International Journal of Science and Advanced Innovative Research
ISSN: 2536-7315 (Print) 2536-7323 (Online)
Volume 5, Number 1, March, 2020
http://www.casirmediapublishing.com

ASSESSMENT OF THE PHYSICAL CHARACTERISTICS AND LAND USES AFFECTED BY FLOOD WITHIN GREATER YOLA, ADAMAWA STATE, NIGERIA

Zarma, I. J., Sangari, D. U. & Ogah, A. T.
Department of Geography
Nasarawa State University, PMB 1022, Keffi, Nasarawa State, Nigeria
Email: jzarma1829@gmail.com, dusangari@yahoo.com; ogahadamu@gmail.com

ABSTRACT
The paper assessed the physical characteristics and land uses affected by flood within Greater Yola in Adamawa State, Nigeria. The paper used both quantitative and qualitative methods. Based on the aim of the study and the analysis, the paper found that the physical characteristics of the study area are made up of both larger and smaller watersheds with river Benue serving as the major pour point; this is the point on the surface within the study area at which water flows out. The landform of the study area is generally grouped into valley and troughs, upland, plains, lowlands and hills/mountain ranges. The vegetation formations of Adamawa State like most northern States are generally of the savannah type. The paper also discovered that the soil formation of the study area are regosol, and the area is well drained by many rivers and most of them are seasonal. The study also found out that areas that are 0-7km off River Benue are highly vulnerable to flooding. It was also discovered that agriculture and settlements are the land use/land cover mostly affected by flood in the study area. The paper found that the heavy rainfall in the study area usually within the month of June, July and August at an average of 194.2mm, 224.2mm and 198.2mm, account for the major cause of flooding in the area. The paper recommends that the dredging of the River Benue from its entry to Nigeria to its conference with River Niger should be undertaken to accommodate more water, as it will help prevent the occurrence of flood in the study area. Similarly, the urban development and planning board in the study area should ensure proper monitoring of structure being erected so as to avoid building on water ways and flood vulnerable sites. The relevant authorities should also ensure that proper drainage systems are built and implemented in the *State Urban and Regional Planning requirements.*
Keywords: Flood, climate, rainfall, river Benue, and vulnerability.

INTRODUCTION
Globally, disasters are said to have devastating effects on economic development, livelihoods, agriculture, and health, social and human life (Wood, 2005). They are sudden accidental events that may cause deaths or injuries. Abam (2006) defined flood as a large volume of water which arrives at and occupy the stream channel and its flood plain in a time too short to prevent damage to economic activities including homes. It is a natural hazard

like drought and desertification which occurs as an extreme hydrological (run off) event (Nwafor, 2006). It could also be seen as the inundation of an area not normally covered with water, through a temporary rise in level of stream, river, lake or sea (Emodi, 2012). Prolonged rainfall events are the most common causes of flooding worldwide. Floods are generally regarded as extreme hydrological events, where there is excess of water which may have devastating effects. According to Ayoade (1988), flooding in the tropics is regarded as partly or wholly climatological in nature as they result from torrential rainfall.

Flood disaster is not a recent phenomenon in Nigeria and its destructive tendencies are sometimes enormous. According to the United Nations Environment Program (UNEP, 2006), flooding is one of the major environmental crises ravaging the universe within the century and the millennium. This is especially the case in most wetlands of the world. The reason is attributed to the general rise in sea level globally, due to the global warming as well as the saturated nature of the wetlands in Nigeria. Periodic floods occur on many rivers, forming a surrounding region known as flood plain. Within the cities, human activities such as rapid industrialization and urbanization, population growth, exploitation of natural resources and location of infrastructures (dams, piers and lands) exacerbates the occurrence of floods. Askew (1999) reiterated that floods cause about one third of all deaths, one third of all injuries and one third of all damages from natural disaster. Floods occur in Nigeria in three main forms; coastal flooding, river flooding and urban flooding. Coastal flooding occurs in the low lying belt of mangrove and fresh water swamp along the coast (Folorunsho & Awosika 2001; Ologunorisa, 2004). It is typically a function of storm surge, waves (driven by wind) and heavy rainfall. River flood is a function of rainfall and run off volumes within the river valley. It occurs in the flood plain of larger rivers where sudden short-lived flash floods are associated with rivers in the land areas where sudden heavy rains can change them into destructive torments within a short period (Folorunsho & Awosika 2001; Ologunorisa, 2004). Urban flooding on the other hand occurs in towns, on flat or low lying terrains especially where little or no provision has been made for surface drainage or where existing drainage has been blocked with municipal waste, refuses and eroded soil sediments (Ali, 2005). Oderrerho (2004) and Nwafor (2006) identified twelve (12) causes of urban flooding. They include; Surcharges in water level due to natural or man-made construction of flood paths, sudden dam failures, inappropriate land use, deforestation of catchment basins, reclamation, construction sites and solid waste, inadequate drainage capacity to cope with urbanization and excess encroachment in flood ways. Urban flood problem is a global experience but the management practices differ according to prevailing technologies and aptness in planning concern.

Nott (2006), points out that 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 are low lying coast and deltas, and small basins subject to flash floods. Empirical researches (Okereke, 2007; Kolawole *et al.,* 2011) have highlighted the basic consequences of flooding 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. In flood events, socio-economic life and livelihood of the affected people may be distorted, in most cases farmlands and livestock are submerged which are the major source of people's livelihood. Flood losses are devastating as many never get recovered after the flood recedes. Vulnerable communities suffer great losses in events of flood, especially when the flood is unprecedented. Hunger, famine, disease and epidemic outbreak are usually resultant impacts of flood (Mmom & Aifesehi, 2003). Malaria and typhoid outbreaks after floods in tropical countries are common. It has been estimated that in India and Bangladesh 300 million people live in areas that are affected by floods (Nott, 2006).

Incidents of flood are not a recent phenomenon to people of Adamawa State as they have been living in flood prone areas for centuries. Like most urban areas of the third world, Adamawa has experienced accelerated population growth which has led to changes in the land use activities. Land use changes in particular, have a direct impact on the magnitude and behaviour of floods (Civco *et al.,* 2002). Flash floods are common features in Nigeria during the rainy season (May-October) but the country's flood event of the year 2012 have been described as the most devastating in over 40 years. Two major events took place between the months of September and October 2012 in Nigeria, namely the Ladgo Dam flood in Adamawa State, and the River Benue and Niger adjoining States floods (Niger and Benue States). The event pushed most of the country's rivers over their banks and submerged hundreds of kilometres of urban and rural land. This resulted in widespread devastating flood disaster that hit the country cutting across major cities in about 14 states that borders the Niger-Benue River. The flood submerged houses and several transportation routes throughout the affected areas nationwide. Overall, an estimated 1.3 million people were displaced and about 431 people lost their lives with several hectares of farmland destroyed (MISNA, 2012). Though the unusually large flood was predicted by the Nigeria Metrological Agency NIMET, government at all tiers failed to act on time, resulting in the worst humanitarian crises in Nigeria since the civil war in 1967-1970. Despite the expected increase in frequency and magnitude of flood in the Nigeria and invariably Adamawa, few impact assessment studies on the socio-economic livelihood of the people have been undertaken to establish the underlying causes of their vulnerability. In the absence of comprehensive data and information, the measures to cope with flood have remained ad hoc. The aim of the study thus was to assess flood prone areas within Greater Yola in Adamawa State, Nigeria.

