Flood Risk Mapping for Effective Mitigation in Lavun Local Government Area, Niger State, Nigeria

[1]Yusuf Ahmed [2]Tasi'u Yalwa Rilwanu [3]Abdulmuakhkhir Bala Ishaq [4]Aliyu Waziri Mahmood [5]Muslim Musa Yakubu

[1]Department of Geography Federal University of Technology Minna
[2]Department of Geography Bayero University, Kano
[3]Department of Geography Federal University of Technology Minna
[4]Department of Geography Federal University of Technology Minna
[5]Aliko Dangote University of Science and Technology Wudil
yusuf.ahmed@futminna.edu.ng,
tryalwa.geog@buk.edu.ng,
aishaq@futminna.edu.ng,
a.waziri@futminna.edu.ng,
mmyakubu30@gmail.com

ABSTRACT

Flood disaster is a common phenomenum in the study which frequently occur and need to be investigated. The study aimed atidentification and Map out of flood vulnerable areas in Lavun Local Government Area for effective mitigation strategy. Two FGD were conducted in each of the selected four (4) communities while total number of eleven male (20 to 40 ages) and seven of 50 years above were interviewed. Field measurement, GIS and Remote Sensing were also used in obtaining the data. The result from the classified DEM shows that about 593.10km^2 (21.76%) of the area is on highly risk and 362.58km^2 (13.31%) on no risk. findings from the FGD reveals that flooding have devastating effects on the schools, clinics, roads and destruction of properties in the communities. The work concluded that, settlements are on the increase towards the floodplain which implies an increasing risk of the built-up areas, farmlands, life and properties to flooding. It was recommended that, the floodplain maps should be used in the structural design of drainages and other flood preventive measures, in communities that are at very high risk.

Keywords: Flooding, Land Degradation, Vulnerability, DEM, Remote Sensing, floodplain.

INTRODUCTION

Floods are the most frequent type of natural disaster and occur when an overflow of water submerges land that is usually dry. Floods are often caused by heavy rainfall, rapid snowmelt or a storm surge from a tropical cyclone or tsunami in coastal areas. Floods can cause widespread devastation, resulting in loss of life and damages to personal property and critical public health infrastructure. Between 1998-2017, floods affected more than 2 billion people worldwide.

Evidence suggests that floods represent the most costly natural hazards one of the most frequent in terms of occurrences in the past three decades, and their effects can be enormous when considering economic loss (Koç, *et al.,* 2021). Changes in land use patterns occasioned by population growth have increased human vulnerability to floods. Floods cause direct death, morbidity, indirect effect on water born and infectious diseases. The impacts created on environmental variables and businesses are directly related to their location (Zaman, 2012). Home to almost 15% of the world's population, as well as some of the most iconic species, Africa faces serious environmental challenges that make her highly vulnerable to climate change. Nigeria, for instance, is said to be free of other natural disasters such as earthquakes, volcanoes, and typhoons at the moment, but weather-related disasters such as floods and desertification are severely impacted, with floods dominating in terms of area coverage (Hossain *et al.,* 2020).

Though the severity of floods differs across geopolitical and ecological zones in the country, social activities and food production are heavily affected as traders and farmers are left with very little to cater for themselves when extreme events occur. In 2020 alone, 24 out of 36 states in Nigeria experienced some form of either pluvial or fluvial flood, which are the two dominant types of flood in the country. Some of the events in recent years are: 2012, 2014, 2017, 2018, and 2019. These flood events primarily impacted the states adjacent to the major rivers (Benue & Niger), and in most cases exacerbated pollution, erosion, and other degradation processes in the areas where they occurred (Adewuyi and Olofin, 2014). Although natural factors (high rainfall & topography) have great influence in Makurdi, anthropogenic factors are of greater significance in the severity of floods. (Isma'il and Kersha, 2018). Caused mostly by a combination of factors such as heavy rainfall, poor drainage facilities and inadequate management of reservoirs (mainly dams) upstream, Makurdi Local Government Area (LGA) has continuously experienced flood episodes at uneven intervals. (Peter *et al.,* 2020). In order to prevent these huge flood losses, disaster risk management requires reliable assessment in terms of the infrastructural impact of the potential flood events, as well as the economic and environmental damages caused (Koç *et al.,* 2021).

