VOLUME 1, NO. 1, NOV., 2017

CONFLUENCE JOURNAL OF PURE AND APPLIED SCIENCES

FACULTY OF SCIENCE
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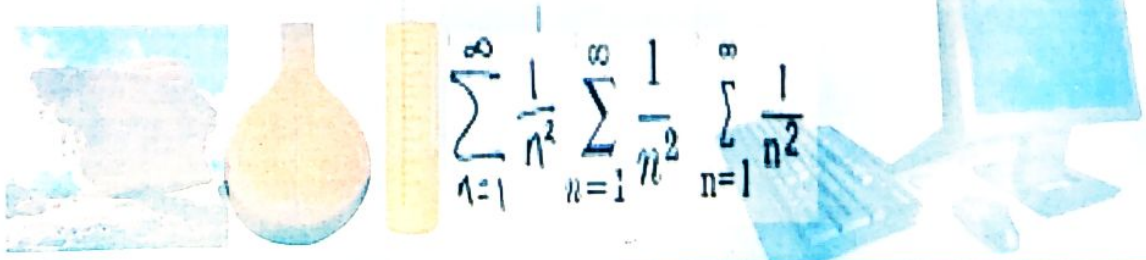

Confluence Journal of Pure and Applied Sciences (CJPAS)

Volume 1, No 1, November, 2017

Federal University Lokoja, Kogi State Nigeria
Faculty of Science

Confluence Journal of Pure and Applied Sciences (CJPAS)
Volume 1, No 1, November, 2017

Printed in the Federal Republic of Nigeria
First Printing, 2017

Printed by:
Cover Design by: Infinity Digital Press, 131 Cemetery Road, Lokoja, Kogi State.

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www.cjpas.fulokoja.edu.ng

From the Desk of the Editor-in-Chief

Confluence Journal of Pure and Applied Sciences (CJPAS) is a product of vision and mission of Federal University Lokoja. The Faculty of Science decided to float the journal as part of its corporate social responsibility to the advancement of teaching, research and community development. The editorial board consists of seasoned academics, trained in various scientific disciplines.

The aim is to show case the level of intellectualism of Federal University Lokoja, Kogi State and the specific objectives include the following:

i) the float of a standard journal;
ii) providing avenue for academics to actualize their academic aspirations through publication of academic research works;
iii) to enable seasoned academics from other reputable institutions to partner with members of the university community in research areas that would have potential impact within and outside the country and
iv) creating an avenue for technological advancement through publications of research findings at regular intervals.

This volume, which is of international standard, is the maiden edition. The frequency will be twice per year.

I recommend this journal to you with the hope that you will continue to patronize it.

Professor Omolehin Joseph Olorunju (FAC)
Editor-in-Chief

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Terrain Analysis for flood Vulnerable Communities in Edozhigi District of Gbako Local Government Area, Niger state, Nigeria.

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Abstract

Most Communities of Edozhigi district are located along the Kaduna River which is one of the largest rivers in Nigeria. The location of Shiroro hydro Electric power dam in the state along this river has brought about annual flood disaster that destroys many lives and properties. The study aimed at geospatial analysis of flood vulnerable communities downstream of River Kaduna in Edozhigidistrict.The study focused on the use of remotely sensed data and Geographic Information System (GIS) techniques for terrain analysis for flood disaster vulnerability assessment of Edozhigi district. The data used for the study include 2002 Base map, Geographic coordinates, 2014 Google earth image and 2014 Shuttle Radar Topographic Mission *(SRTM) of the study area.Digital Elevation Model (DEM) of the district was created for reclassification of elevation differences. The areas liable to flooding was also determined and their vulnerability level, the Digital elevation model extracted from SRTM data and flow direction map created, shows twenty one(21) Communities trapped within the flood plain;and these lies between 65 to 95 meter above sea level. The study concluded that geospatial tools were very necessary in assessing the terrain of the area and identify areas liable to flood. The study recommended theconstant monitoring of the communities in the flood prone areas and public enlightenment on adherence to early flood warning and mitigation measures should be taken serious.*

Keyword: Flood, vulnerability, Terrain analysis, Remote sensing

Introduction

Oxford Advance Learners Dictionary (7th Edition) refers flood as a large amount of water covering an area that is usually dry and become so full that it spreads out unto the land around it. Flood is a temporary covering by water of land normally not covered by water. This includes floods from rivers, mountain torrents, Mediterranean ephemeral water courses, and floods from the sea in coastal areas, and may exclude floods from sewerage systems. The geomorphology of a river system to flood is directly influenced by major variables including channel width, depth, velocity, discharge, channel slope, roughness of channel materials, sediment load and sediment size Mull, (2011).

Flood is the most current and common problems associated with most urban and rural areas whose effects have caused unquantifiable damages to lives and properties. The case of seasonal flooding which ought to have been prevented through adequate land use planning and implementation came about as a result of gross neglect of planning regulations due to either omission or commission on the parts of the building developer. The trend of these is likely to continue if not halted because of the daily increase in urban

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growth and associated human activities which further heighten the rate of run-of, Falade, (2010).

Vulnerability is the degree to which a system or unit is likely to experience harm due to exposure to perturbations or stress. Vulnerability is the degree of fragility of a natural or socio economic, community system towards natural hazards. It is a set of conditions and processes resulting from physical, social, economical and environmental factors, which increase the susceptibility of the impact and the consequences of natural hazards. It is determined by the potential of a natural hazard, the resulting risk and the potential to react to and/or to withstand it, i.e. its adaptability, adaptive capacity and/or coping capacity. The concept of vulnerability originated in research communities examining risks and hazards, climate impacts and resilience Donelly, (2013).

