View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by International Institute for Science, Technology and Education (IISTE): E-Journals

Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.5, No.12, 2015
www.iiste.org

Geospatial Analysis of Flood Problems in Jimeta Riverine Community of Adamawa State, Nigeria

Innocent E. Bello[1*] Steve O. Ogedegbe[2]
1. MP, IT and Data Management Dept., National Space Research and Development Agency (NASRDA), Obasanjo Space Centre, Airport Road, PMB 437 Garki, Abuja, Nigeria.
2. Department of Geography, College of Education, Igueben, Edo State, Nigeria

Abstract
Floods are among the most devastating natural disasters in the world, claiming more lives and causing more property damages than any other natural phenomena. In recent times, the incidence of flooding across Nigeria has left both the government and the governed devastated. It is no longer news that flooding and its attendant consequences are injurious to man while the spatial dimensions are often not mapped. This study, therefore, examined the nature of water level/extent and vulnerability in the riverine community of Jimeta, Adamawa State. Using time series analysis, four epoch satellite images covering the study area was used to evaluate the geospatial coverage of water along the watercourse of Upper Benue bordering the study area. Using ILWIS 3.8, ArcGIS 10.1 and statistical analysis, the spatial extent and vulnerability of settlements was mapped. Highly vulnerable (50m buffer) were differentiated from low risk zones (100m buffers). Study revealed that besides rainfall, excess water from Cameroun dam is largely responsible for the identified high level of inundation. The impacts of flood on the local people are devastating as lives and properties have been lost while economic activities reduced due to health risks and mass migration to neighbouring villages and towns. Early flood warning system (EFWS), rapid response mechanism and outfit, strict adherence to zoning and building principles, evacuation of waste and maintenance of drainage systems, mass awareness campaign on flooding and other environmental hazards and, continuous rehabilitation and assistance of victims as a government, individual and NGOs are recommended hence synergy among stake holders is advocated.
Keywords: Flood, GIS Buffer, Settlement, Vulnerability, Water Coverage,

1. Introduction

According to the Centre for Research on the Epidemiology of disaster, floods are the most common natural disasters in both developed and developing countries, and they are occasionally of devastating impact, as the floods in China in 1959 and Bangladesh in 1974 and the tsunami in Southeast Asia in December 2004 (Ahem *et al.* 2005). Risk associated with flood makes it a requirement to capture information on rainfall pattern and drainage systems. In particular, information on drainage systems and the hydrologic morphometry of any nation is a veritable resource among the core dataset usually captured when producing a topographic map of a country (Bello, Adzandeh and Rilwani 2014). In theory, therefore, flooding or inundation is the excess water above the surface carrying capacity of an area. A situation where water exceeds the normal ground level, flooding is said to have occurred. For example, flooding occurs naturally on the flood plains which are prone to disaster and when water in the river overflows its banks, or sometimes results from a constructed dam (Etuonovbe 2011). Flood impacts on health vary between populations for reasons relating to population vulnerability and type of flood event (Western 1982; Seaman 1984; Malilay 1997; Hajat *et al.* 2003; and Ahem *et al.* 2005). Under future climate change, altered patterns of precipitation and sea level rise are expected to increase the frequency and intensity of floods in many regions of the world (Intergovernmental Panel on Climate Change 2001). Flood often happens without warning but with a surprise package that always delivers to unprepared community like the ones in most Sub-Saharan African countries. The hurricane Katrina which happened in China is a well feted disaster because several lives and properties worth billions of dollars were lost. The huge human, financial and economic risk associated with most flood plains have made many experts to recommend avoiding such ecologically viable environment to a less vulnerable area especially at it relates to agriculture and habitation activities (Bello, Onothoja and Asikhia 2013).

Factors generally responsible for flooding are numerous. Notable among them are heavy rainfall, blockage of drainage systems, irregular topography, urban encroachment, soil type and geological formations. A settlement is here defined as an assemblage of buildings with people residing in them. Thus, considering their general makeup, settlements are of major concern when discussing flood hazard. Going by number and economic losses, flood disasters account for about a third of all natural disasters (Nwilo, Olayinka & Adzanzeh, 2012). Thus, Nigeria is no exception to countries that experienced flooding in recent time. Nigeria like many other coastal countries of the world is blessed with a plethora of drainage systems of varied river morphometry (Bello *et al.* 2014). Many communities have suffered losses due to flood problem. The 2012 rainy season in Nigeria has been worse than earlier years, and heavy rains at the end of August and the beginning of September led to serious floods in most parts of the country. While many people still grapples with the impact of flood in

Nigeria and in the world at large, the concept of flood has been defined/understood differently but a common denominator is that, water is at the heart of flood. In order to better situate the approach to this study, a concise and well-articulated explanations and related case scenarios in literatures are succinctly provided.

In recent times, the incidence of flooding across Nigeria has left both the government and the governed devastated. For example, the flood events in Sokoto in 2010, Ibadan in 2011, Lagos in 2011, Jimeta (the study area) in 2012, Niger-Benue floods of September - October in 2012 which affected over 13 states: Niger, Benue, Kogi, Edo, Ondo, Anambra, Ebonyi, Imo, Delta, Bayelsa, Rivers States, etc, caused huge socio-economic loss to Nigeria (Ojigi, 2012, Bello *et al.* 2014). This is as a result of the negative impacts it has on the natural and built environments. Properties worth billions of Naira have been lost while unquantifiable numbers of lives have equally been lost. No thanks to flooding and its attendant consequences. According to the International Federation of Red Cross and Red Crescent Society (IFRCS, 2012a), the Nigerian authorities contained the initial late August and early September 2012 excess run-off through contingency measures, but during the last week of the period under review, water reservoirs over flown and authorities were obliged to open dams to relieve pressure in both Nigeria and neighbouring countries of Cameroun and Niger, leading to destroyed river banks and infrastructure, loss of properties and livestock and flash floods in many areas (IFRCS, 2012a). The impact of flooding has not be adequately quantified in terms of loss of lives and properties, at best what is quantified are mere approximations. In this study, the geographic dimension: spatial extent and pattern, problems and impact of flooding in Nigeria using part of Jimeta village in Adamawa State of Nigeria as a case study is carried out. As a study novelty, this research will serve as a proof of concept for evaluating similar flood impacts in similar geographic and environmental scenarios.