MATERIALS AND METHODS

Study Area

Lavun is a Local Government Area in Niger State, Nigeria. Its headquarters is in the town of Kutigi, the study area is located between latitude 9°1′50″N - 9°46′45″N and longitude 5°18′ 55″E - 5°51′ 35″E. The Kaduna River forms the eastern border of the LGA. It has an area of 2,835 km² and a population of 209,917 at the 2006 census (FGN, 2007). The local government area is situated in the southern part of Niger state and bordered by Kaduna River and Gbako local government in the east, Wushishi and Mashegu local government areas in the north, Edati local government area in the south and Mokwa local government area in the west (figure 1). The majority of the population is Nupe. The working population of Lavun Local Government are

Farmers, livestock/poultry farmers, marketers and also some administrative workers in the local government with rich cultural values.

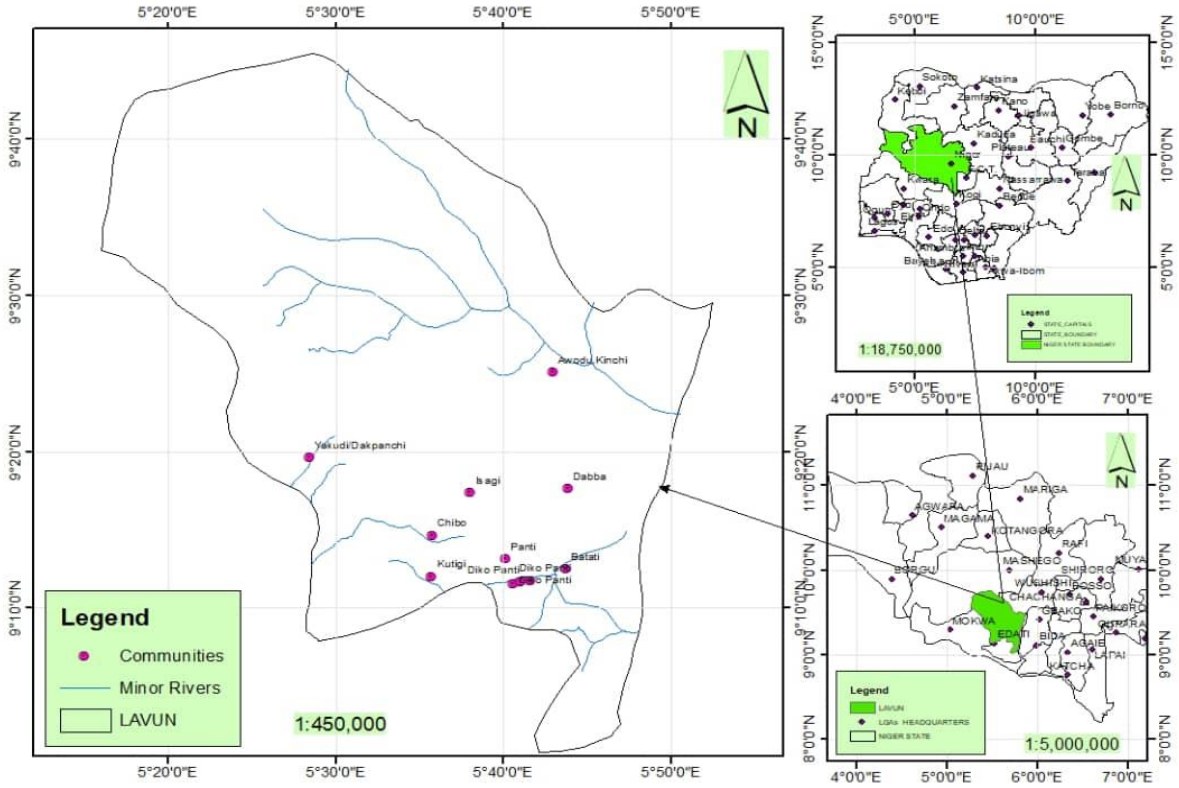

Figure 1: Map of the Study Area
Source: Geography Department, Federal University of Technology Minna.