Flooding along the Kaduna River in Gbako Local Government Area of Niger state is an annual occurrence. The unsafe condition of lives and properties along the river has over the years become an issue of serious concern to individuals, Local, State and the Federal Government as properties amounting to billions of Naira are damaged yearly.

The vulnerability of Edozhigi to flood disaster could be attributed to two major factors, the first being the location of large parts of the area in a lower terrain (Niger valleys and Plains) along the largest rivers in Nigeria, that is, River Niger, making the land and communities that are located in this low terrain area be prone to annual flooding. The second factor is the presence of the three Hydro Electric Power (HEP) stations in the state; the Kainji dam and Jebba dam on River Niger at Kainji and Jebba towns respectively and the Shiroro dam on River Kaduna, Muhammad and Iyortim,(2013). Communities downstream of these three dams are usually vulnerable to floods especially when the spillways are opened to reduce water volumes in the dam so as to avoid dam collapse.According to Anunobi,(2013), historically, Nigerian floodplains have always attracted settlements especially in the northern part of Nigeria where the population is mostly agrarian. Those involved in the fishing sector of the agrarian industry normally settle along river banks and tributaries which are naturally flood prone.

On the causes and impacts of flood hazards,Nachlik, et, al., (2000)asserted that flood hazards are natural phenomenon, but the damages and losses from floods are the consequences of human actions because it has been known that floods can be caused by anthropogenic activities and human interventions in the natural processes such as increase in settlement areas, population growth and economic assets over low-lying plains prone to flooding which may lead to alterations in the natural drainage and river basin patterns, deforestation and climate change.

Following the annual increase of flood disaster especially the devastating 2012 flood hazards in Nigeria coupled with improvement in the use of modern technologies for environmental

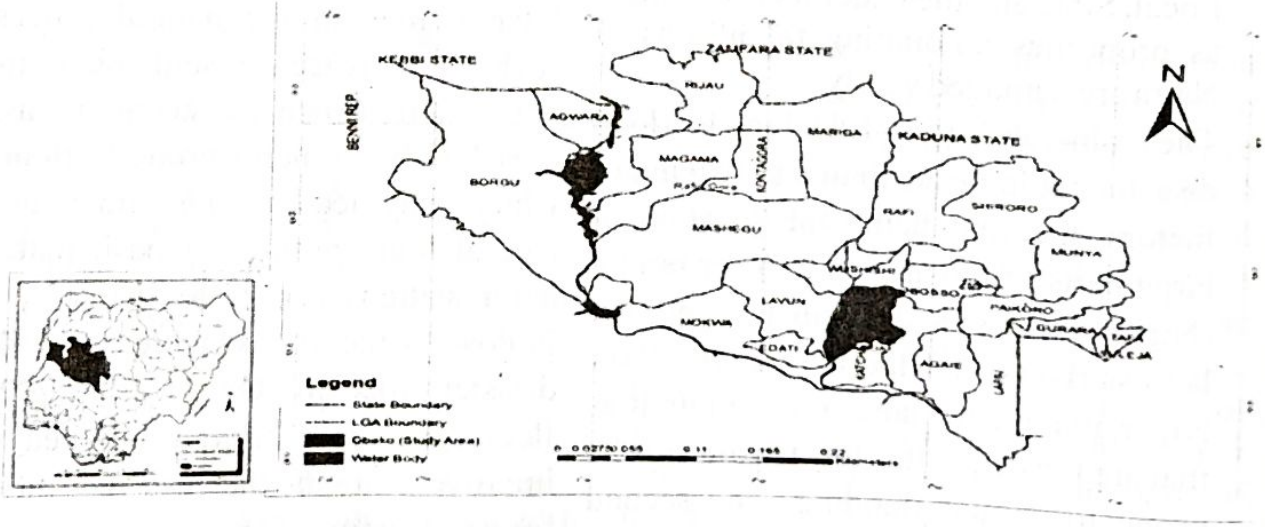
monitoring such as remote sensing and GIS, the government of Nigeria and the relevant agencies have recently put all hands on deck for environmental monitoring and management especially flood disaster. Flood disaster monitoring and management involves several process and data generation, Geographic Information System is the modern tool and technology that is being effectively applied to detect and map out areas that could be considered as vulnerable to the construction of super structures and endangered human activities based on statute, experience and peculiarities (Ikusemoran, et, al,.2013).

The aim of this study therefore was to map and asses the vulnerability of the communities and features within Edozhigi district that are persistent to flooding by River Kaduna. This was achieved through the following set of objectives.

- To map the communities in Edozhigi district of Gbako LGA located within flood plain of River Kaduna.
- To generate Digital Elevation Model (DEM) to show flow direction of River Kaduna in the study area
- To attempt to produce risk map which will delineate risk zones and capture the at-risk elements.
- To determine the proximity and asses the vulnerability of communities or feature to flooding along River Kaduna channel

Study Area

The study area is in Edozhigi district in Gbako local government area of Niger state. The study area is bounded by latitude 9.208^{0}N longitude 5.901^{0}E, latitude 8.987^{0}N longitude 5.837^{0}E.and covering an area of about 31.2square kilometers. It is within a typical fast growing farmland and residential land-use area, the River Kaduna form its western boundary (figure 1).