2. Statement of the problem and Justification for Study

Unheard of in history, serious flooding hit Jimeta -Yola in Adamawa State after a heavy down pour in the North-Eastern State of Nigeria on the 25th of August, 2012 and hundreds of residents were rendered homeless by the ravaging floods (Saharareporters 2012). According to IFRCS (2012a), on the 17th of September, 2012, spillways for the Shiroro dam on the River Niger were opened. Kainji dam also released excess water as a follow-up to a similar action in neighboring Niger Republic. This did not only leave several people homeless, but also destroyed properties and disrupted business activities. The latest flooding affected the Doubeli area of Jimeta with increasing water level reported. Based on UNFPA data, the 2008 DHS report indicated that only 23.2% of the Adamawa households have access to improved source of drinking water while 21.3 % of the households have access to improved sanitary facility. Only 32.5% of the households have access to electricity. 69.6% of women in Adamawa state are employed while 74.8% of the men are unemployed. The women are largely engaged in agriculture and petty trading which are 44.7% and 36.5% respectively. 56.1% of men population are engaged in agriculture 28.5 % are traders. The total fertility rate is 6.8 while the mean number of children ever born to women age 40-49 is 7.1. The DHS 2008 report showed that 19.2% women age 15-19 have had a live birth or are currently pregnant. This leaves a large population of girls with the potential of high risk pregnancy in the state. 61.1% of women have heard of family planning methods while 94.1% of men have heard about family planning methods, however only 2.8% of women age 15-49 are using any method of contraceptive as reported by 2008 DHS. Considering the environmental and socio-economic challenges and resource level of the study area, flood hazard has added to their pain. The socio-economic and political pattern of the study area shows that traditional method of flood management (culvert/drainage systems) are becoming insufficient hence the clamour for the application of geoinformation science and technology in probing into and providing detailed georeferenced case scenarios which is currently lacking in most rural areas in Africa.

As a justification for the study, the extent of flood hazard damages recorded has not been properly mapped as a result of inadequate preparations and lack of political will to fully investigate damages resulting from flood hazard. Providing basic information on flood dynamics, geospatial pattern, and socio-economic and environmental impacts have remained sketchy on local communities like Jimeta. The goal of this study, therefore, is to examine the impact of flood in Nigeria with emphasis on riverine community of Jimeta along the Upper River Benue in Adamawa state.

3. Aim and Objectives

The aim of this study is to provide a synopsis of flooding problems in Nigeria using Jimeta riverine community in Adamawa State as a case study.

The specific objectives include to:

i. examine the factors responsible for flooding;
ii. determine, delineate and map the geospatial extent of water coverage and vulnerability;
iii. examine the impact and problems of flooding on the people, and
iv. proffer or suggest solutions on flood control and management in general

4. Study Area

The study area is a riverine part of Jimeta community having the upper left corner coordinate as 12^0 28' 24.5"E and 9^0 15' 45.9"N and lower right corner coordinate of 12^0 29' 6.4"E and 9^0 15' 17.9"N. Jimeta is a major town located on the eastern path of Adamawa state, Nigeria (Figure 1). In general, the state is located on the North western part of Nigeria. Jimeta lies on the south bank of the Benue River, and on the highway between Zing and Girei. Merged with Yola in 1935 by the Fulani administration, Jimeta regained independent town status with its own council in 1955. With the construction of a spur road to Yola (5.5 miles [9 km] south-southeast), the town became a river port for Yola, gradually taking over most of the river-borne traffic along the Benue River. From mid-July to mid-October, when the Benue has deep water, boats carry peanuts (groundnuts) and cotton from Cameroun and hides and skins from the hinterland of Yola-Jimeta downstream to the Niger River delta ports for export. Local trade handles sorghum, millet, yams, shea nuts, onions, peppers, indigo, cattle, sheep, goats, and poultry *(http://www.britannica.com/EBchecked/topic/303934/Jimeta).*

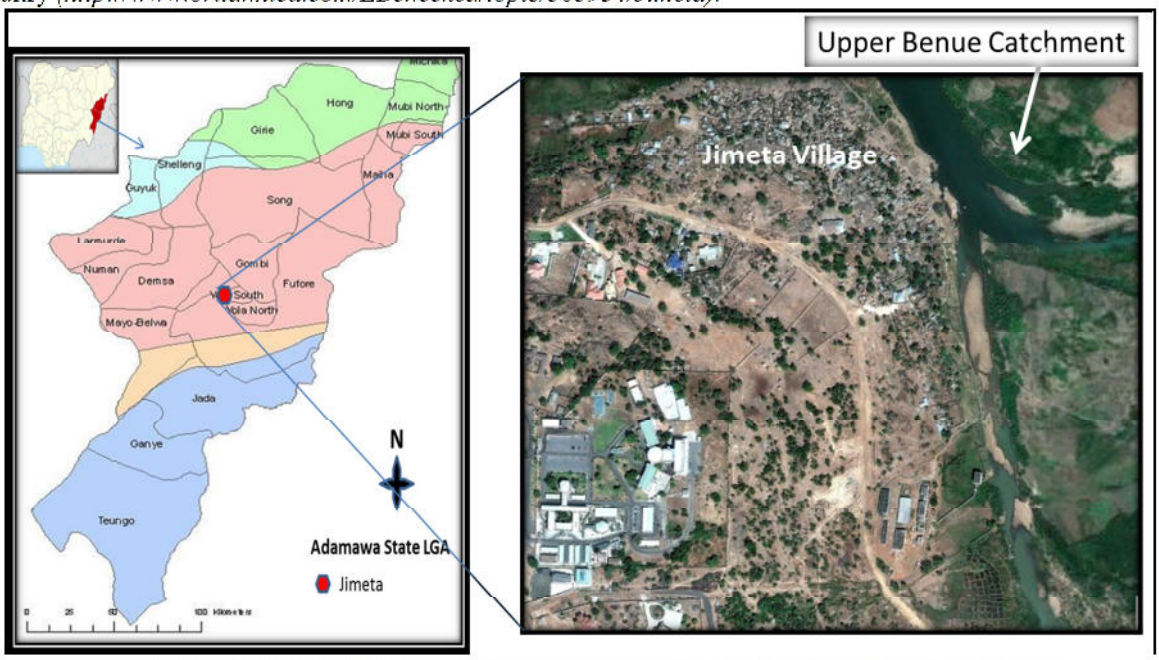


Figure 1: Map of Adamawa State with Nigeria Map Inset Showing Jimeta study area
(Satellite Image - lower left, obtained from Google Earth)

Jimeta is linked by road to Bombi, Mubi, Bama, and Maiduguri; a ferry service in the town crosses the Benue River. 2008Jimeta Population estimate is put at 254,967. Adamawa is one of the largest states of Nigeria and occupies about 36,917 square kilometres. It is bordered by the states of Borno to the northwest, Gombe to the west and Taraba to the southwest. Its eastern border also forms the national eastern border with Cameroon. Topographically, it is a mountainous land crossed by the large river valleys - Benue, Gongola and Yedsarem. The valleys of Cameroun, Mandara and Adamawa mountains form part of the landscape.