Methods of Data Collection

Flood risk map was produced by carrying out the following operations: Digital Elevation Model of the Area was generated from satellite image of the study area which was Buffered and Overlay to identified and locate communities that are at risk of flood. Also Vulnerability of the terrain and the communities was based on their locations, it was classified into the following: Highly vulnerable, vulnerable, marginally vulnerable and not vulnerable.

For the effect of flood in the area, the coordinates of the structures affected by flood which was collected using handheld GPS was overlaid from the existing flood vulnerability map. This was complemented with FGD carried out in the area in order to identify the effects of flood in the communities.

Methods of data Analysis

In order to generate flood risk and vulnerability map, the following operations Digital Elevation Model of the Area, Buffering and Overlay was carried out. Flood vulnerability map was

generated from the generated DEM map, the buffer maps and the locations of the communities. Flood vulnerability of the terrain and the communities based on their locations was classified into the following: Highly vulnerable, vulnerable, marginally vulnerable and not vulnerable.

For the Effect of flooding on the area based on their vulnerability, a spatial analysis tool of ArcGIS software operation was done by merging maps of the same location, ArcGIS software overlaid, helps in understanding the relationships between network analysis and specific geographic features such as farmlands, building and other infrastructures to check areas susceptible to flood in the study area. The Shuttle Radar Topography Mission (SRMT) data was imported to ArcMap and Lavun community or district map was clipped out from the SRMT through the spatial analyst tool, of the ArcGIS, Data fill was done on SRMT using fill in hydrology of spatial analyst tool, contour map of between 50meter interval was produced, this is to help identify elevation around the river using the contour value.

Vulnerability analysis was also done by querying the buffered and overlaid map to clearly see the settlements that fall within the vulnerable areas, and the attribute for each of the zone was created so that the hectares of farmland, settlement and other features can be quantify. It helps to ascertain the effects of flooding on the communities. This was complemented by FGD discussion with the inhabitant of the area to give more insight on the effect of flooding in the study area. The FGD was analyzed after transcribing and translating them to English Language. Narrative analysis was also used to classify the qualitative data gotten from FGD.

RESULTS AND DISCUSSION

FLOOD RISK AND VULNERABILITY MAPPING

The flood risk map shows the level of risk of the communities in the study area, it is discussed under the following subheadings; that include Digital Elevation Model of the study area and Flood Risk Vulnerability Mapping.

Digital Elevation Model of the Area

The Digital elevation model (DEM) of the study area shows differences in height between 298m to 78m above sea level. It shows that the western, north-western parts of the study area has highest elevation, lying between 78m and 298m above mean sea level depicted in red and yellow color, while eastern and south-eastern parts has low elevation of 78m above mean sea level an indication of high level of vulnerability as revealed in Figure 2 and indicated in blue.