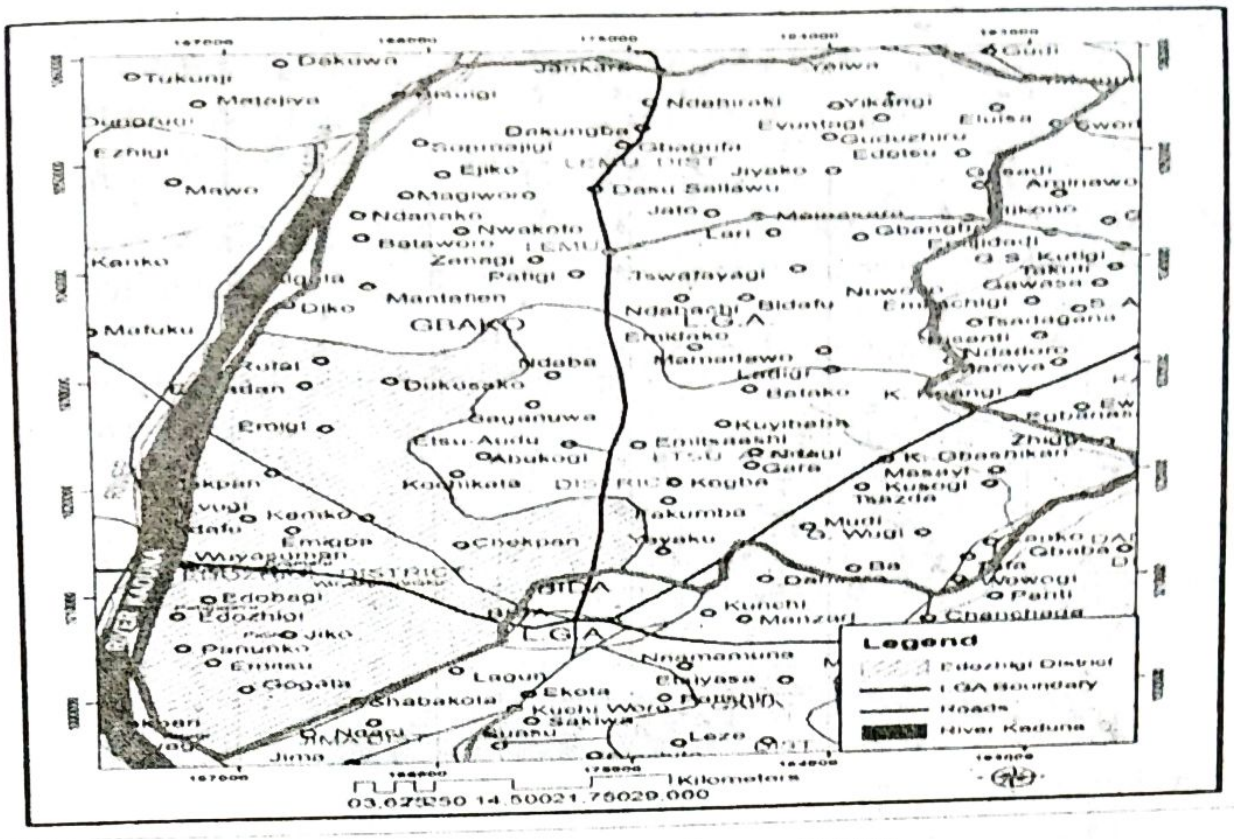


Figure 1: Study area coverage (Edozhigi District). Source: NIGIS

The climate of the area is characterized by dry season from November to March and a wet season from April to October, with average annual rainfall of about 1320mm and the dry season has high temperature and low relative humidity of about 30% while the wet season has lower temperature small diurnal variation and high relative humidity of around 60-70%899, the dry season winds are predominantly from North-East to south-west and the season are predominantly from south-west and north-East.

Methodology

Data collected and used for this study includes coordinates taken in the field with the use of GPS, QuickBird satellite imagery, SRTM and Base Map of study domain and oral interview.The Arcmap 10.1 software was used to reclassify the Shuttle Radar Topographic Mission software (SRTM) of the study area to identify the flood vulnerable areas. The data was clipped to the base map in order to perform the extraction by mask operation of the study area using Arcmap processing interface. Arc Analysis tool – Spatial analyst tool-Hydrology tool-then the DEM fill were carried out to fill the missing information on the SRTM. Reclassification was performed on the filled SRTM data to reclassify terrain using Arctool box. Further analysis like flow accumulation, flow sink and lookdown were done to determine directionof flow of water bodies.

Various geographical coordinates taken from the field with the use of hand held GPS, were projected as Northern, Eastern, Elevation (x, y, z) to generate the 3-dimmesional configuration of the study area terrain using Arc scene software.The High resolution satellite (Quick Bird) image and SRTM used were analysed using Arcmap 10.1 software and Arcscene for generation of 3-dimmesional view.Image importation and georeferncing was done. The Arc tool box was used to mosaic the various

sections of interest of satellite imagery of thestudy area for digitization. Shape files were created for the various features in the study area to create layers for each digitized features.The following were identified as the view of reality for the flood vulnerable zone of river Kaduna under investigation:

1. River was represented as polygon feature.
2. Road was represented as line feature.
3. Building was represented as polygon features.
4. Districtwas represented as polygon feature
5. Risk map was produced using Geo-processing interface in which buffering analysis were perform to show the levels of vulnerability of features and communities around the river channel.