The major occupation of the people is farming. The cash crops are cotton and groundnuts, while the food crops include maize, yam, cassava, guinea corn, millet and rice. The village communities (the study area) living on the banks of the rivers engage in fishing while the Fulani are cattle breeders. According to United Nations Fund for Population Activities (UNFPA, na), net attendance ratio in secondary school in Adamawa is generally 34.4% and was 37.7% for male 30.8% for female in Adamawa state; primary education net attendance ratio is 62.9 with a difference of 58.7 for female and 66.5 for male. Majority of Adamawa male population have no formal education (34.8%). Only 5.6% of the population have more than secondary education. Close to half of the female population 49.8% have no formal education and 1.8% has more than secondary education. The Nigeria drainage system is divided into eight (8) catchments. The two major rivers in the country are the Benue and Niger. Adamawa State is in the Upper Benue catchment. The Benue is an international river entering into Nigeria across the border with Cameroon, and runs for a distance of about 900 km from the border to the confluence with the Niger River at Lokoja, Kogi state (FMWR 1994; Nwilo *et al.* 2012). The drainage system peculiarity of the study area and the recent flood hazard informed this study.

5. Review of Related work and conceptual framework

Flood and flooding is an environmental threat that has continually affected lives and properties. The causes are numerous but of particular interest is rainfall (See figure 2) occasioned by global warming due to climate change. Several weeks of above-average and heavy rains across southern Nigeria and Cameroon led to widespread flooding across the region and elevated river levels resulting in the closures of highways,

displacement of local populations and damages to infrastructure (IFRCS 2012). With heavy rain forecasted, the risk for additional flooding is elevated (USAID/FEWS-NET 2012). For example, in examining the drainage characterisation of River Muya in Niger State, Bello, Adzandeh and Rilwani (2014) reiterated that flood hazards and impact often happened, partly, because issues often appraised centers on vulnerability, risk and impact(s) of flooding without attendant evaluation of the drainage pattern of the affected area. According to Nwilo *et al.* (2012), flood analysis for low, medium and high flow regimes showed that an average of 134 settlements are at risk in Adamawa state. In general, causes of flood in Nigeria can be classified either as natural or man-made. Natural causes in form of Heavy or torrential rains /rainstorm, Oceans storms and tidal waves are usually along the coast. Man made flood in the form of Burst water pipes, Dam burst levee failures and Dam spills. Flooding occurs throughout Nigeria in the following forms: Coastal flooding, River flooding, flash floods and urban flooding.

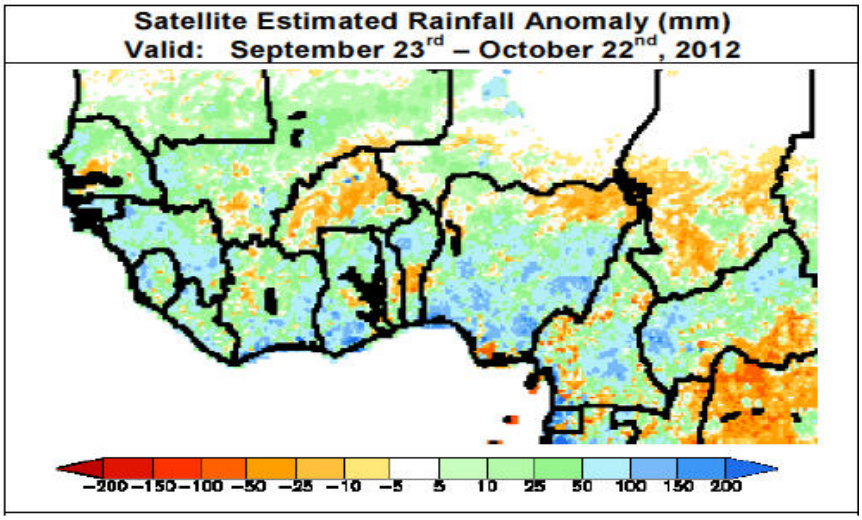


Figure 2: Satellite Estimated Rainfall Anomaly (mm). *(Source: NOAA/CPC)*

The application of geoinformation technology in flood management and control in Nigeria is on the increase. For example, Ojigi (2012) carried out flood water kinematics using numeric terrain descriptors in Minna and environs and observed that a multi-approach will be beneficial in handling flood problems. Similarly, Fabiyi, *et al* (2012) also made a frantic effort to classify Nigeria local government areas into series of lowland and highland using SPOT images to serve as a veritable tool for flood emergency response while Nwilo *et al* (2012) carried out a study on Flood Modelling and Vulnerability Assessment of Settlements in the Adamawa State Floodplain Using GIS and Cellular Framework Approach. Bello *et al*. (2013) on the other hand applied GIS technology in floodplain delineation and risk mapping in some communities in upper Benue catchment in Taraba State of Nigeria and concluded that siltation of river channels, increase in water level, heavy rainfall and encroachment into floodplains are partly responsible for flood hazards. What is remarkable in the above studies is that they have all provided a perspective into the understanding of flood dynamics in the study area. Therefore, effort should be intensified to improve on their study especially in the area of vulnerability, water level dynamics and impact analysis using case scenarios of affected local communities such as Jimeta and this forms the core of this study.

On the concept of rainfall-induced flooding, coastal flooding has been found to occur in the low-lying belt of mangrove and fresh water swamps along the coast. River flooding generally occurs in the flood plains of the larger rivers thus putting pressures on the smaller ones (see Bello *et al.* 2013). Flash floods are also associated with rivers in the inland areas where sudden heavy rains can change them into destructive torrents within a short period as experienced in the riverine community of Jimeta in 2012.