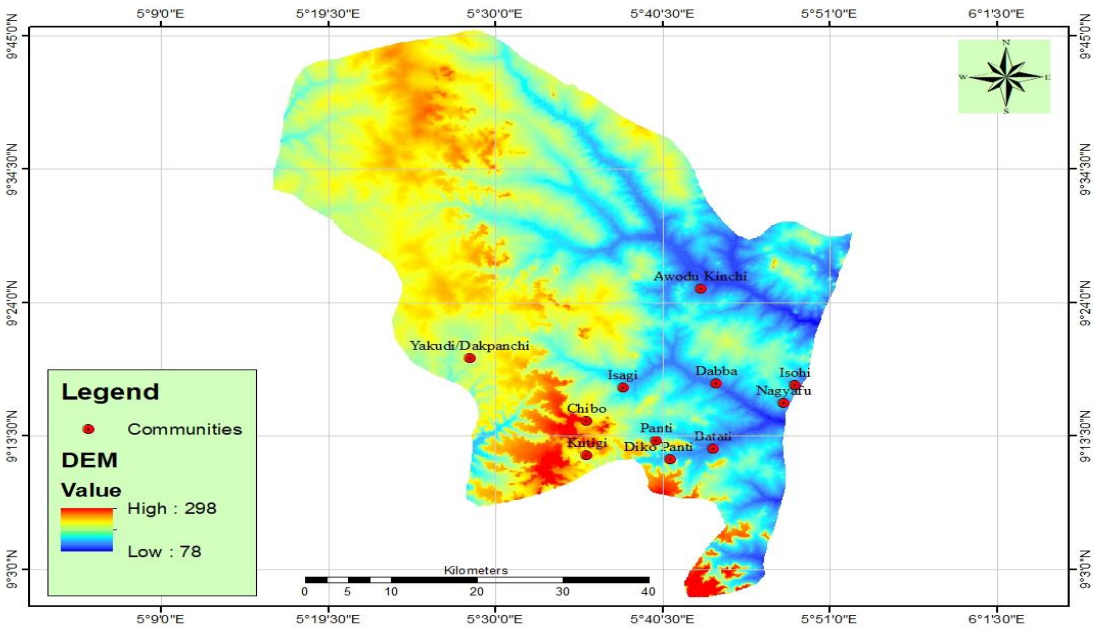

Figure 2: Digital Elevation Model of the study area
Source: Author's Analysis, 2023.

The DEM of the study area indicate that Tsogi, Nagyafu, Dabban, Batati, AwoduKinchi, and Isagi are on low elevation which is represented with Blue colour on the map its located in eastern and south-east part of the study area, while YakuduDakpanchi, Chibo, Kutigi, Panti and Dikko Panti are in high elevation which is represented with Yellow, Red colours, and its located in western and north-west part. This signify that communities in lower elevation are more prone or vulnerable to flood and are at high risk, while those communities that are located in high elevation are less vulnerable to be affected by flood and they are at low risk. This work is similar with the wok of Ismail and Saanyol (2013) who work on Application of Remote Sensing (RS) and Geographic Information Systems (GIS) in flood vulnerability mapping: Case study of River KadunaUsing High resolution imagery, a Digital Elevation Model was developed with ArcGIS to identify flood prone areas along the Middle Course of the river. A flow accumulation model was created using the DEM and the DEM was reclassified into high risk, moderate risk and low risk zones using equal interval of separation based on elevation. This was overlaid on the map of the area to produce a vulnerability map of the area.

Flood Risk Vulnerability Mapping

Finding from the flood risk map

Figure 3 shows the flood risk zones of the study area; it has revealed that the study area is in fact susceptible to flooding. This statement is drawn from the fact that several areas most especially the southern parts and the settlements are in low elevation. These have been attributed to some degree of susceptibility. This was also confirmed through a ground truth exercise. The classification of flood risk zones in the area was mainly based on the interaction

of relief and drainage. The DEM of the area revealed that the western part of the area has high topography that is prone to erosion.

The DEM further revealed that the study area is generally more susceptible to rain induced flash floods as well as river floods. As presented, there are variations in the degree of susceptibility to flooding in the study area; these include high flood risk zone, Moderate, Low and No flood risk zones. These relate to the work of In addition, Abah (2013) also applies Geographic Information Systems (GIS) in mapping flood risk zones in Makurdi Town. In the study, he draws its relevance from the importance of a GIS database in tackling flood related problems and creates a map of flood risk zones in Makurdi town. The ArcView GIS package was used to digitize a topographic map and other relevant themes of the study area. Through GIS overlay and manipulative functions, a Digital Elevation Model of the study area; and a classification map of flood risk zones in Makurdi town were created. The map of flood risk zones generated shows that Makurdi town is generally susceptible to flooding and very little has been done in steering away development from 'highly susceptible 'areas.