Table 1. Material used for the study

S/N	DATA/MATERIALS	DATA TYPE	SOURCE	DESCRIPTION
1	Base Map	Secondary	NIGIS	Base Map of the study area (Gbako Local Government Area Map), date 2001.
2	GPS Coordinates/ GPS	Primary	Field work	Spatial location of some features and places in the area.
3	Satellite imagery of the study area/ Satellite sensor	Secondary	Google earth	Google earth image, 2.5 x 2.5 resolution (multispectral), 2014.
4	Shuttle Radar topographic Mission (SRTM) data of the study area.	Secondary	NIGIS	SRTM for terrain analysis and generation of digital elevation model, 90m resolution, 2014.

Results and Discussions

Digital Elevation model of the study area

Digital elevation model extracted from SRTM data is presented in figure 2. It shows the nature of the terrain from lowland to highland also helped to visualize low and highland. From the figure, it was discovered that places covered with dark tones have low elevation and are identified to be those floodable terrain which lies between 56 to about 95 meters above the sea level. This was also observed during field work.

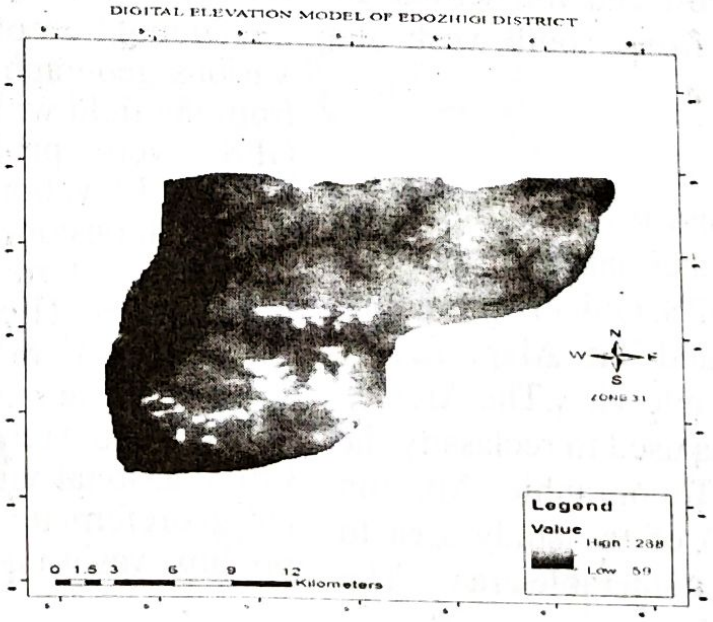


Figure 2. Digital Elevation Model (DEM)

Reclassified map of the study terrain

This was carried out in order to visualize the nature of the terrain of whole district and most especially floodable terrain from the reclassified map. The reclassified map presented in figure 3 field survey that the elevations of the floodable area were almost uniform around the river channel and all the floodplain communities are also trapped within the elevation of 56 to about 95 meters above sea level which are liable to

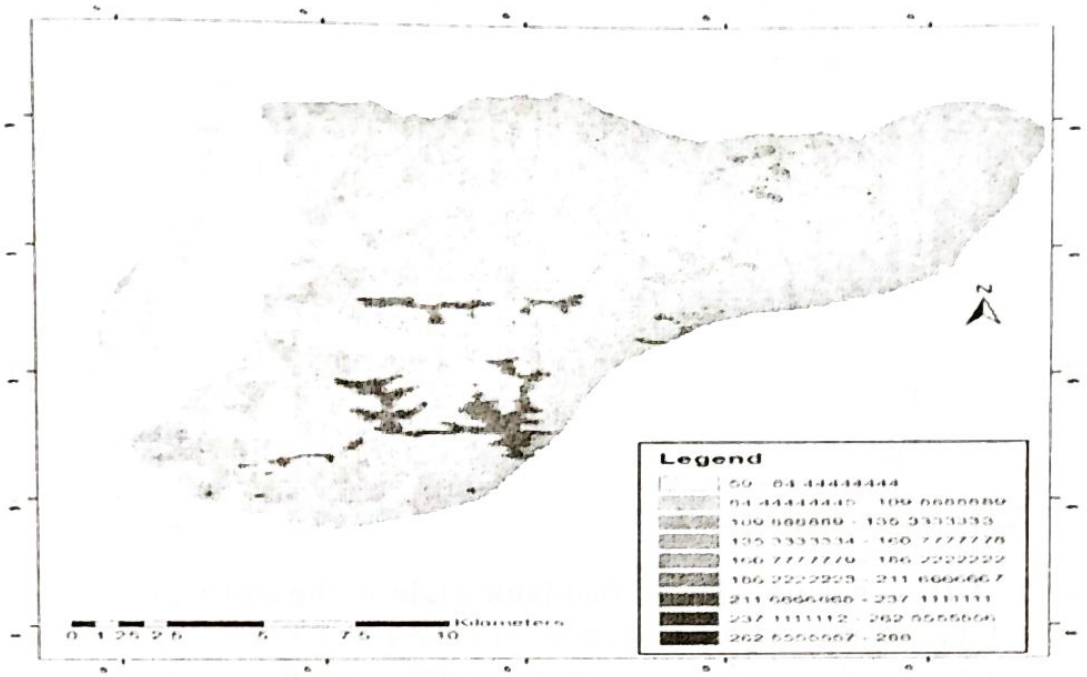


Figure 3 Reclassified terrain map of the study area

Direction of Flow of River Kaduna in the Study area

The direction of flow of River Kaduna as revealed in figure 4 is southward but the rivers from the highland surrounding flow westward to river Kaduna.