In the USAID/FEWS-NET October 25 – October 31, 2012 report, rainfall surpluses increase during the period under review. The report has it that, heavy rain (>50mm) was observed along the Gulf of Guinea. The heaviest rains (>75mm) fell across saturated areas in southern Nigeria, Ghana, Cote D'Ivoire, Guinea and Sierra Leone. Moderate rains (10-50mm) were recorded farther inland. During the past thirty-days, rains have been above-average across much of West Africa. The abundant rains in Nigeria have caused substantial flooding across the southern half of the country and have elevated water levels along the Niger, Benue, Chari and Yobe Rivers. Moderate to strong thirty-day rainfall surpluses (50-150mm) are present in Nigeria, northern Benin, Ghana, Cote D'Ivoire, Guinea and Sierra Leone. Elsewhere in West Africa, slight surpluses (5- 50mm) are present (Figure 2). Overall, seasonal rainfall across West Africa has been above-average dating back several months resulting in flooding concerns in Nigeria, and far western West Africa.

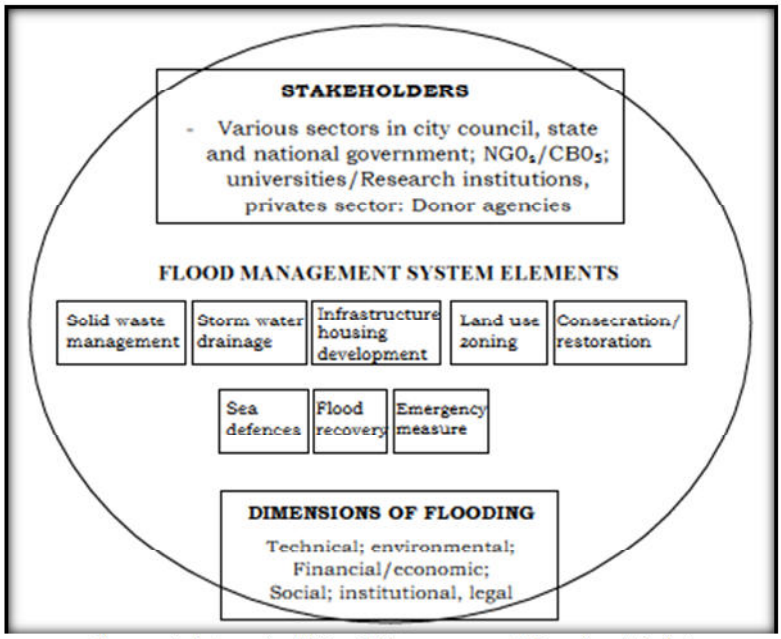


Figure 4: Integrated Flood Management Planning Model
(Source: Ogba and Utang, 2008 as adapted from Klaudert and Anschiitz, 2000)

According to the International Red Cross and Red Crescent Society's report (IFRCS, 2012a), the rainy season in Nigeria has delivered more precipitation than earlier years, causing flooding in 18 of 36 states including FCT. The report also stated that the excessive water run-off was initially contained through contingency measures, but the heavy rain in the last couple of weeks steered to the overflow of water reservoirs, forced release of dam water and breaching of river boundaries and banks, resulting in damage to roads, bridges and other infrastructure, loss of property and livestock and displacement of people.

The conceptual framework adopted in this study is based on the Integrated Flood Management Planning Model (IFMP - see figure 4) developed by Klaudert and Anschiitz (2000) obtained from Ogba and Utan (2008). The model shows a multi-level and holistic integration of variant stakeholders such as research organisations, NGOs, government bodies and individuals. The model recognises various elements that are considered germane in flood analysis. Flood impacts and dimensions (technical, environmental, financial, economic, social, institutional and legal) are taken into consideration in discussing the findings of this study as justified by the above model or framework.

6. Materials and Method

In this study, reference was made to existing literatures and available statistics on flood obtained from research studies conducted by individuals, governments and Non-Governmental Organisations (NGOs). For the geospatial coverage analysis, a four series (2002, 2003 and 2004 (GeoEye) and 2010 (DigitalGlobe) Satellite images were used to evaluate the water coverage, level and dynamics around the study area (Figure 4b shows the workflow for adopted methodology). For visual interpretation, the integrated satellite images were enhanced using ILWIS software. It was further georeferenced and rectified using the Nearest Neighbour resampling technique in ArcGIS 10.1 software. Vector features were captured as follows: road network (*line*), major settlements (*polygon*), and minor settlements (*point*), water body and vegetation (*polygon*). The water level was determined by differentiating the high (deep) areas from the low (shallow or silted) areas. The 2002, 2003, 2004 and 2010 satellite images were compared to show the different levels of water whether it has increased (high) or decrease (low or silted) in Jimeta coastal community while quantifying the area coverage in squared meters using the *calculate geometry and statistics operation in ArcGIS software*. A 100m buffering was done for all the years under review in order to determine the severity of vulnerability in the study area. A graph was used to present the result while comparing the various dates under review. The 3D terrain visualization of vulnerable areas was carried out using ArcScene.

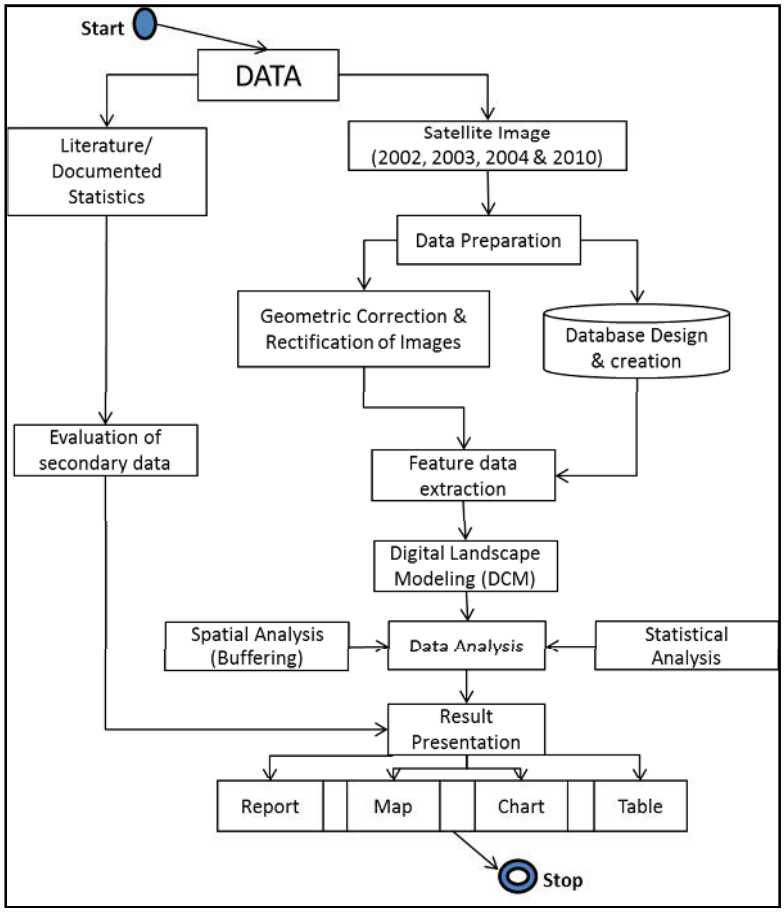


Figure 4b: Study Methodology Workflow for Jimeta

7. Results, Discussion of findings and Contribution to Knowledge

Presented below are the findings reached based on consulted literatures, GIS analysis and drawn inferences from collated data and statistical analysis from the time series Satellite data for the study area.