METHODOLOGY

Description of the Study Area

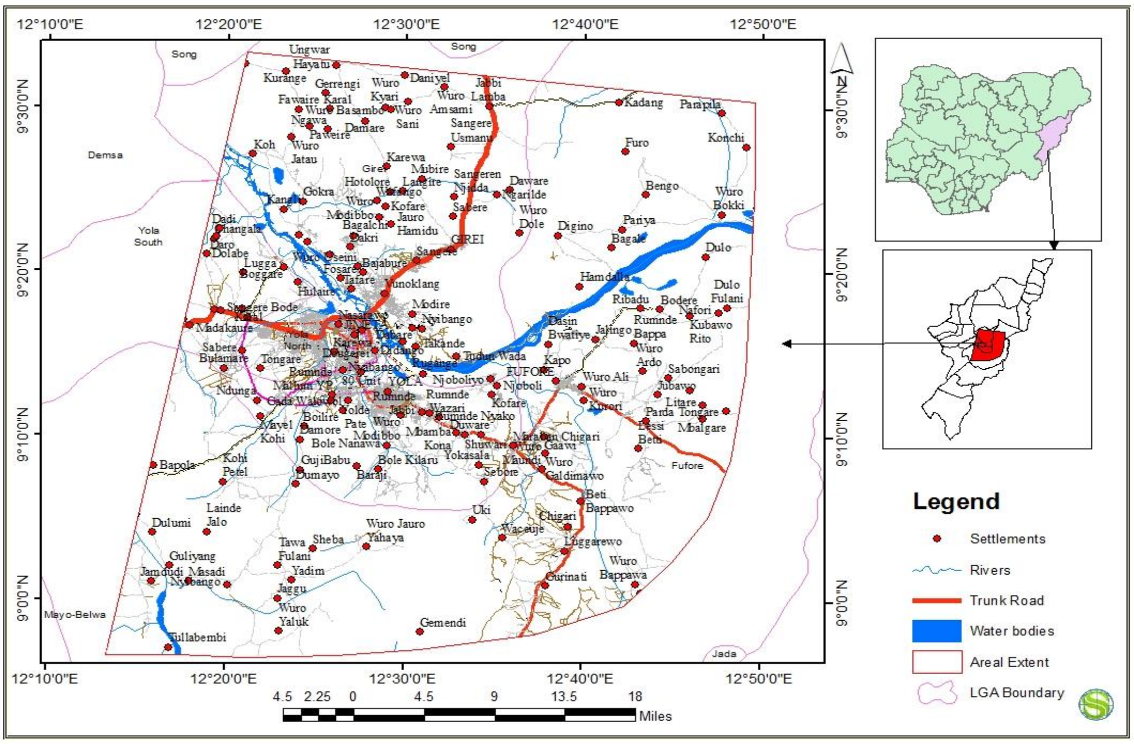


Figure 1: Map of the Study Area

Adamawa State is located in the North Eastern part of Nigeria. It lies between latitude 7° 11 and 7° 30 North of the Equator and between longitude 11° 14 and 11° 10 East of the Greenwich Meridian. The state covered a total land area of about 39,972 square kilometres (Figure 3. 1). It shares boundaries to the South and West by Taraba State, Northwest by Gombe State and to the North by Borno State. The State also shared an international boundary with the Cameroun Republic along its Eastern border. The State is divided into 21 Local Government Areas. Specifically, the areas under study were communities within the greater Yola and environs. It traverses through four local government areas of the state namely: Yola North, Yola South, Girei, and Fufore Local Government Areas. The area is made up of the major flood plains of Adamawa state with major concentration of people and settlements. The delineated area under study spatially lies between 12°13'25.588"E, 8°56'48.721"N and 12°53'4.746"E, 9°33'54.652"N covering an area of 3,605.816183 Square Kilometres.

Nature and Source of Data

The data used in the study include both qualitative and quantitative data (Primary and Secondary). Primary data used were mostly quantitative gotten from questionnaire administration, interview and focus group discussion; these include: age, sex structure, income level, marital status, experience in flood related disasters and the host of others. Secondary data comprises of mostly qualitative data such as existing topographic maps, soil data, hydrologic data, rainfall data, lands at satellite imageries, digital elevation model, slope data, and related literatures that bother on causes and effects of flood on the local and broad global perspectives. The land use/land cover data was instrumental in detecting extents to which each landuse is affected by flood, and the contribution of landed developments in flood occurrences. River Benue and other water bodies were extracted from the classified landuse map. Because most of the settlements are formed along the river coast, this feature played a major role in ascertaining areas that could get flooded in times of heavy downpours and the release of Lagdo Dam when river banks are overflown. Slope data, elevation data, and watershed analysis were derived from Digital Elevation Model (DEM) also acquired from the USGS. These information were crucial in the analysis of flood causes and vulnerabilities in that, the first plays a major determinant of surface saturation as surface water lodging is impacted by the time it remains stagnant mostly during heavy downpours. The second and the third impact mostly areas that are low-lying than uplands. Uplands are naturally areas that scarcely accommodate waters. Rainfall data was collected from Nigerian Meteorological Agency NIMET.

Method of Data Analyses

For the quantitative data collected in this research, data entry screens were developed in SPSS for Data Entry. The data were coded and entered into MS Excel before being transported to SPSS. For the spatial data collected, a geographical information systems (GIS) based multivariate analysis was undertaken to first produce factor maps for flood vulnerabilities. Each factor in question was modelled through rasterization and reclassification to produce a single variable vulnerability map for each factor based on expert's judgment. In the reclassification process, pixels of each factor were regrouped into three (3) namely: vulnerable, moderately vulnerable, and not vulnerable. Because one factor alone might not give a true picture and explanations for flood vulnerabilities, a multifactorial approach was deployed in a GIS to combine all single-factor vulnerability map using weighting and scoring in spatial analyst raster calculator of ArcGIS. The result yielded one single map with four vulnerability status namely: highly vulnerable, vulnerable, moderately vulnerable, and not vulnerable.

RESULTS AND DISCUSSION

Physical Characteristics of Greater Yola

Rainfall

One of the primary natural causes of flood in Greater Yola is the level of experienced. The data presented in Table 1 shows the distribution on rainfall in Greater Yola for a period of twenty (20) years. From the data presented, it was found that Greater Yola, like most area in the north-eastern part of Nigeria experiences steady rainfall from the month of April to October. Although rainfall is also experienced in the months of February, November, and December, its occurrence varies, and the quantity less significant. From the data presented in Table 1 and pictorially presented in Figure 2, it is very clear that the months of June, July and August represent the peak period of rainfall in the study area for the entire years under consideration. While the month of June recorded an average rainfall of 194.2mm, the month of July experienced an average rainfall of 224.2mm. Similarly, the month of August experienced an average rainfall of 198.2mm respectively.

