Respondents

Marital status	Frequency	Percentage
Single	139	36
Married	183	47.4
Divorced	48	12.4
Widower	16	4.1
Total	**386**	**100**

Source: Authors analysis

Table 4: Educational Qualification

Educational Qualification	Frequency	Percentage
Non-formal	42	10.8
primary	66	17.1
secondary	117	30.3
tertiary	139	36
Others specify	22	5.7
Total	**386**	**100**

Source: Authors analysis

3.4 Flood Management Strategies in the study area

Floods are among the most recurring and devastating natural hazards causing colossal loss of lives and severe economic damages throughout the world. While anthropogenic factors such as indiscriminate use of land by man, seasonal rainfall, and release of water from Lagdo Dam in Cameroon have been blamed for accelerated surface water runoff and large scale inundation (flood) in the study area, it has been argued that inability to manage flood by vulnerable communities often results in deaths and blighted environment. Therefore, the flood management strategies or practices put in place to ensure environmental sustainability and ecological security includes in the study area includes flood plain management (20%), natural flood control system (19%), construction of flood barrier (15%), while early warning system had 25%.

It is important to note that all the identified measures need strengthening and improvements to enable them help to check the menace of flood as far as the loss of lives, properties and farm produce are concerned. There is also room to carry out detailed flood damage assessment by adopting a hybrid system and GIS analytical hierarchical approaches in line with the works of Nkeki, Bello and Agbaje (2022; 2023).

4. Summary and Conclusion

The study was aimed at examining the spatial pattern of landuse/landcover as a possible driver of accelerated surface runoff and flood in Kogi State. The study then examined and identified impacted communities especially in the lowlands of Kogi State, majority of which are farmers, fishermen/women and sand miners as revealed in the study. It is abundantly clear that the majority of respondents examined in this study have stayed long enough (more than 40 years) in the study area to understand, contribute and provide useful information on the subject matter. The study also showed that rains during the rainy seasons and the release of water from Lagdo Dam in cameroon are the major environmental drivers of flooding in the study area. Naturally, most of the areas affected or impacted are communities within the riverine areas which are economically engaged in sand mining, fishing and wetland farming. While efforts have been made to relocate residents during the raining seasons, the need to survive often makes residents to remain in the flood risk zones thereby making them more vulnerable and, of course, in the end, loosing properties, lives and farm produce.

The study, therefore, recommends that the government should intervene by providing the residents with mobile houses and support the residents with fishing tools. They should also be relocated to the uplands where lands are available with necessary facilities like clean portable drinking water, electricity and healthcare centres to take care of their health challenges because they are contributing to the socio-economic and business life of the local community and the country at large. Developing early warning system for the areas, as well as making provisions for emergency evacuation route and emergency evacuation health centers are also advocated for in the study area.

Declaration of Conflict of Interest:

There is no conflict of interest in this study. The study was also not funded by any sponsor.

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