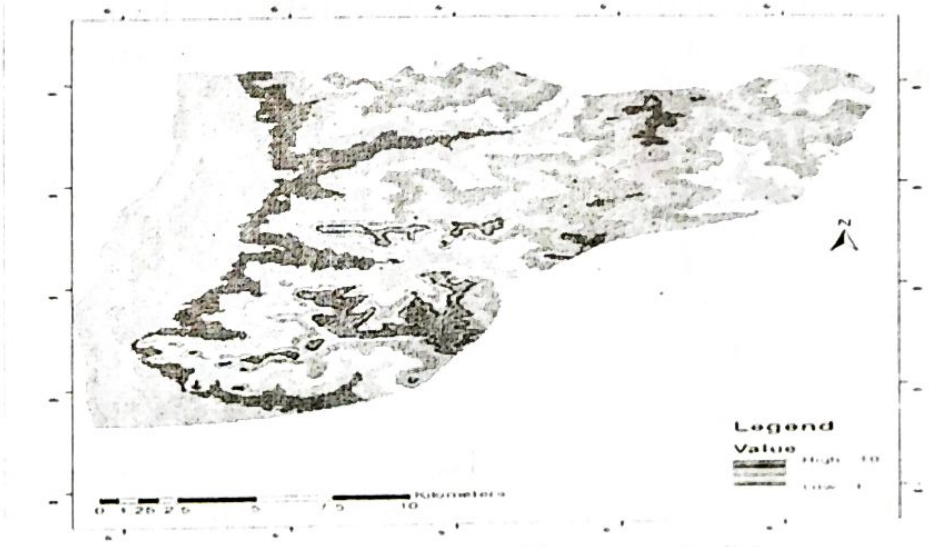


Figure 4.Flow directions Map.

The 3 Dimensional View of floodable plain using Arc scene

The terrain of the floodable area was also viewed in 3D using Arcscene. This was achieved from 104 coordinates (xyz) collected from field survey and the analysis was carried out using Arcscene analytical tools in order to visualize the terrain in 3Dimension (xyz) as shown in figure 5

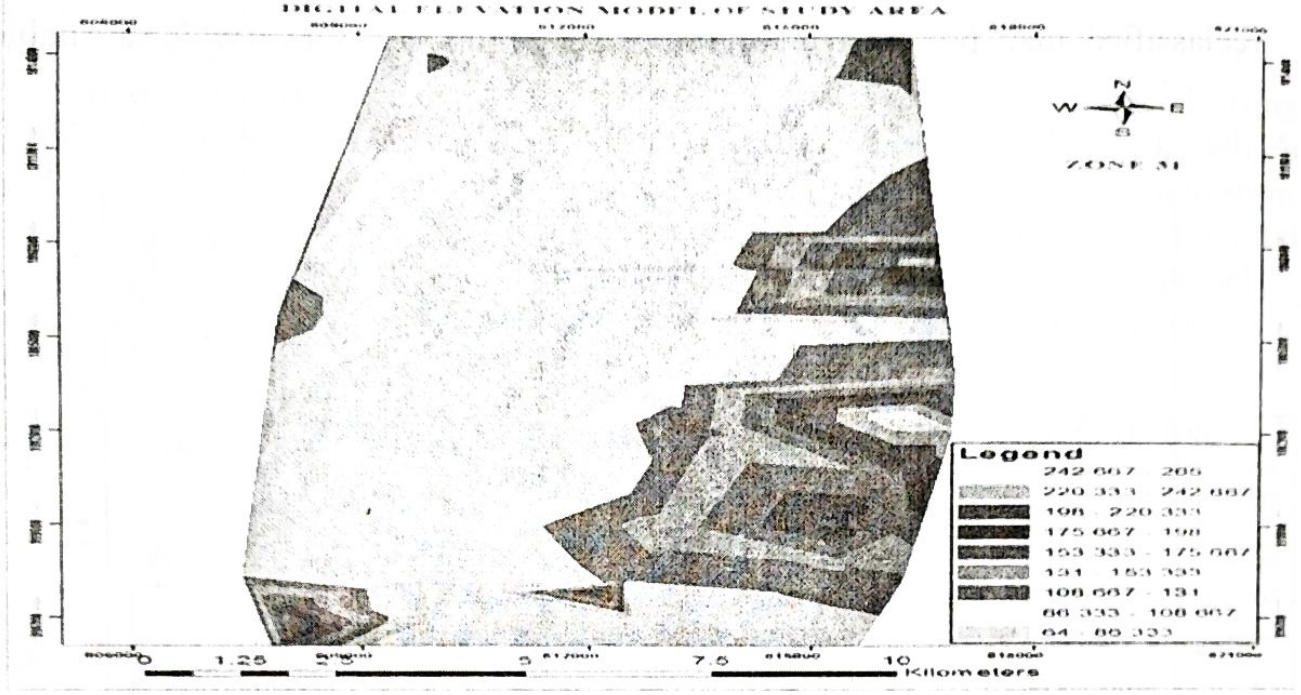


Figure 5. 3-Dimensional view of floodable plain in the study area.