Years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Annual Rainfall
1999	0.0	0.0	10.2	98.6	189.8	144.4	451.1	205.5	147.0	108.0	0.0	0.0	1354.6
2000	0.0	0.0	0.0	90.2	100.2	202.0	231.0	240.9	215.0	70.2	0.5	0.0	1150.0
2001	0.0	0.0	0.0	40.0	190.0	60.1	190.6	80.0	205.3	96.1	0.0	0.0	862.1
2002	0.0	0.0	0.0	60.3	88.4	196.2	160.2	270.0	176.9	129.6	5.0	19.6	1106.2
2003	0.0	0.0	10.5	30.6	89.0	33.1	250.0	120.0	199.1	170.4	0.9	0.9	904.5
2004	0.0	0.0	2.0	0.4	82.1	132.1	190.2	150.3	112.0	38.1	0.0	0.0	707.2
2005	0.0	0.0	12.6	82.4	175.6	210.2	268.2	240.6	208.0	110.1	0.0	0.0	1307.7
2006	0.0	0.0	0.8	62.1	100.5	172.5	165.6	260.8	132.6	140.6	0.8	0.0	1036.3
2007	0.0	0.0	0.0	46.2	120.0	62.1	190.4	120.8	175.6	40.7	0.0	0.0	755.8
2008	0.0	0.0	0.9	121.0	227.5	410.2	201.0	291.8	193.2	102.8	1.8	0.0	1550.2
2009	0.0	0.0	2.2	142.6	208.1	223.3	271.0	261.0	172.5	116.4	0.0	0.0	1397.1
2010	0.0	0.0	5.0	107.2	142.0	191.7	148.2	310.3	106.6	96.5	0.8	0.0	1108.3
2011	0.0	0.0	0.0	86.0	201.0	156.0	121.1	147.0	176.1	76.9	0.9	0.7	965.7
2012	0.0	0.0	8.2	121.6	192.6	310.0	412.6	202.8	272.5	113.1	6.0	0.0	1639.4
2013	0.0	0.8	5.2	142.1	126.0	182.7	119.1	146.6	132.1	96.2	0.0	0.0	950.8
2014	0.0	0.0	0.0	98.1	108.4	172.1	139.0	112.8	102.7	89.0	0.0	0.0	822.1
2015	0.0	0.0	0.5	96.8	210.9	290.2	178.6	286.5	262.0	189.8	0.5	0.0	1515.8
2016	0.0	5.0	8.2	81.5	97.7	275.0	162.1	139.5	127.0	107.5	0.0	0.0	1003.5
2017	0.0	0.0	0.0	76.1	105.2	159.8	172.2	181.0	120.0	87.9	0.0	0.0	902.2
2018	0.0	0.8	10.2	112.7	262.0	301.0	462.2	196.5	177.4	109.1	10.1	0.0	1642.0
Average Rainfall	0.0	0.3	3.8	84.8	150.9	194.2	224.2	198.2	170.7	104.5	1.4	1.1	1134.1

Table 1: Rainfall Distribution in the Study Area

From the data presented, it was found that Greater Yola, like most area in the north-eastern part of Nigeria experiences steady rainfall from the month of April to October. Although rainfall is also experienced in the months of February, November, and December, its occurrence varies, and the quantity less significant. From the data presented in Table 1 and pictorially presented in Figure 2, it is very clear that the months of June, July and August represent the peak period of rainfall in the study area for the entire years under consideration. While the month of June recorded an average rainfall of 194.2mm, the month of July experienced an average rainfall of 224.2mm. Similarly, the month of August experienced an average rainfall of 198.2mm respectively.

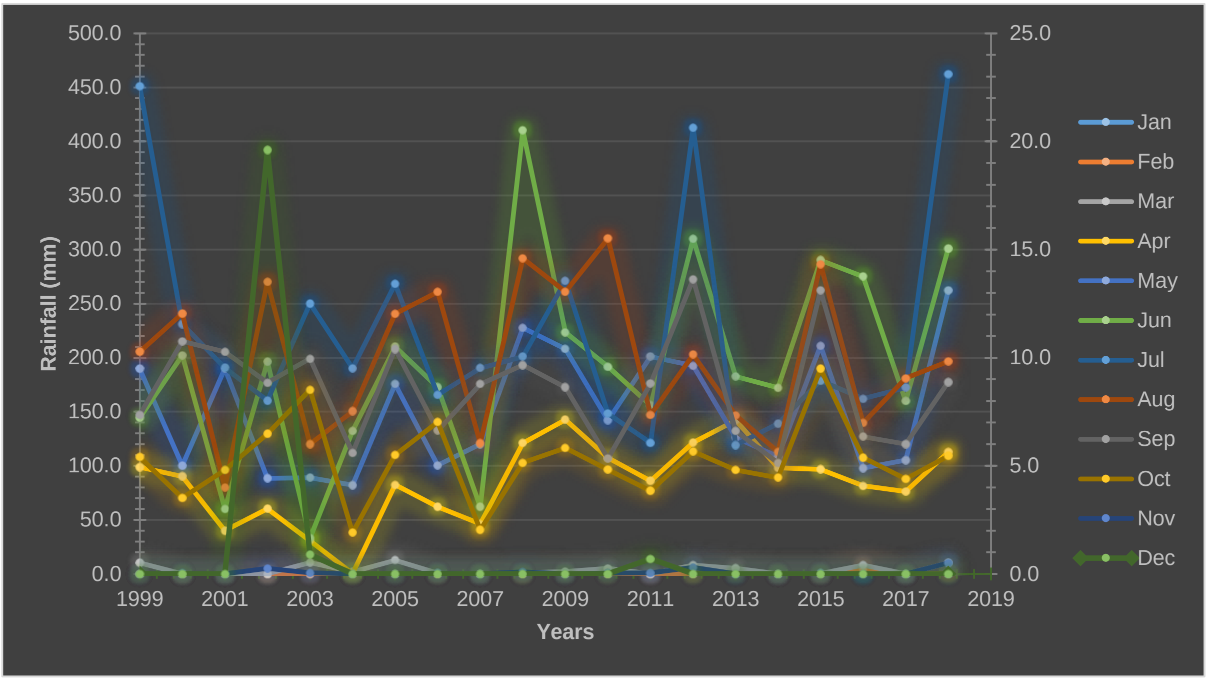


Figure 2: Trend of Monthly Distribution of Rainfall in the Study Area

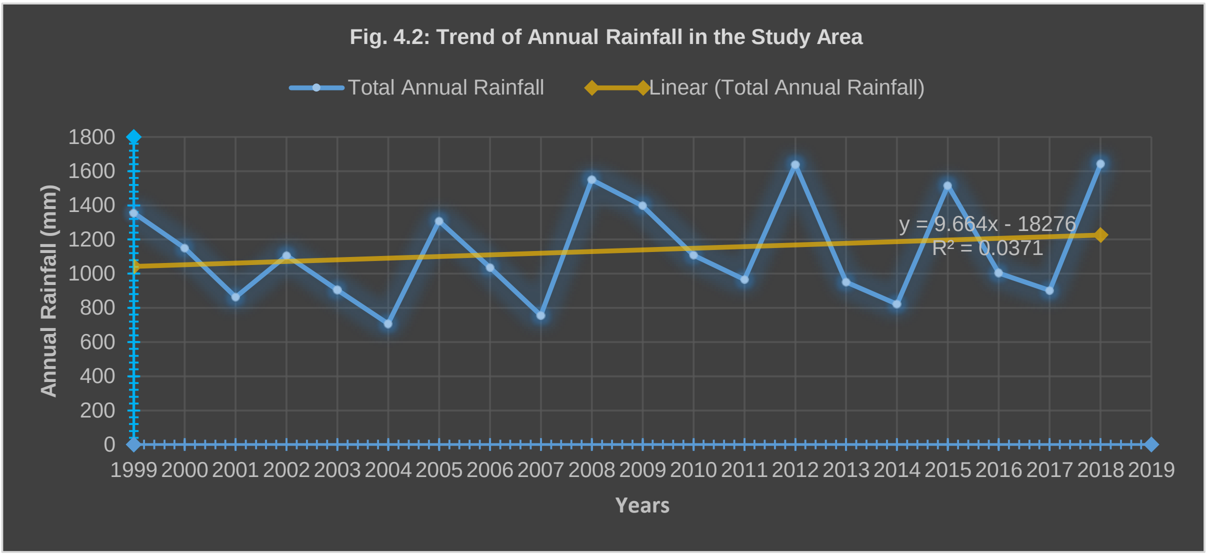


Figure 3: Trend of Annual Rainfall in the Study Area

The trend chart shown in Figure 3 represents the trend of annual rainfall distribution in the study area over a spread of 20 years. From Figure 3, the trend chart gives a true picture of the variability of rainfall in Greater Yola of the time frame (20 years), as well as the year that experienced the highest rainfall in the study area. The trend chart in Figure 3 also shows fluctuating trends of rainfall in the study area. It can be observed that the year 2018, 2012, 2008 and 2015 recorded the highest distribution of rainfall in the study area at

1642.0mm, 1639.4mm, 1550.2, and 1515.8mm respectively, while the year 2004, 2007, 2001 and 2014 recorded the lowest distribution of rainfall at 707.2mm, 755.5mm, 862.1mm, and 822.4mm respectively. The linear regression equation in the trend line shows R^2 value at 0.0371, implying a 37% variation annual rainfall across the entire time frame under consideration. On an average, the total rainfall distribution in the study area for the past twenty (20 years) was recorded at 1134.1mm. This results thus imply that rainfall in the study area has been steady with only a variation of 37%, and as such contribute immensely to the level of flood in study area.