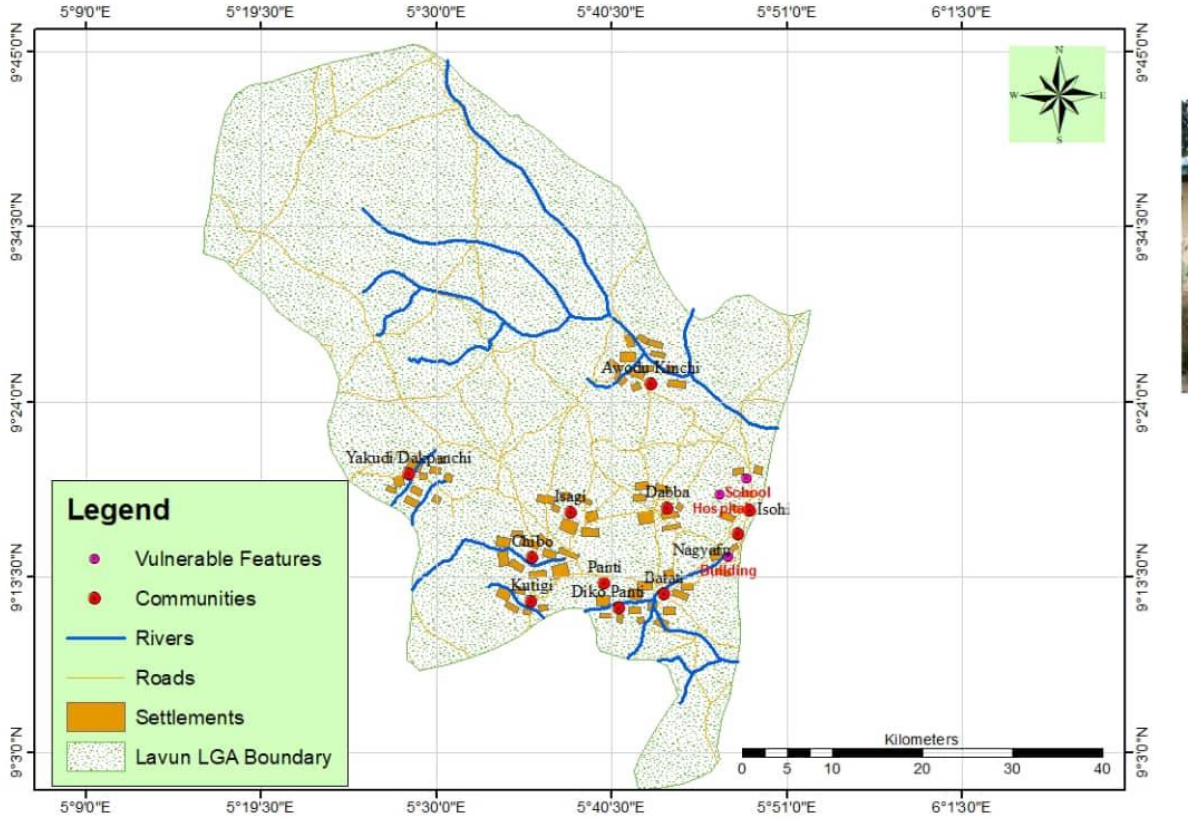

Figure 3: Level of Flood Risk in the study area.
Source: Author's Analysis, 2023.

The settlements at high risk are mostly those located close to the river banks, flooding are experienced in most areas in this classification yearly. The areas are characterized by low relief and water-logged soils (Figure 3). The result from the classified DEM shows that about 593.10 square kilometer (21.76%) of the area is on highly risked area which is an evidence of recurrent

flooding in the study area, while about 811.77square kilometer (29.79%) are moderate risk areas. Also, 957.68square kilometer (35.14%) are low risk areas and finally 362.58square kilometer (13.31%) on no risk, hence, it can be concluding that Eastern and southern Eastern part of the study area is generally High risk and prone to flood event. This also correspond with the work of Gambo and Tasi'u (2020) that work on assessment of flood disaster risk prevalence in Malumfashi town, Katsina state, Nigeria which categorise the area into three flood prone areas, as High risk 225km^2 (33.3%), Moderate risk 337km^2 (50%) and Low risk 112km^2 (16.7%). Also there is decrease vulnerability away from the river, it shows that there is tendency of people close to the river to facing more risks of flood disaster than area away from river.