The operation was used in order to properly have a better visual perception of the configuration of terrain of the study area in comparison with result analysis from STRM, The elevation of the floodable area as revealed by Arc scene 3D view is also 56 to about 95m while the highest elevation is 265 meters above sea level as presented figure 5

From the result of the analysis done on SRTM to create configuration of digital elevation model (DEM) of the study area in comparison with the one with the use of geographical coordinate (GPS) coordinate both revealed the elevation of floodable area to be 56 to 95 meters above sea level and the 21 communities were trapped to be under this floodable environment.

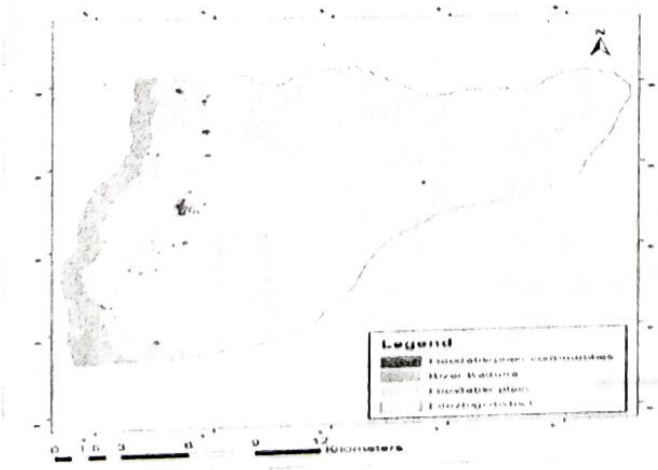


Figure 6. floodplain map of Edozhigi district

Floodable plain map presented in figure 6, is very important because there is need to visualize the areas prone to flood in the study area. From the interview, is was discovered that the areas pointed out as floodablelies within 3000meters (3km) away from the River channel. The flood prone area mapped was also discovered to have almost uniform terrain.

Table 2: Communities within the flood plain of River Kaduna channel in Edozhigidistict of Gbako local government area, of Niger state, Nigeria.

S/N	Name of Communities	Northern	Eastern	Elevation
1	Evugi	101723	813257	79
2	Dalli	1016733	814624	83
3	Dingi	1016310	814306	90
4	Bramafu	1014414	814433	84
5	Wuyakpansanako	10111752	814507	85
6	Wuyakpata	1011931	811973	71
7	Gbajigi	1011828	812400	72
8	Edobagi	1008750	813722	81
9	Patigi	1007991	813482	84
10	Edozhigi	1007557	813277	77
11	Picifu	1004197	813085	88
12	Sonkpata	1002107	811230	71
13	Emibakolo	1001901	811792	84
14	Kusokpangi	1000667	811330	87
15	Sheshi-Audu	1000552	811965	85
16	Emisuasun	999152	809976	74
17	Emimayaki	998923	810013	72
18	Dakpandzuko	998913	810418	88
19	Emitswanya	998135	810629	79
20	Yeregi	995997	812439	78
21	Ndatete	994810	814057	76