Watershed

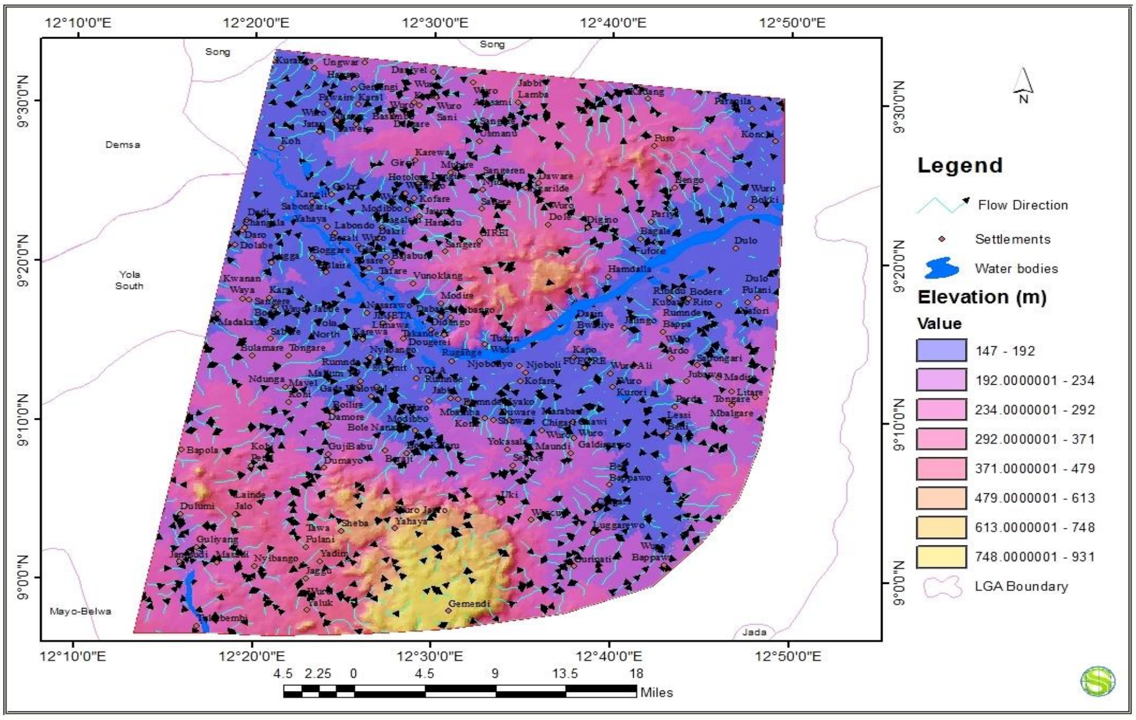


Figure 4: Watershed and Topography of the study area

A watershed is the upslope area that impacts flow of water to a common outlet as concentrated drainage. The study area is made up of both larger and smaller watersheds with river Benue serving as the major pour point; this is the point on the surface within the study area at which water flows out. It is the lowest point along the boundary of the watershed. Other rivers (apart from river Benue) within the study area form some drainage divided giving rise to sub-basins. The physical characteristics of the area under study such as, vegetation, soil, watershed, drainage. The drainage system shows that the area is well drained by series of rivers, streams and natural drainages that drain in to River Benue having impacted by Furo hill at the Northern flank of the study area, Bagale hills at the middle flank, and Yadim hills at the Southern flank respectively.

Settlements along sub-basins of the Northern flank comprise of Kadang, Jabbi Lamba, and Wuro Usmanu. Others are Damare, Paweire, Karal, Wuro Jatau West of the flank. Settlements at the middle flank are drained by Mayo Gireithese are: Wuro-Dole, Hamidu, Batare, Wafango. Still within the flank are those drained by Mayo Jiberuand Usmanu the settlements are: Daware, Ngarilde, Sangeren Njidda, Mobire, Langirei, Dakri and Kangli. The settlements that are drained by Mayo Rowo are Mallam Madugu and Wuro Amsami. Except for few rivers, such as Mayo Jibiro, Shematata and Mayo Girei that had their sources from the Gagure, Movido and Bagale hills in the south eastern part of the area, most rivers and their tributaries in the area originate from the Tambo and Nguntutun-Zama-Biam hills and ranges. This is why the direction of streams flow in the area is mostly in the North-South direction. The areas also have natural lakes such as Lake Gokra and Falai Girei. East of the Bagale – Furohills at the middle flank are Hamdalla, Pariya, Bagale, Wuro Bokki, Dulo, Ribadu, Bodere, Kubawo Rito all lying within Wuro Bokki-Dulo sub-basin. At the Southern flank, Yadim – Uki mountain ranges impact Lessi Betti – Fufore sub-basin. Settlements within this basin include Chigari, Betti Bappawo, Alaraba, Gaawi, Fufore, Njoboli, Njoboliyo, and Rugange. Within the same flank is Bole – Yolde Pate basin with settlements such as Bole Nanawa, Shagari, Yola, Rugange, Yolde pate, and Gujibabu.