It also shows the level of risk each community are facing, Tsogi, Nagyafu, Batati, Awodu Kinchi, Isagi, Dikko Panti falls on the high risk zone which is highly vulnerable. Panti and some community's falls on the moderate risk areas which is the vulnerable to flood. Chibo, Kutigi falls on the Low risk areas which are the marginally vulnerable. Yakudi Dakpanchi and other communities that are on the high elevation falls on the no Risk zone areas which are the not vulnerable areas. Also from DEM, the risk of these settlements to flood depends on the elevation of which each of the settlement is located. Settlements that are in low elevation areas tend to experience frequent flood than those on high elevation. This is in line with the work of Mayomi *et al*., (2014) who carried out mapping of some communities located at the downstream of Kainji, Jebba and Shiroro dams and assessed for flood vulnerability through the assessment of the spatial locations of each of the communities within some specific buffer zones assed by spatial analysis of a generated database.

EFFECTS OF FLOODING IN THE AREA

Figure 4 shows the structures affected in the study area, flooding have been a major concern for the people living in those communities where by some structures are affected most especially residential houses, clinic (PHC), Schools, Roads, Mosque among others. The structures like residential houses, clinic (PHC), Schools, mosque, agricultural practices are mostly affected by the flood, when the flood occurs it consume the most tallest building which might be up 25 meters in the communities which sometimes lead to loss of lives and also property, when the flood occur they sometimes use canoe boat to move to another place that is not affect and they later comes back when the flooded water is drained. This support the work of Emigilati and Abdulkadir (2019) who carried out similar work evaluation of the effect of flooding on Danchitagi community of Lavun Local Government Area. Find out that the greater proportion (66.8%) of these buildings observed less than 5 meters setback to the river channel, followed by 24.9% building within 6m to 10m and 11m to 20m record the least setback. Specifically, 91.7% of the buildings have a setback of less than 10 meters and also flood had adverse effect on the agricultural practices and health of the people.

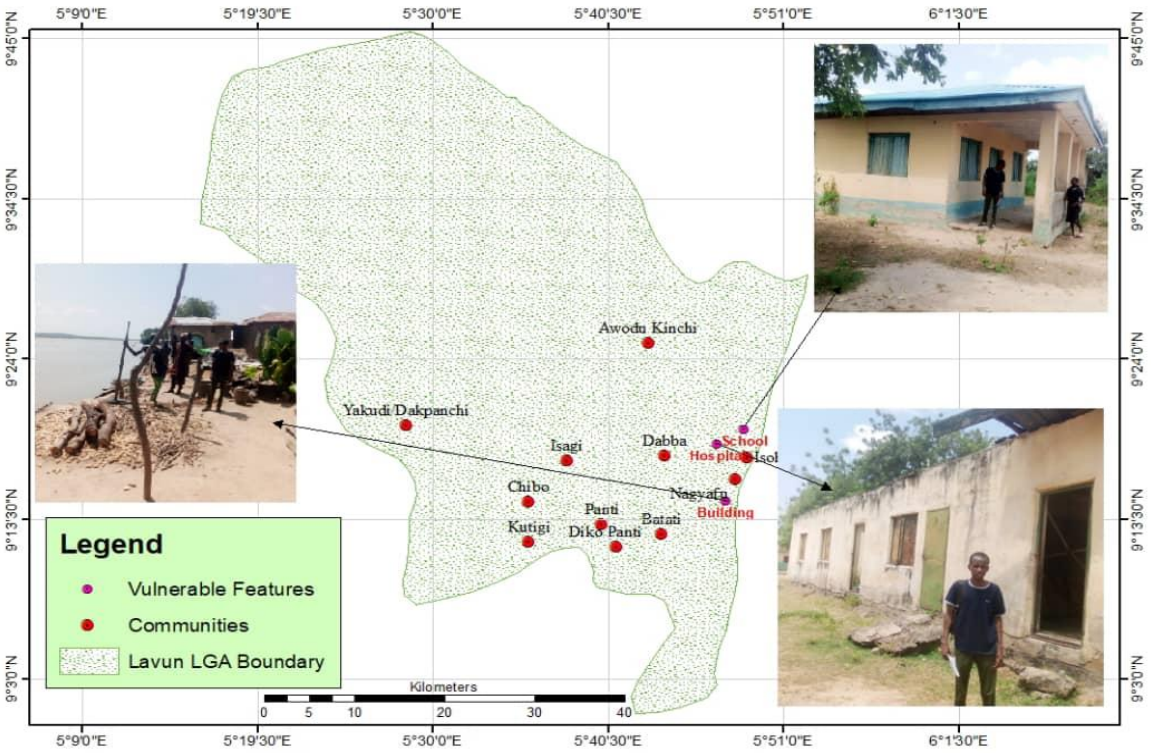

Figure 4: Study Area Map showing the affected structures
Source: Author's Analysis, 2023.