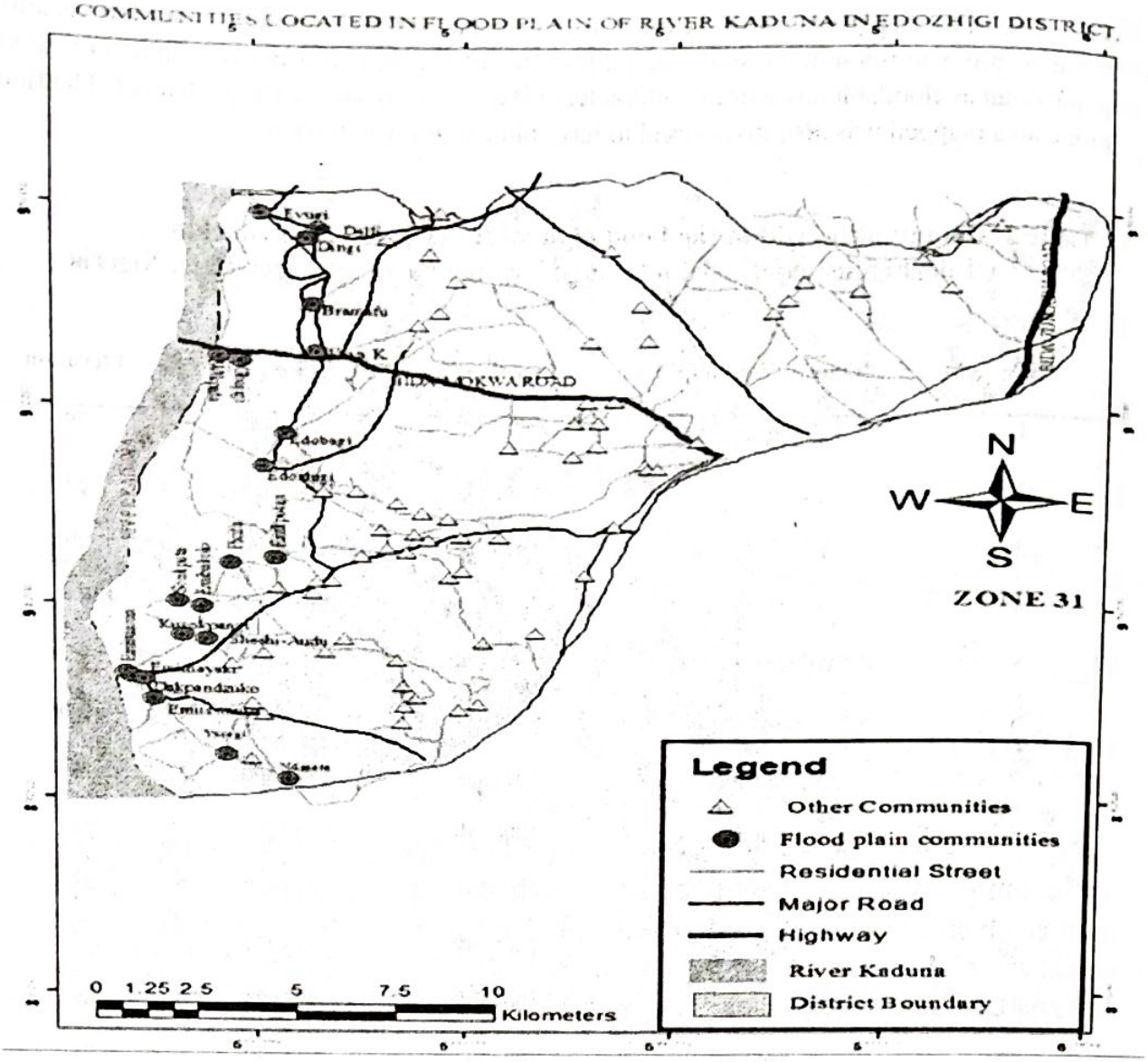


Figure 7.Edozhigi District Map of floodplain communities.

Based on the flood plain demarcation map presented in figure 7. It clearly showed the spatial location and the name of floodplain communities on the map. Therefore, these named communities and the farmland around are under the threat of flood of river Kaduna which is mainly caused by release of water from shiroro dam when the intake capacity of the dam is exceeded.

Proximity Analysis.

The proximity of the communities was carried out in order to identify the distance of each settlement from the river Kaduna channel. This was achieved by measuring tool of ArcGIS as shown in Table 3.

It was discovered that four (4) communities falls below the distance of 800m (between 0 to 0.73km) from the River channel and the terrain is not favourable for such closeness to the river channel since the elevation of the highly floodable areas of 1000 meter away from the river channel is almost uniform which is highly vulnerable to flood.

Table 4. Buffered distance and their vulnerability zone.

S/N	Buffered zone level	Categories
1	0-1000meters	High risk zone
2	1000-2500meters	Medium risk zone
3	2500-3000meters	Low risk zone