7.1 Identified Factors Responsible for Flooding in Jimeta, Adamawa State

The study reveals that coupled with heavy rainfall, the release of water from the Kiri Dam in Adamawa State and from Lagdo Dam in Cameroun both accentuated the flood in Jimeta and most other parts of Nigeria especially along the Benue/Niger river waterways. Thus, human modifications and alteration of nature's right of way has equally heightened the problem, while the disastrous consequences are dependent on the degree of human activities and occupancy in vulnerable areas. In general, study shows that besides rainfall, the following factors, among others, are adduced to be responsible for flooding in the study area:

a) released of Dam water and surface overflow,
b) siltation (due to sand pillage) along the river course,
c) low carrying capacity of the soil (sandy-loam),
d) low level of percolation of water due to soil sheer strength,
e) lack of drainage systems, and
f) urban growth and encroachment resulting in unplanned settlement along the water course

Record shows that the 2012 floods in Nigeria directly affected about 134,371 people; displaced 64,473 people; injured 202 and killed 148 people (Table 1). Specifically for the study area, 10 Local government areas (LGAs) were severely affected in Adamawa State with 46,030 numbers of persons affected; 10,456 displaced; 50 injured and 18 recorded dead (IFRCS, 2012a). The impact of the flood also resulted in some bridges been cut off from the Benue River. Details of similar cases in the other parts of Nigeria are also contained in Table 1.

As a quick measure, the displaced population had to seek shelter with some host families or in makeshift camps. As rain comes and goes with its consequential wind, the forced release of additional dams and reservoirs increased the extent and impact of floods.

Table 1: Flood Hazard Statistics in Nigeria

S/No.	State	No. of LGA	No. of People Affected	No. Displaced	No. Injured	No. of Death
1	Adamawa	10	46,030	10,456	50	18
2	Anambra	4	-	-	-	-
3	Bauchi	15	7,853	6,586	-	-
4	Benue	5	8,750	6000	-	8
8	Cross River	4	832	105	2	3
6	Ebonyi	3	-	156	-	Nil
7	Gombe	6	791	658	-	3
8	Jigawa	11	350	234	-	6
9	Kaduna	3	3,410	3,112	-	-
10	Kano	7	16,125	5,386	106	18
11	Katsina	2	3,215	2,730	8	6
12	Kebbi	1	3,500	2,700	27	2
13	Lagos	1	150	150	-	16
14	Nasarawa	2	5,000	4,200	6	2
15	Niger	4	250	200	2	7
16	Plateau	7	10.000	9.489	2	38
17	Taraba	5	23,750	10,420	-	21
18	Yobe	2	4,375	1,891	-	-
	TOTAL	**93**	**134,381**	**64,473**	**202**	**148**

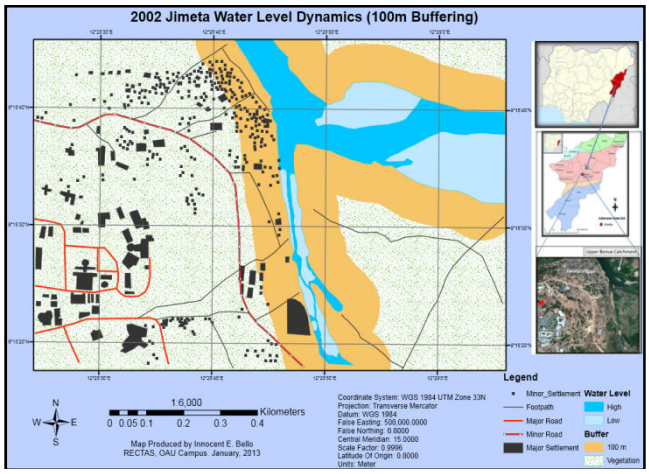
(***Source***: *Modified after IFRCS, 2012a.);*

7.2 Geospatial extent of water coverage and flooding in Jimeta, Adamawa State

7.2.1 Water Coverage and Geospatial Dynamics of Flood

Large scale flooding in Jimeta riverine community has not been recorded until August, 2012. Figure 5a: 2002 statistics (162,057.54 Sqm) and 5b, 2003 statistics (160,533.80 Sqm) shows that the volume of water and the geospatial coverage were relatively the same with slight increase in 2003 due to seasonal flow but no flood of damaging capacity was recorded hence the local inhabitants probably saw no reason to vacate their neighbourhood. The study also reveals that if flood had taken place, a number of settlements within 100m buffer of the water body would have been lost to flood.

But if this study was conducted about a decade ago with the result made known to the people, the likelihood of having lesser damages would have been guaranteed. Unfortunately, according to Abdul'aziz (2012), Red Cross reported that on the 17th of September 2012, at least 20 corpses swept away by flood were recovered from River Benue in Adamawa state.



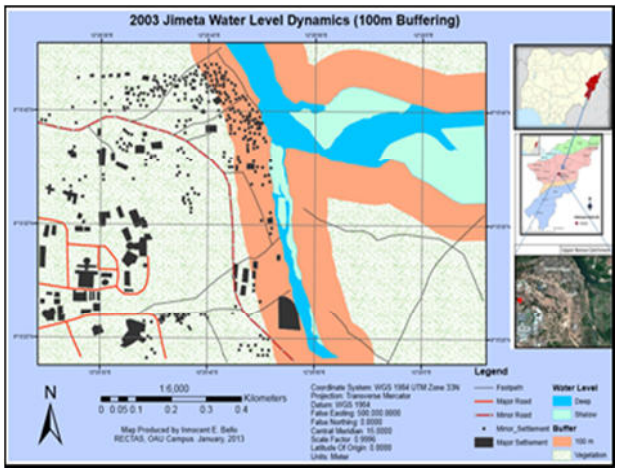


Figure 5a: Water level Dynamics -100m (2002) Figure 5b: Water level Dynamics -100m (2003)

7.2.2 Flood Vulnerability Analysis

Figure 5c and 6 shows that in 2004 the total area coverage of water was around 146,744.95 Sqm. This figure is less than those of 2002 (162,057.54 Sqm) and 2003 (160,533.80Sqm) showing decrease in the volume of water. The indication of this result is that rainfall which usually recharges the water level of a river is not the main cause of Jimeta flood. This is also confirmed from the 2010 data which puts the total water coverage at 73,903.84 Sqm. The 2010 coverage is twice less than the total of 2002, 2003 and 2004 respectively. This short fall is graphically represented in Figure 6.