Vegetation

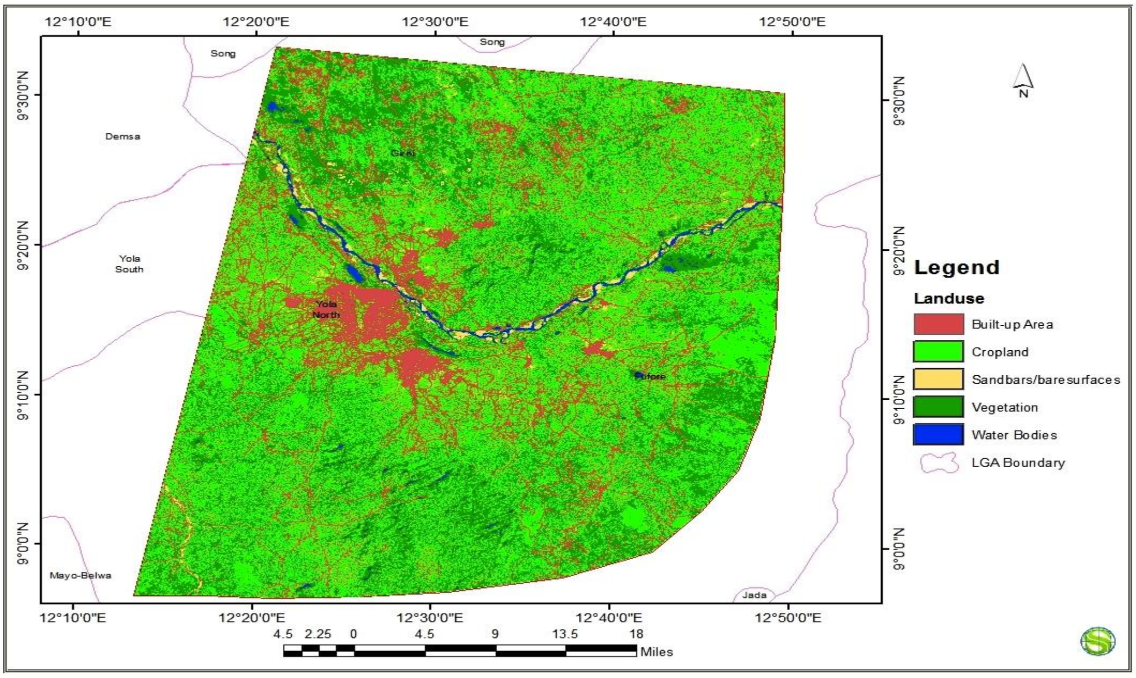
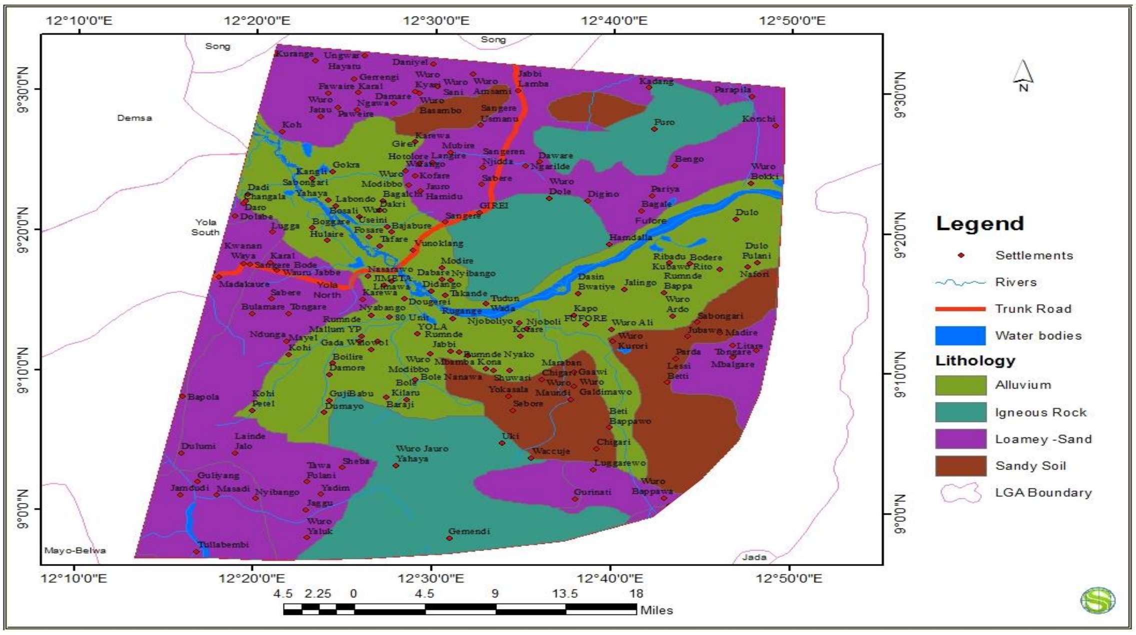


Figure 5: Vegetation Map of the Study Area

The vegetation formations of Adamawa State like most northern States are generally of the savannah type. Based on the climatic condition of the State, the vegetation formations have been grouped into three namely: southern guinea savannah, northern guinea savannah and the Sudan savannah. The region northern guinea savannah vegetation is one of the most extensive vegetation in the study area which stretches from the Taraba River in the south to River Yedzeram in the northern part of the State. It has a mean annual rainfall between 900, and 1100 mm and the rainy season last for about 4-5 months. The region is characterized with prominent trees namely, *Afzelia africa, Viterllaria paradozla, Terminlia laxiflora, Terminalia glaucescens, Annonase negalensis, Burkea africana, Albiziazygia* (Akosim *et al.,* 999). In terms of the landuses, building area and cropland appear to be close to the River Benue. This suggest that human activities are always located to water and so, such landuses are mostly affected in an even of flood.

Soil

Figure 6 shows that the soil formation of the study area are regosol (Clay, loamy sand, Rock-outcrop, Sandstone and Shale) these are immature weakly developed soils consisting of rock fragments which occur in isolated hill areas and derived from basement complex. Apart from loamy sand, most other soil types in the area do not easily absorb water which makes most of the area flood prone. Areas in Greater Yola prone to flood in respect of soil composition include all settlements along the Benue valley within a distance of 1km from River Benue centreline: (Wuro Useini, Modire, Dabore, Didango, Takande, Dakri, Labondo, Sabongari, Koh, Tabongo, Gereng); and



others along river Daniel whose soil type is alluvium. The alluvial soil is said to be clayey in **Figure 6:** The Soil Map of the study Area

nature and has the capability of retaining surface water because of its semi-impervious nature. Other settlements that fell within the marginally vulnerable zone include Girei town and others at the Northern flank of the study area. However, soil alone, is not enough a regional factor that determines absolute vulnerability status of an area to flooding but a combination of different factors analysed above. In addition, none of the four factors considered can stand in isolation at regional level to represent as a criterion for flood vulnerability analysis, rather, a scientific system of fusing all the multi-criteria vulnerabilities into a single spatial vulnerability map based on weighting and scoring of each criterion using map algebra or the conditional tool in ArcGIS spatial analyst tool. The soil of the area close to the River Benue appear to accommodate many landuses such as cropping

International Journal of Science and Advanced Innovative Research
ISSN: 2536-7315 (Print) 2536-7323 (Online)
Volume 5, Number 1, March, 2020
http://www.casirmediapublishing.com

grazing due to the level of fertility. Hence, any invent of flood along the channel or River Benue, such landuses become prone to flood.

Drainage

The study area is well drained by many rivers and streams, and most of them are seasonal. The main river is River Benue which cuts across Greater Yola.

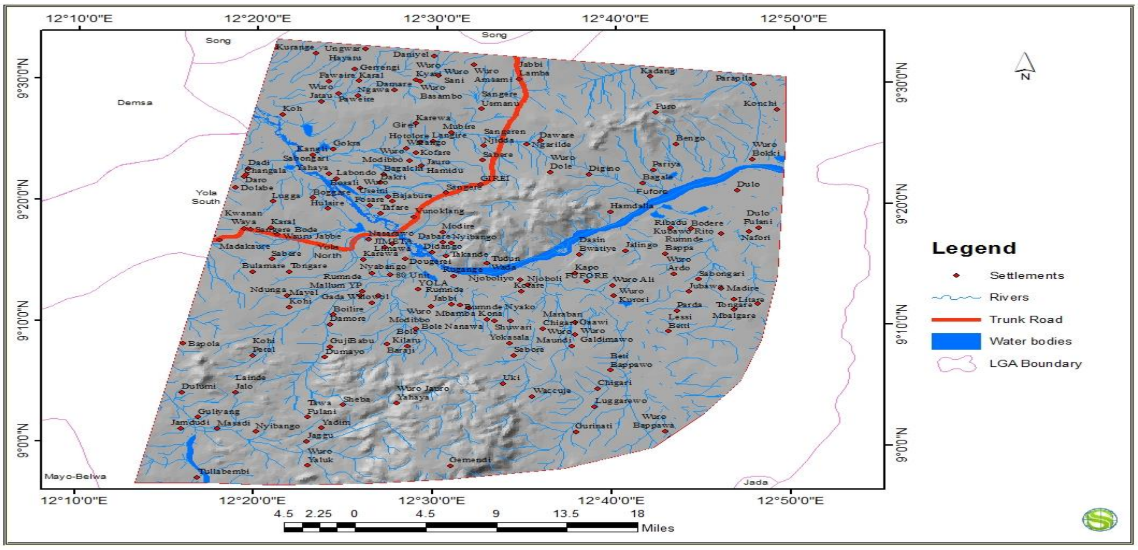


Figure 7: Drainage of the study area

Most rivers have flat sandy beds and steep rocky valley sides. There are normally flooded during the rainy season. The study area is characterized with lakes, streams scattered all over have connective tributaries to River Benue.