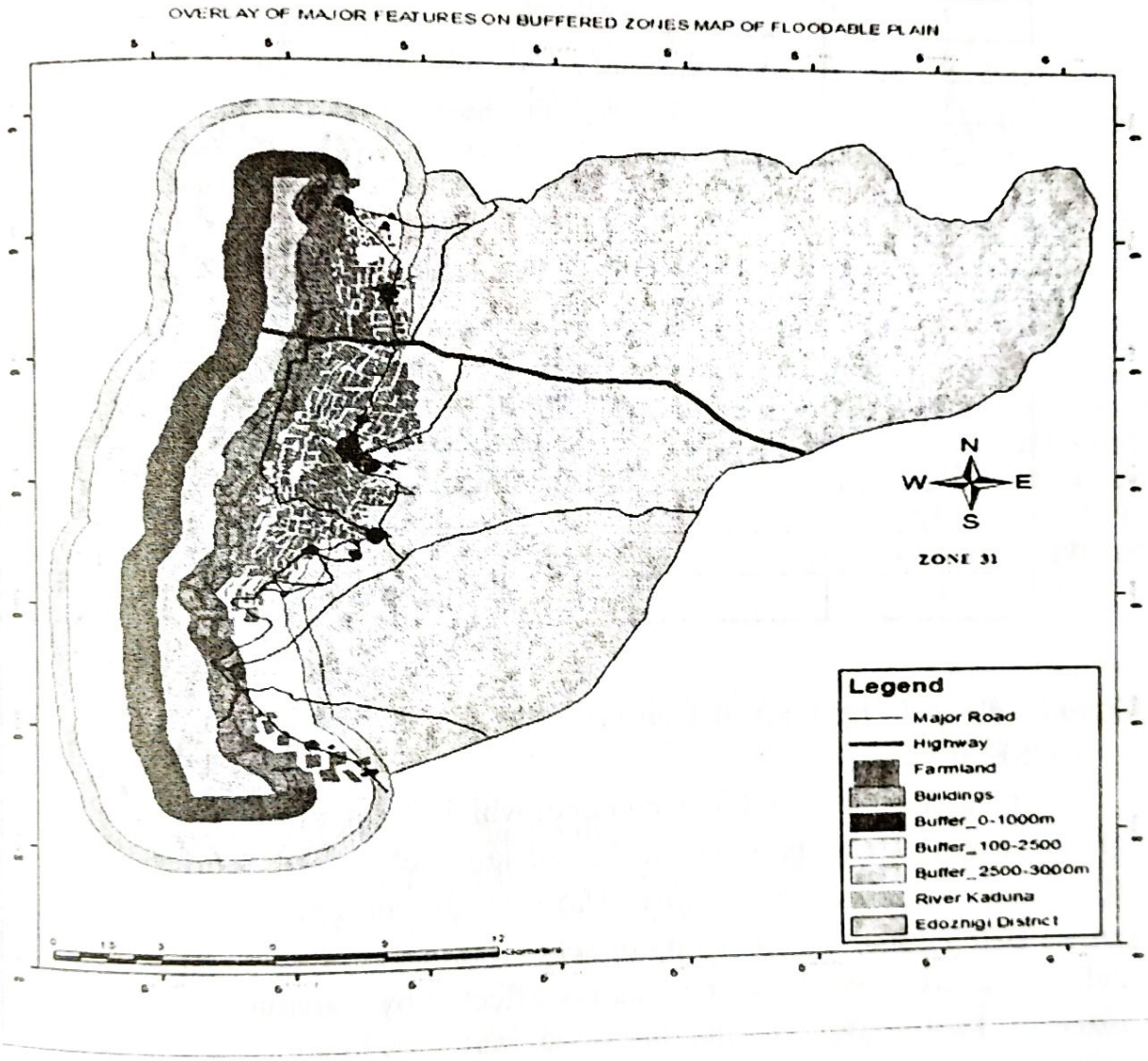


Figure 8: Overlay of communities and surrounding farmland on buffered map

Therefore the flood vulnerability of the terrain andthe communities or buildings based on their locations was classified into the following:

(i) **High risk vulnerable zone:** the Elevation within 0-75m (Low land) is on buffered zone of 1000m distance away from the river.

(ii) Medium risk vulnerable zone: the Elevation within 75-85m (Low land) is on buffered zone of 1000m to 2500 distance.

(iii) **Low risk vulnerable zone**: the Elevation within 85-95m are buffer zone on 2500m to 3000m distance

Table 3: Distance of communities to river channel.

S/N	Name of Communities	Proximity(Km)
1	Evugi	1.02
2	Dalli	2.03
3	Dingi	1.93
4	Bramafu	2.21
5	Wuyakpansanako	2.80
6	Wuyakpata	0.12
7	Gbajigi	0.46
8	Edobagi	2.73
9	Patigi	2.30
10	Edozhigi	2.80
11	Picifu	2.52
12	Sonkpata	1.90
13	Emibakolo	2.41
14	Kusokpangi	1.91
15	Sheshi-Audu	2.53
16	Emisuasun	0.22
17	Emimayaki	0.28
18	Dakpandzuko	0.61
19	Emitswanya	0.73
20	Yeregi	2.01
21	Ndatete	2.42

Flood Vulnerability map of Communities and farmlandin Edozhigi District (RISK MAP).

One of the capabilities of GIS techniques which distinguished it from other forms of spatial analysis is its ability to be spatially referenced. Buffering Operation *(Criterion One for Vulnerability Map)* is the process by which zones of influence/interest around an entity or set of entities are created. It is often used to delineate areas affected and the area not affected by a spatial activity or to show extent of coverage of an activity.

The bases for the buffer distances of this study is field survey and personal interview conducted with residents of the communities located on floodplain in the study area.**Criteria for the buffer operation was carried out based on the nature of elevation of the terrain collected with GPS and the reoccurrences of flood along the river channel from interview in which 1000meters, 2500 meters and 3000meters buffer zones were established as shown in figure 8**

This revealed that communities such as Gbajigi, Wuyakpata, Emisuasun, Emimayaki, Dakpandzuko and Emitswanya falls within high vulnerable, while communities like Evugi, Dalli, Dingi,Bramafu,Patigi, Edobagi,Sonkpata, Emibakolo, Kusokpangi, Yeregi, Ndatete falls within medium vulnerable and Edozhigi, Picifu, Sheshi-Audu communities are located on low vulnerable zone of river Kaduna as represented in figure 4.6.

Conclusion

The use of remotely sensed data and GIS techniques for floodplain (terrain) analysis of Edozhigi district of Gbako Local Government area of Niger State in order to assess the flood disaster vulnerability of the area has been demonstrated in this study. The study revealed that the terrain of communities such as Gbajigi, Wuyakpata, Emisuasun, Emimayaki, Dakpandzuko, Emitswanya are highly vulnerable because the elevation is 75meter and below while communities like Evugi, Dalli, Dingi, Bramafu, Patigi, Sonkpata, Emibakolo, Kusokpangi, Yeregi, Ndatete are considered to be "medium vulnerable" because their elevation fall between 76 to 85meter above sea level and Edozhigi, Picifu, Sheshi-Audu communities are located on low vulnerable zone of river Kaduna and their elevation falls between 86 and 95meters above sea level.this was made possible with the use of Remote sensing and GIS.Geographic Information System capabilities explored for this research confirmed the appropriateness of the technology in the mapping and analyses of flood vulnerability challenges.

Recommendations

Based on the findings of this study, the following recommendations are made to effectively minimize the impacts of flood disaster in the study area:

(i)In order to effectively tackle the menace of flood disaster, there is the need for terrain analysis for proper landuse assessment and planning, the need for automated data gathering and analysis for generation of information that is reliable and dependable upon for flood disaster monitoring, managementand decision making.

(ii)Resettlementof communities within highly vulnerable zone to flooding of River Kaduna in Edozhigi district and where they would be resettled as well as compensation of persons and communities that are victims to flood in the district and generation of a comprehensive data and periodical reviews of all the communities that are vulnerable to flood in Edozhigi District and the entire Gbako Local Government for quick decision making especially during flood disaster.

(iii) Finally, Government should as a matter of urgency enforce restrictions to all forms of construction activities within the flood vulnerable zones while a comprehensive renewal programmed should be put in place to review physical developmentactivities within areas in the study area. Such renewal programme should involve a redesign, clearance, rehabilitation and sustainability action which is a holistic and best practice approach to riverline area planning of slum and sprawl areas as it is the case of this flood prone area within the study area.

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