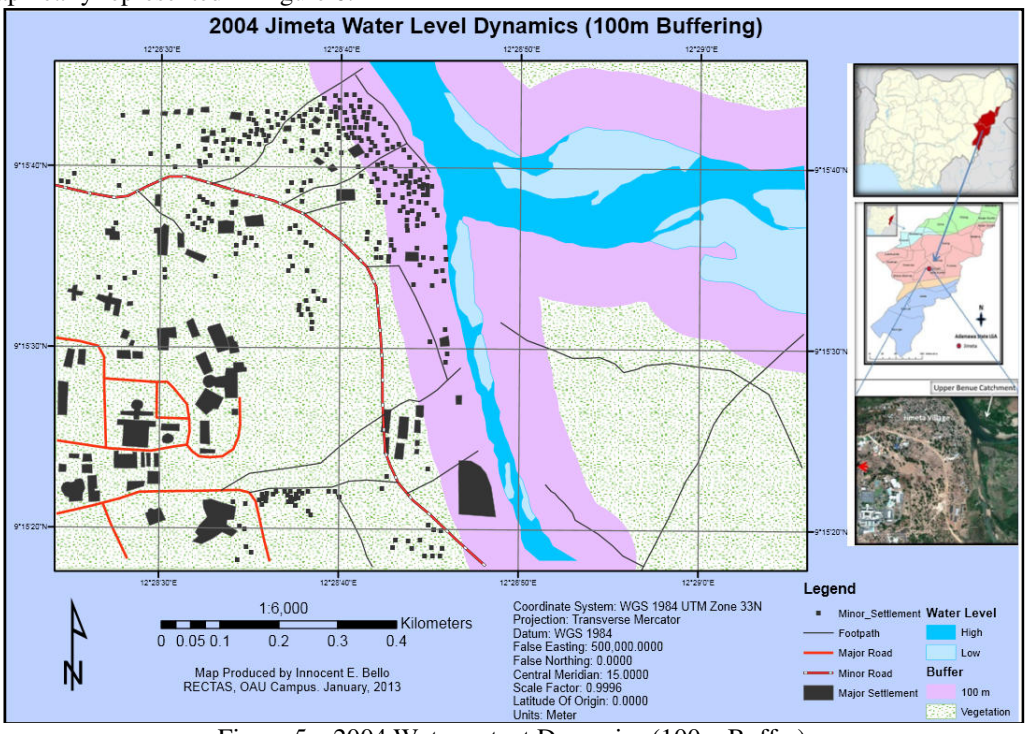


Figure 5c: 2004 Water extent Dynamics (100m Buffer)

Study reveals that the total average water extent for the study area is 135,810.07 Sqm while the high (deep) area covers a total of 73,642.72 Sqm and low (shallow or silted area) covers 62,167.35 Sqm. Figure 5d shows that based on 0-50m buffer, few settlements are vulnerable to flood while more areas are affected when 50-100m buffer was carried out. The silting of the river course due to the transportation of debris is partly responsible for the flood in Jimeta. Thus, identified (buffered) area is most likely the highly affected parts of Jimeta during the 2012 flooding.

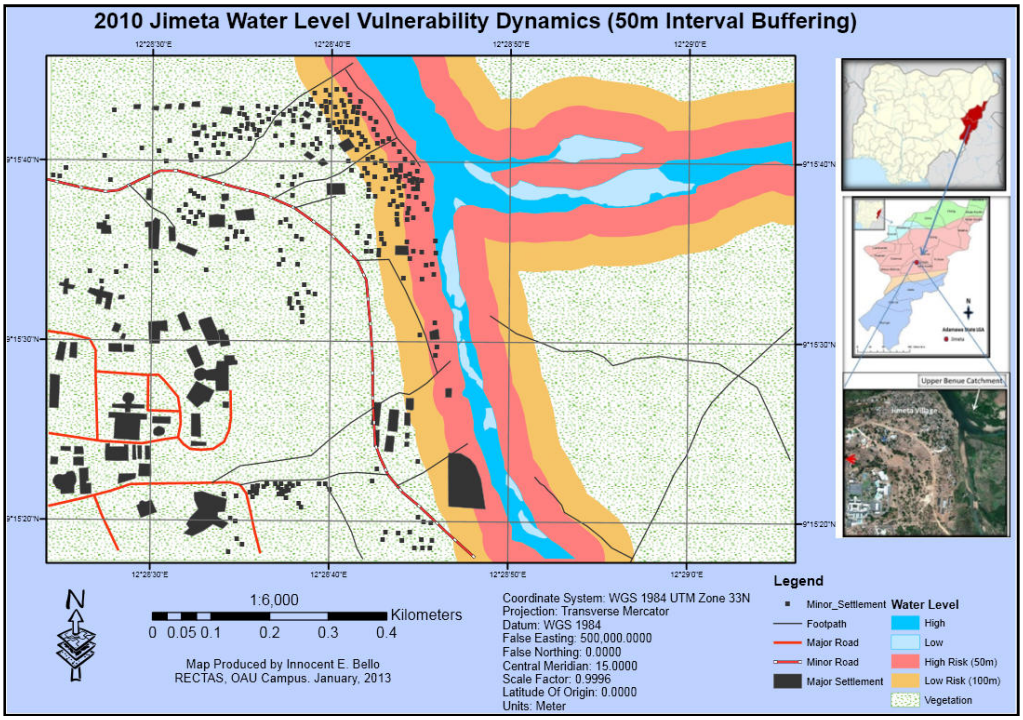
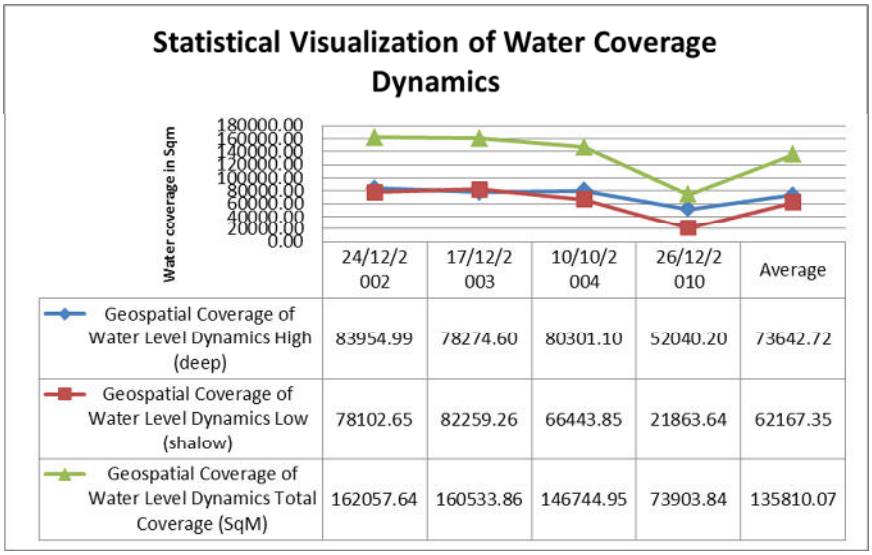