Slope

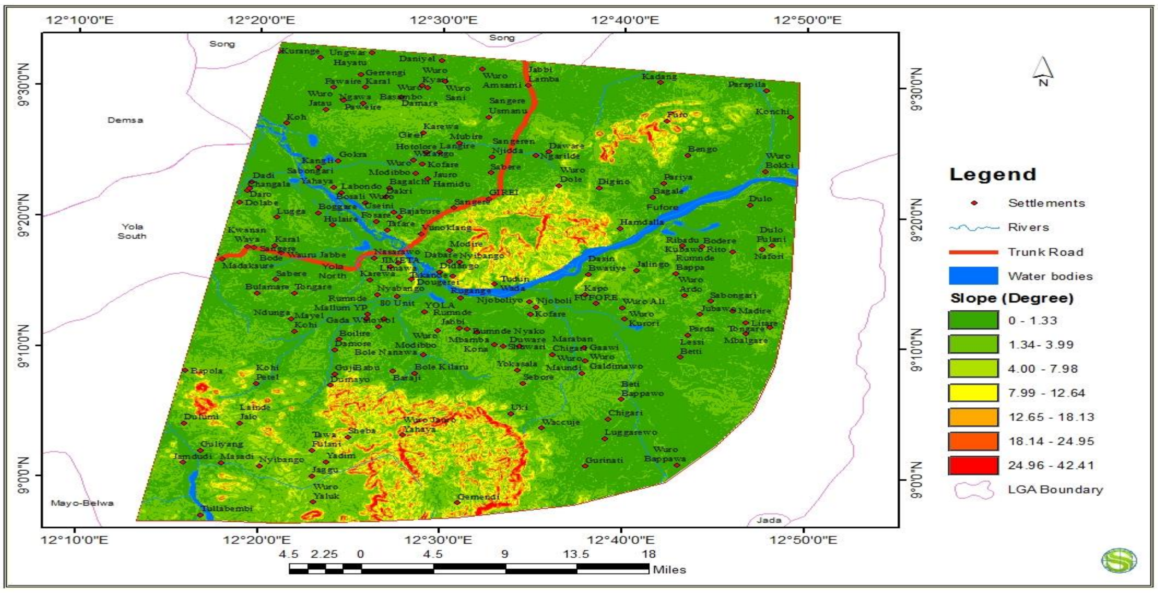


Figure 8: Slope of the Study Area

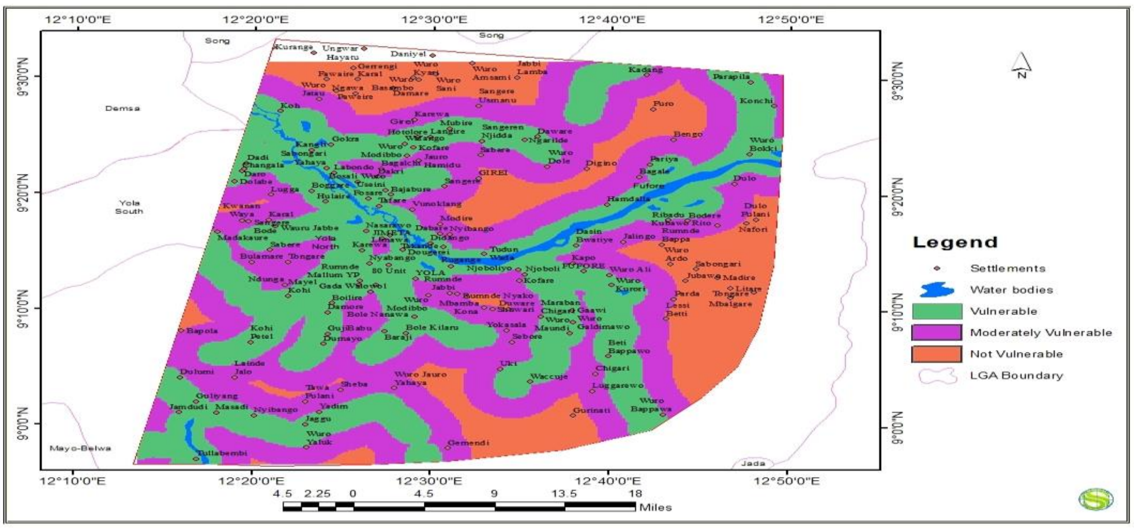
The slope vulnerability analysis was performed in ArcGIS Spatial analyst extension by reclassifying all the slope values (in degrees) of the slope map into classes that define three vulnerability dynamics (i.e. Not vulnerable, marginally vulnerable, and Vulnerable). The values of slope between 0 – 1.3 is considered as flat areas that are not well drained and can lodge surface water for a very longer period in an event of heavy downpours; hence, it is classified under slope parameter as Vulnerable to flooding. Slope values ranging from 1.35 – 4.5 are reclassified as marginally vulnerable because such areas have ability to drain water to some extent, while slope values from 4.51 – 32 as observed in the slope map are reclassified as not vulnerable within the boundary of Greater Yola. From the slope classification in Figure 4.8, it is very clear that areas close to the River Benue fall within the flood vulnerability slope. This implies that human activities based on land uses that are close to the River Benue within Greater Yola are at a higher risk of being flooded.

3.2. Areas Liable to Flooding

Table 3: Areas Liable to Flood

Variables	Distance in Km	Frequency	Percentage (%)
Highly Vulnerable	0 – 4	167	66.8
Vulnerable	4 – 7	53	21.2
Moderately Vulnerable	7 – 13	30	12
Not Vulnerable	13 – 17	0	0
Total		250	100

The data presented in Table 3 represents the responses of the sampled population of the study on the area in Greater Yola that are liable to



International Journal of Science and Advanced Innovative Research
ISSN: 2536-7315 (Print) 2536-7323 (Online)
Volume 5, Number 1, March, 2020
http://www.casirmediapublishing.com

flooding. From the data presented in the table, 66.8% of the respondents were of the opinion that areas 0-4km off River Benue are highly vulnerable to flooding, while 21.2% of the respondents were of the opinion that area that are 4-7km off **Figure 9:** Vulnerability Map of the study area to flooding

Rivers Benue are vulnerable to flooding. 12% of the respondents however pointed out that areas that are 7-13km off River Benue are only moderately vulnerable to flooding.
From Figure 9, it areas in green such as Tundu Wada, Njoboliyo, Hamdalla, Dougerei, Rugange, and Fufore, among others, are vulnerable to flood. The areas in purple such as Kwanan Waya, Kauwa, Girei, Bapola, Yokasala, and Mbamba Kona are moderately vulnerable, while the areas in orange such as Sabongari, Wuro Ardo, Jubaw, Puro, Wuro Amsami, Jabbi Lamba etc. are not vulnerable to flood.