Result show as well that Tsogi community and Nagyafu communities are mostly affected because it's mostly River flood as they are very close to River Gbako, Tsogi and Nagyafu,are affected with the river flood from the Gbako river but not like that of Dabban, Batati, Isagi and Dapkanchi it is mostly affected by flash flood (Figure 4).

Plate 1**:** Impact of flooding on Education (A block of classroom destroyed by flood)

It has shown that flooding have really affected the communities in the study area which have led to last of lives, properties, houses, schools, primary health care (PHC), roads, Businesses, farmlands. As shown in Plate 1 which a block of classroom destroyed by flood. These have been very challenging for them as they became divasted which they have to start from the scratch to carter for themselves and also take care of their families.

Impact of flooding on the physical structures in the area

This present the people responses on the impact of flooding on structures, farmlands and businesses in the study area, it is discussed under the following subheadings;

Effect of flood on physical structures in the area

The FGD findings stated that flood has affected structures, roads among others. The responses are discussed below;

> **‘‘**The effect of flood in our community are washing away of houses, farmlands, personal properties in our households, destruction of primary healthcare facility (PHC), schools, and mosque.**’’**

> **‘‘**The flood destroys houses, farmland, roads, schools, healthcare facility (PHC), which sometimes makes it very difficult for us to access our village or community.**’’**

> “It destroy our houses and we are sometimes left with only the cloth in our body, it also destroy our farmland, it destroy our school which our children cannot go to school during that period”

In addition, the flooding affects the communities on various ways ranging from the destruction of roads, restricting of businesses, sometimes lead to loss of lives, movement of people and also denying the communities the ability to farm as their farmlands are submerged which is their major occupation. Hundreds of hectares of farmlands are flooded during the event of the flood. This lead to destruction of various types of crops which causes low yield and food insecurity. Pollution of various sources of water points also occurred when there is flooding. Business activities are disrupted thereby rendering people helpless, because the flood water washes away everything on its paths. This agreed with the work of Buba *et al*., (2021), work on A Participatory Assessment of the Impact of Flooding in Some Communities in Lokoja, Kogi State, Nigeria.

When water sources are polluted; the implication on the communities is the outbreak of diseases; such as cholera outbreak, malaria, typhoid, and diarrhea amongst others. These results also agreed with the study carried out by Umaru and Hafiz (2019) on the perceived effects of

flood on lives and properties of the residents of Lokoja. Their study showed that flooding caused damage to, among others, buildings, farmlands, and other infrastructure. The people's health are tempered and the available health facilities are also destroyed; in many cases the health facilities are locked up making seeking for treatment difficult and challenging.

Effect flood on farmlands and infrastructure in the communities

The FGD findings stated that farmlands are submerged and also infrastructures (schools, clinics, roads). It is discussed below;

> ''It has affected a lot of things in this community, it have affected our business as the main occupation of this community is fishing which we do sell, so when the flood occurs, we can't fish not to talk of selling the fish. It also destroy schools, clinic (PHC), Roads and also sometimes the community cannot be accessed because the community normally get consumed by water.''

> ''Yes, it affects infrastructure and farmland. Infrastructures like schools, clinic (PHC), and roads. Sometimes our kids cannot have access to the school because the road and school are flooded by water. As farm been our major occupation, our farmlands are been flooded and wash away by water leaving us in a difficult situation to carter for ourselves.''

> "It has destroy our farmland which sometimes we are left with nothing to harvest and to eat, it sometimes cut-off roads, destroy our clinic.''

The implication is that it might lead to poverty because there source of lively hood have been tempered with. This agreed with the work of Umaru and Hafiz (2019) that carried out Perceived effects of flood on lives and properties of the residents of Lokoja, Kogi State Nigeria which stated that flood have affected their farmland and businesses. And also this agrees with the work of Zitta *et al.,* (2015) who carried out Mapping Surface Hydrological Patterns in the Southern Part of Niger State which Lavun is inclusive and find out that the southern part of Niger state is affected by annual flood event due to the low elevation and increased encroachment to river bank.