Figure 5d: 2010 Water extent Dynamics and Vulnerability Analysis (50m & 100m Buffers)



	24/12/2002	17/12/2003	10/10/2004	26/12/2010	Average
Geospatial Coverage of Water Level Dynamics High (deep)	83954.99	78274.60	80301.10	52040.20	73642.72
Geospatial Coverage of Water Level Dynamics Low (shalow)	78102.65	82259.26	66443.85	21863.64	62167.35
Geospatial Coverage of Water Level Dynamics Total Coverage (SqM)	162057.64	160533.86	146744.95	73903.84	135810.07

Figure 6: Statistical Analysis of Water extent dynamics in Jimeta, Adamawa State (in SqM)

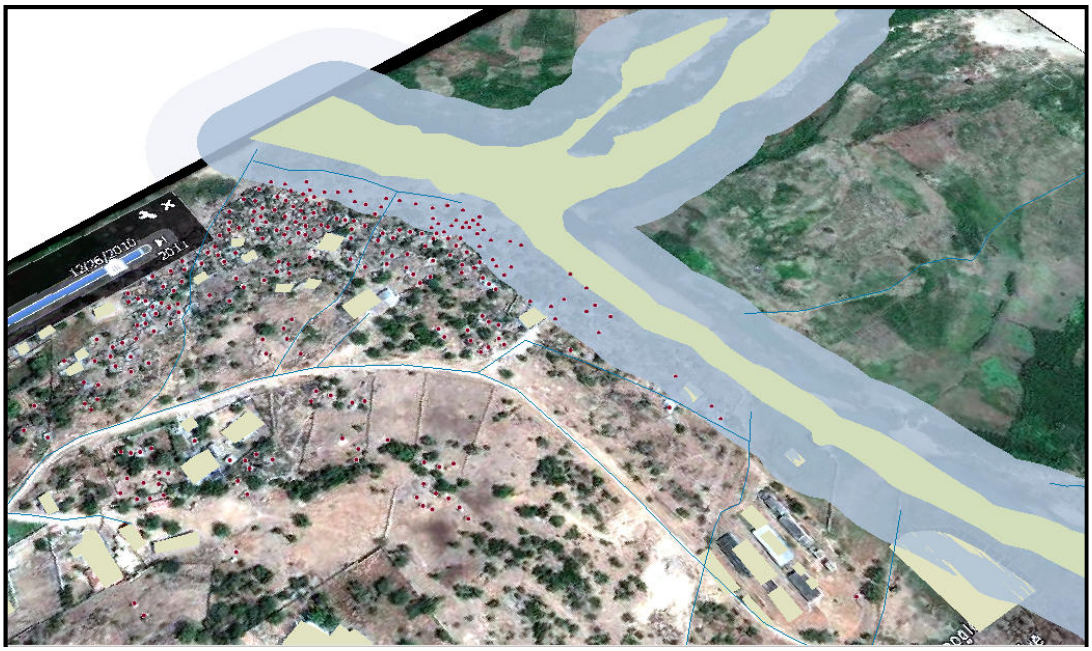


Figure 7: 3D Visualization of vulnerability in the study area,

7.3 Impact and Problems of Flooding in Jimeta, Adamawa State

As observed above, the impact and problems of flood are numerous. The stark revelation on death and subsequent loss of properties and environmental blight in Jimeta shows that flooding blows no one good. The infringement of the coastal region by Jimeta fishing community shows that although most flood hazard are natural, human modification and alteration of nature's right of way can accentuate the problem, while the disastrous consequences are dependent on the degree of human activities and occupancy in vulnerable areas. Flooding of areas used for socio-economic activities produces a variety of negative impacts. The magnitude of adverse impacts depends on the vulnerability of the activities and population and the frequency, intensity and extent of flooding. In this study, the following specific impact and problems have been identified. Detailed discussion of the flood hazards are reiterated below.

7.3.1 Loss of lives and properties:

Figure 8 shows that an entire neighbourhood in Jimeta village was taken over by flood. The inundation, according to Red Cross, was sequel to heavy rains and unexpected release of water from Lagdo Dam in the Republic of Cameroun (IFRCS, 2012a).

Figure 8: Inundated environment in part of Jimeta community
(Source: http://saharareporters.com/news-page/flooding-hits-jimeta-adamawa-state)

Immediate impacts of the flood include loss of human lives, damage to properties, destruction of crops, loss of livestock, non-functioning of infrastructure facilities and deterioration of health condition owing to waterborne

diseases. Flood of this nature, with little or no warning time, caused more deaths than slow-rising riverine floods.

7.3.2 Loss of livelihoods:

It is argued that as communication links and infrastructure such as power plants, roads and bridges are damaged and disrupted, economic activities come to a standstill, resulting in dislocation and the dysfunction of normal life for a period much beyond the duration of the flood. Similarly, the direct effect on production assets; be it in agriculture or industry, has inhibited regular activities and lead to loss of livelihoods. The spill over effects of the loss of livelihoods is been felt in business and commercial activities even in adjacent non-flooded areas. The only thriving business observed in Jimeta after the flood, though presumed awkward, was canoe transportation.