Land use Affected by Flood in the Study Area

Table 4: Land uses Affected by Flood

Land uses/ Land cover	Frequency	Percentage (%)
Agriculture	100	40
Settlement	100	40
Infrastructure	30	12
Others	20	8
Total	**250**	**100**

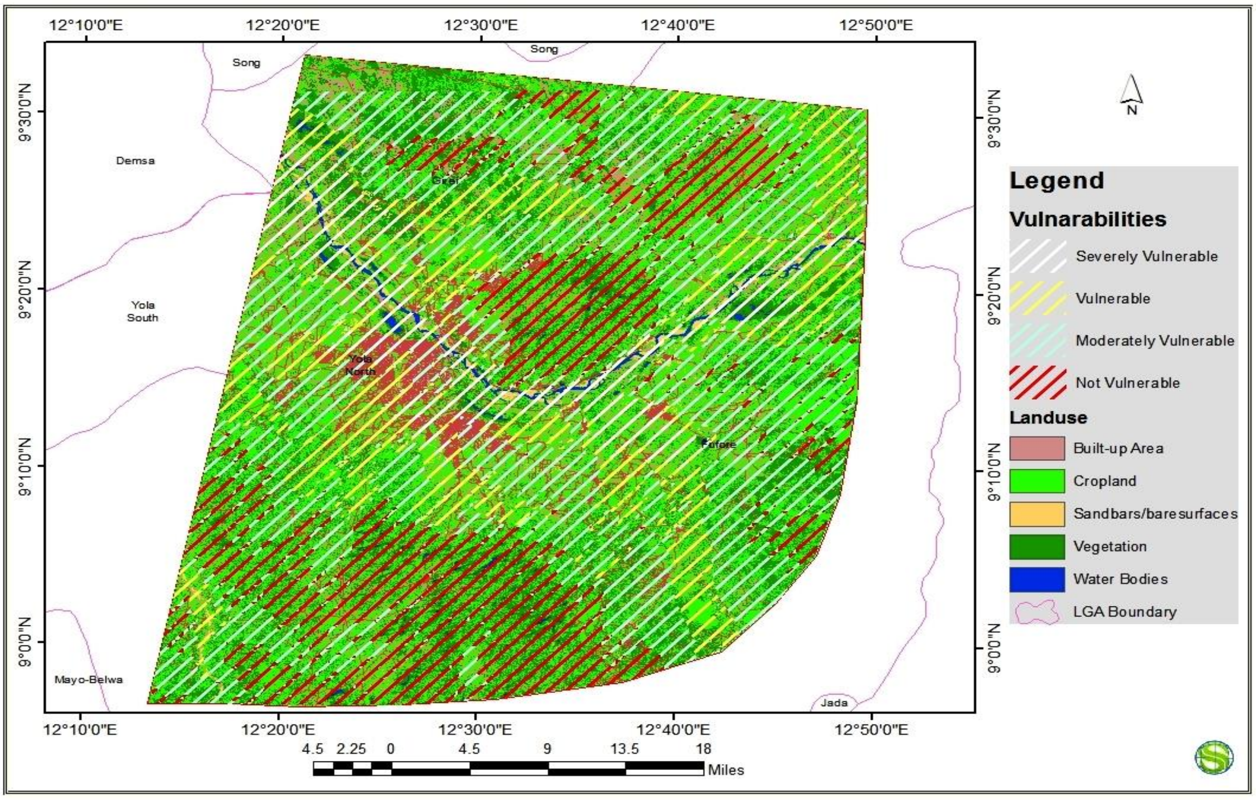
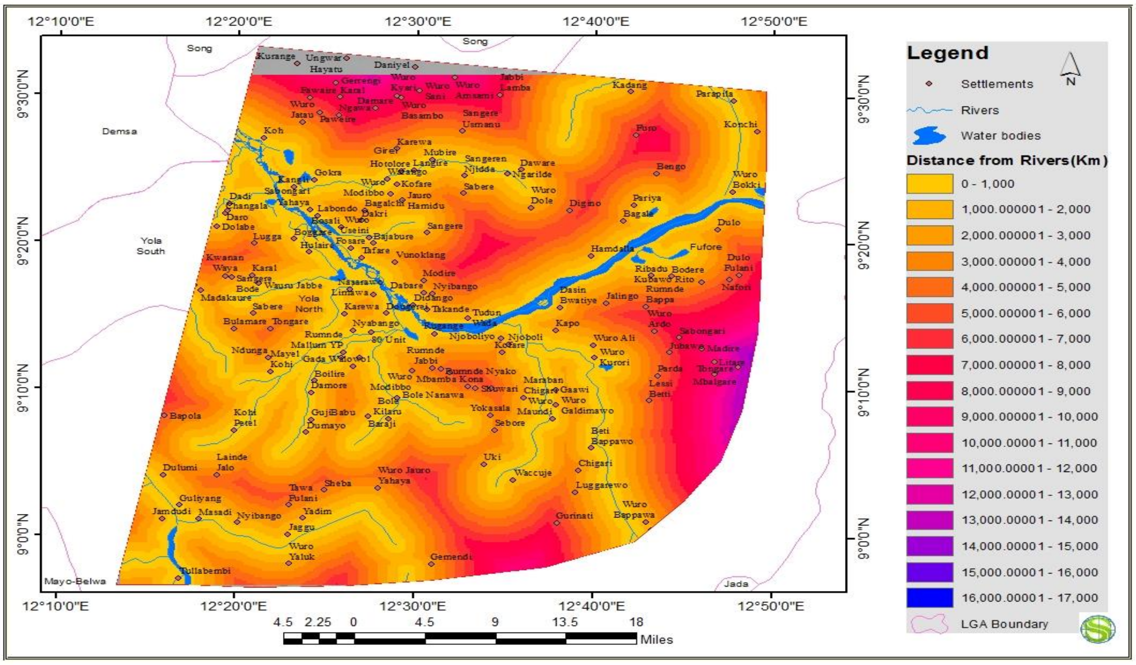


Figure 10: Land use of Greater of the Study Area

The data presented in Table 4 represents the results of the investigation on the landuse affected by flood in Greater Yola. From the data in Table 4.3, it can be seen that 40% of the respondents of the study were of the opinion that agriculture and settlements are the land use cover affected by flood in the study area, while 12% were of the opinion that infrastructure facilities are the land use affected by flood in Greater Yola. 8% of the respondents however opted other land use affected by flood in the study area. The land use affected as seen in Figure 9 are build-up areas, cropland, sandbars/bare surfaces, vegetation, water bodies. The areas on the white stripes are severely vulnerable because there are close to River Benue and can easily be flooded either by rainfall or release of water from Lagdo dam. Areas with yellow stripes are also vulnerable which comprises of all the land uses (Build-up areas, cropland, sandbars/bare surface, vegetation, water bodies). Areas in blue stripes are moderately vulnerable, and those in red stripes are not vulnerable to flood.

International Journal of Science and Advanced Innovative Research
ISSN: 2536-7315 (Print) 2536-7323 (Online)
Volume 5, Number 1, March, 2020
http://www.casirmediapublishing.com

.Figure 11: Extent of land Affected by flood in the Study Area



Extent of Land Affected by Flood in the Study Area

Table 5: Extent of Land Affected by Flood

Square Meters	Frequency	Percentage (%)
0 - 20	95	38
20 - 40	85	34
40 - 60	50	20
60 and above	20	8
Total	250	100

The data presented in Table 5 represents the responses of respondents in the study area in respect to the extent of land affected by flooding in Greater Yola. From the data presented in Table, it can be observed that 38% of the sampled population of the study were of the opinion that that the extent of land affected by flooding in the study area rages between 0-20 meters, while 34% of the respondents were of a contrary opinion that the area of land affected by flooding in the study area ranges between 20 and 40 meters in the study area. The areas that fall between 0 – 4 Square meters are 38% which are severely affected by flood, 20 - 40 Square meters represent 34% of areas that affected, 40 – 60 Square meters are moderately affected, while 60 and above represent areas which are not affected. In the same vein, 20% of the sampled population of the study were of the notion that the area of land affected by flooding in the study area, ranges between 40 to 60 meters, while a handful of 8% of the responded indicated that the area of land affected by flooding, ranges from 60 meters and above. The extend of land affected as seen in figure 4.9 areas from 0 – 2km distance from the river are severely vulnerable. Areas from 2km – 5km are vulnerable. Areas from 5km – 13km are moderately vulnerable, while 14km – 17km distance from the river are not vulnerable.