Effect of flood on businesses and trading activities

The FGD findings also stated that businesses and trading are been restricted as movement become difficult during flood event. It is discussed below;

> ''When the flood occurs, all activities are shut down, because no coming in and going out, it normally consume the village which we

> have to use canoe to move to another place to settle for a while. It affects our business and our trading activities whereby we can't farm or do our fishing activities, we loses our money use in transacting businesses, we do lose our stocks, and equipment.''
>
> ''Some of us are engage in trading and businesses and farm product, flooding have affected our trading and businesses where by destroys our farmland which we normally uses our farm produce to transact businesses and trade are been wash away by flood and water and also led to the destruction of stocks, equipment and loss of money.''
>
> "Our major occupation in this community is farming and fishing, when the flood occurs we can't go to the farm because water wash our farm for us to harvest and take it to the market, and also we can't fish."

Agricultural practices are the major occupation of the people living in this community. It is normally at threat as the flood destroy farmlands which lead to low agricultural yield and also lead to low income as they cannot trade their farm product because of the destruction and low yield. This correspond with the work of Ibrahim and Tasi'u (2020) on Flooding And Agricultural Productivity: The Coping Strategies Of Farmers In Ringim, Northern Nigeria, which found out that the effects of flood highly reduced yields of the main cultivated crops in the study area, low yield in the agricultural production was the main difficulties faced by farmers as indicated by almost all the respondents (88.75%) and majority of the farmers had to faced insufficient farm investments, pest or disease infestation due to the flood. Low yield in agricultural production couple with pest or disease infestation and insufficient farm investments leads to scarcity of labour and lack of quality seeds. Fishing is also among the source of livelihood in the community, they cannot catch fish as everywhere is flooded not to talk of selling them in the market. Some of them most especially the women do go to the market for buying and selling not just their own farm produce but also other product in the market. The flooding makes it difficult or impossible to carry out all that. Businesses are affected which result to loss of capital in transacting businesses. It has also lead to the destruction of food stocks, farming equipment, and loss of valuable time among others. In order to reduce the effects of the flood, the people temporarily leave the community to other high elevation area not affected by flood and later come back when the flood water is drained. This is similar to the work of Frederick *et al*., (2010) Impact of Floods on Livelihoods and Vulnerability of Natural Resource Dependent Communities in Northern Ghana who said the effects of floods on natural resource-dependent communities in northern Ghana Being essentially agricultural producers, the main consequence of flooding has been the destruction of food crops on farms as well as seeds stores; eventually culminating in a decline in food production.

Plate 2: showing the vulnerability of the settlement and some houses in Tsogi community

Plate 2 shows the vulnerability of some structure to the river and some settlement that have been destroyed by flood and also some are close to collapsing. Hence, most of the inhabitants are living in fear not knowing what will happen next. According to one of the respondent their hope only lies in God almighty. This is related to a report by Akinola and Nwangoro (2021) through ChannelsTV the Devastating Flood That Left Taraba Residents in Distress which a respondent said there is nothing we can do actually, and the destruction is enormous. It is something we never planned for, but we thank God that we still have shelter over our heads. This is the second time this is happening. Some of us are still counting our losses till now.

CONCLUSION

Lavun Local Government Area is one of the few local Governments that are along major rivers in Niger state, it has been affected severally by flood disaster events. Also it shows that activities like dam construction (spill-water from the major river) and back flow of the river, excessive rainfall, building and farming activities on flood plain in the study area, low vegetation along the river bank are causes of flood in the study area which has led to submerging of farmlands, destruction of crops, destruction of houses, health care facility, schools, roads among others. The study indicate that Tsogi, Nagyafu, Batati, Awodu Kinchi, Isagi, Dikko Panti falls on the high risk zone, Panti and some community's falls on the moderate risk areas, Chibo, Kutigi falls on the Low risk areas which is the marginally vulnerable, Yakudi Dakpanchi and other communities that are on the high elevation falls on the no Risk zone areas.

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