Frequency and Period of Flooding in the Study Area

Table 6: Frequency of Flood in the Study Area.

Variables	Frequency	Percentage (%)
Annually	200	80
Biannually	30	12
Perennially	0	0
Others, specify	20	8
Total	**250**	**100**

The need to establish the frequency and period of flooding in the study area cannot be overemphasized. To this extent, the sampled population of the study were asked the frequency of flooding in greater Yola. Their responses as presented in Table 6 indicates that flooding in the study area occurs annually as indicated by a majority response of 80% of the respondents of the study. Only a handful of 12% and 85 of the respondents of the study were of the opinion that flooding occurs biannually and other periods.

Table 7: Period of occurrence of the flood in the area.

Variables	Frequency	Percentage (%)
July	30	12
August	70	28
September	130	52
Specify, others	20	8
Total	**250**	**100**

The data presented in Table 7 shows the period in which flood occurs in the study area. From the data presented in Table 7, it can be observed that

International Journal of Science and Advanced Innovative Research
ISSN: 2536-7315 (Print) 2536-7323 (Online)
Volume 5, Number 1, March, 2020
http://www.casirmediapublishing.com

flooding in Greater Yola occurs during the month of September as indicated by a majority of 52% response of the sampled population of the study. However, it can be seen from the results in Table 4.8 that 28% of the participants of the study were of the view that flooding usually occurs during the month of August, while 12% highlighted the month of July.

3.6. Effects of Flood in the Study Area

Table 8: The effects of the flood in the area.

Variables	Frequency	Percentage (%)
Loss of lives	48	19.2
Damage to properties	160	64
Destruction of the ecosystem	27	10.8
Destruction of economic facilities	15	6
Total	**250**	**100**

The results of the investigation show that flood has affected both man and his physical environment. The result in Table 8 show that the most affected of all was properties of the people, where it accounts or about 64 percent of the total. This is followed by the destruction of lives. From Table 8, the highest percentage recorded on lives and properties is as a result of their areas being close to the river. The effects of flooding in the area of the study is further presented in plates 1 to 4. In Plate 1, it can be observed that the effect of flood in Yola South forced residence to evacuate the area, while plate 2 shows the effect of flood in Yola North submerging houses in the area. Similarly, plate 3 shows the effect of flood overflowing rivers in Girei, and submerging residences and grazing area, while plate 4 shows the effects of flood in Fufore destroying roads, settlements and grazing areas.

Plate 1: Effect of flood in Yola South (forced residents to evacuate the area).

Plate 2: Effect of flood in Yola North (submerging of housing in the study area).

International Journal of Science and Advanced Innovative Research
ISSN: 2536-7315 (Print) 2536-7323 (Online)
Volume 5, Number 1, March, 2020
http://www.casirmediapublishing.com

Plate 4: Effect of flood in Fufore (destroying road, settlements and grazing area)

Plate 3: Effect of flood in Girei (overflow of river, submerging residents and grazing area)

CONCLUSION

The effects of floods in one sector can affect other sectors of society. Under the health section, the outbreak of different diseases such (malaria, diarrhoea and coughing) was attributed to the impact of floods on water sources and sanitation facilities. The issue of water contamination of the river at the pick of floods and the handling of water from the borehole increase the health risk. Furthermore, although health facilities were damaged due to damage of the road and transport due to floods, accessibility to health services was a problem due to infrastructure (roads and bridges) damage as discussed under the housing section. In addition, school attendance was disrupted due to impassable roads as discussed under the education section. Communities should be encouraged to build houses using durable materials and away from the flood prone area as a way of coping with the floods. Furthermore, the Ministry of Agriculture should through the Extension Services, encourage the communities to increase the area cultivated on the upland to enhance the food security at household level. Input support programme for the vulnerable but viable farmers should be considered. Clearly, there is need to develop better and appropriate measures to prepare and mitigate the effects of the floods. Above all, the aim must be to involve all the stakeholders to enhance communities' resilience to floods. There should be a deliberate policy to compel communities, especially in rural areas, to build house using durable materials and away from the flood prone areas as well as the height from the flood level must be considered. Furthermore, Multi-sartorial approach to flood mitigation as opposed to single sector should be promoted and should be link it to the impacts of flood on various aspects of society. Government should ensure proper dredging of the river Benue, so as to deepen the channel in order to accommodate more water rather than allowing the water to flood the environment.

REFERENCES

Abam, T.S.K. (2006). Developing Policy Framework for Erosion and Flood Control in Nigeria. *EARTHWATCH Magazine for Environment and Development Experts in 5(1), 25-32.*

AKOSIM, C. T. IO and JATAU, DF (1999). *Vegetation and Forest Resources of Adamawa State: Adamawa State in Maps. 1st edition,* Paraclete Publishers, Yola, Adamawa State, Nigeria, 32-35.

Ali, P.I.O. (2005). *Flood damage assessment in Makurdi town,* Unpublished M.Sc. Thesis, Department of Geography, Benue State University, Makurdi, Nigeria.

Askew, A. J. (1999). Water in the International Decade for Natural Disaster Reduction. In Leavesley et al. (Eds.), *Destructive Water: Water-Caused Natural Disaster, their Abatement and Control* IAHS Publication No. 239.

Ayoade, J.O. (1988). *Tropical Hydrology and Water Resources,* MacMillan Publishers, Ibadan.

Civco, D. L., Hurd, J. D., Wilson, E. H., Song, M., & Zhang, Z. (2002, April). A comparison of land use and land cover change detection methods. In ASPRS-ACSM Annual Conference (Vol. 21).

Emodi, E.E. (2012). The Menace of Flood in Nigeria: Impacts and Rehabilitation Strategies. Journal of Environmental Management and Safety. Centre for Environment and Population Activities. Retrieved on 14th July, 2019, 2:00pm, from http://www.cepajournal.com

Folorunsho, R. and Awosika, L. F. (2001). *Flood Mitigation in Lagos, Nigeria through wise management of Solid Waste: A Case of Ikoyi and Victoria Islands, Nigeria,* UNESCO-CSI Workshop, Maputo.

Kolawole, O. M., Olayemi, A. B., & Ajayi, K. T. (2011). Managing flood in Nigerian cities: Risk analysis and adaptation options–Ilorin city as a case study. *Archives of Applied Science Research, 3(1), 17-24.*

MISNA-Missionary international news service agency. "Floods from North to South, Alarm for Crops," 2012. http://reliefweb.int/report/nigeria/floods-north-south-alar

Mmom, P. C., and Aifesehi, P. E. E. (2013). Vulnerability of Niger Delta Coastal Communities to Flooding. *Journal of Humanities and Social Science, 10(6), 27-33.* http://dx.doi.org/10.9790/0837-1062733.

Nott, J. (2006). *Extreme Events: A Physical Reconstruction and Risk Assessment.* Cambridge University Press. New York.

Nwafor, J. C. (2006). *Environmental Impact Assessment for Sustainable Development: The Nigerian Perspective.* Enugu EL DEMAK Publications.

Oderrerho, F. O., (2004). Benin City: "A Case Study of Urban Flood Problem".

Okereke, R. A. (2007). Incidence of Flooding in Southern Nigeria, *International Journal of Environmental Issues, Vol. 5, No. 1-2, pp. 20-28.*

Ologunorisa, E.T. (2004). An assessment of flood vulnerability zones in the Niger Delta, Nigeria, *International Journal of Environmental Studies, Vol.61, 31-38.*

UNEP (2006). Gathering Storm: The Humanitarian Impact of Climate Change.