7.3.3 Perceived epidemics and decreased purchasing and production power:

As a result of the flood, damage to infrastructure has caused both short and long-term impacts, such as disruptions to clean water and electricity, transport, communication, education and health care. Loss of livelihoods, reduction in purchasing power and loss of land value in the flooded area lead to increased vulnerabilities of communities living in the area. The additional cost of rehabilitation, relocation of people and removal of property from flood-affected areas can divert the capital required for maintaining production. This is evident from the activities of the Red Cross and Red Crescent Society (IFRCS, 2012a and b) and that of the government (NEMA) and concerned individuals.

7.3.4 Mass migration:

As a result of the severity of the flood, loss of livelihoods, production and prolonged economic impacts and suffering has trigger mass migration or population displacement to the neighbouring settlements. Migration to developed urban areas contributes to the overcrowding in the cities. These migrants, no doubt, swell the ranks of the urban poor and social vices such as prostitution and criminal acts. Selective out-migration of the workforce sometimes creates complex social problems which are already experienced in the study area.

7.3.5 Psycho-social effects:

The huge psycho-social effects on flood victims and their families can traumatize them for long periods of time. The loss of loved ones can generate deep impacts, especially on children. Displacement from one's home, loss of property and livelihoods and disruption to business and social affairs has caused continuing stress. The stress of overcoming these losses is overwhelming and produces lasting psychological impacts.

7.3.6 Hindering economic growth and development:

The high cost of relief and recovery is adversely impacting investment in infrastructure and other development activities in the area and in certain cases may cripple the frail economy of the region. Recurrent flooding in affected parts may discourage long-term investments by the government and private sector alike. Lack of livelihoods, combined with migration of skilled labour and inflation may have a negative impact on Jimeta's economic growth. As Loss of resources can lead to high costs of goods and services, delaying its development programmes is inevitable.

7.3.7 Political implications:

Ineffective response to relief operations during major flood events like what happened in the study area may lead to public discontent or loss of trust in the authorities or the state and national governments. Lack of development in flood-prone areas may cause social inequity and even social unrest posing threat to peace and stability.

7.4 Flooding Control And Management

Resulting from the recent flood impact across Nigeria, and in Jimeta, Adamawa state in particular, an integrated flood management approach is advocated as already illustrated in Figure 4. To some extent, this management approach find relevance in the effort of IFRCS and the government (NEMA) so far, though still not well organized because most researchers, NGOs, etc, are not sufficiently carried along. A critical review of Table 2 below shows that not all affected communities (including Jimeta, the study area) have been captured in the flood palliative measures.

However, study reveals that the IFRCS (IFRCS, 2012b) in collaboration with NEMA did provide palliatives to victims. Shown in Table 2 below are the numbers of beneficiary by states (LGA and communities) served with bucket, blanket, mat, soap, jerry can, low flow dispensary, kitchen set mosquito net, tarpaulin, aqua tab, shelter kit and hygiene kits. The major challenges faced in reaching the victims of flood included long distances and remoteness of the affected communities as well as impassable roads and constant security concerns.

Table 2: Palliative Measures for 2012 Flood Management in Some States in Nigeria

S/NO	State	LGA	Community	Beneficiaries	Bucket	Blanket	Mat	Soap	Jerry can	Low Flow Dispensary	Kitchen set	Mosquito net	Tarpaulin	Aqua tab	Shelter kits	Hygiene kits
		Etsako Central	Udaba	539	154	154	154	385	154	77	77	154	154	847	77	0
1.	Edo		Ifeku Island	630	180	180	180	450	180	90	90	180	180	990	90	0
			Illushi	1197	342	342	342	455	342	171	171	342	342	1,191	171	0
			Igori	1197	171	513	342	1,881	171	0	171	513	171	0	171	0
		Kogi	Ozahi	462	132	132	132	330	132	0	66	132	132	660	66	0
		"	Numaye	189	54	54	54	270	54	0	27	54	54	270	27	0
		Lokoja	Budon	210	60	60	60	150	60	0	30	60	60	300	30	0
2.	kogi	"	Kinami	490	140	140	140	350	140	0	70	140	140	700	70	0
		Bassa	Ogande	70	20	20	20	50	20	0	10	20	20	200	10	0
		"	Mozum Ose	630	180	180	180	450	180	0	90	180	180	900	90	0
		Ibaji	EjuleEgbebe	560	160	160	160	400	160	0	80	160	160	800	80	0
		"	Onyedega	245	70	70	70	175	70	0	35	70	70	350	35	0
		"	Ikumo	140	40	40	40	100	40	0	20	40	40	400	20	0
		Ajaokluta	Koto Karfe	420	100	600	100	600	100	0	40	0	80	0	40	0
3.	Adamawa	Girel Yola	Numan	2,128	304	608	608	1,200	200	0	0	0	200	0	100	0
4.	Benue	Agatu Guma	Logo	420	100	300	100	600	100	0	0	0	80	0	40	0
5.	Jigawa	Dutse	Warwadi	350	0	100	100	0	0	0	20	100	0	0	0	100
6.	Katsina	Maiadua	Maiadua	350	0	100	100	0	0	0	20	100	0	0	0	100
7.	Taraba	Wukari Ibi	Ardo kola	1,750	250	500	500	1080	175	0	100	0	200	0	100	0
	Total			11,977	2,457	4,253	3,382	8,926	2,278	338	1,117	2,245	2,263	7,608	1,217	200

(Source: Modified after IFRCS, 2012b).

8. Summary, Conclusion and Recommendation

In this paper we reiterated that floods are among the most devastating natural disasters in the world, claiming more lives and causing more property damage than any other natural phenomena. While flooding or inundation and its attendant consequences are injurious to man, effort must be made politically and scientifically to prevent and where possible prepare for probable outbreak. In Nigeria, though not leading in terms of claiming lives, flood affects and displaces more people than any other disaster; it also causes more damage to properties as shown in this study. At least 20 per cent of the population is at risk from one form of flooding or another. In 2012 alone, flood disaster has been adjudged to be terrifying to people, communities and institutions. Recently, many parts of the country including Jimeta, Adamawa State was affected by flood, resulting in massive loss of lives and properties on one hand, chasing the inhabitants away to neighbouring settlements for shelter and food on the other hand, while psychological pain is still been nursed by affected populace.

The Flood which has been attributed to both rainfall and dam failures has shattered both the built-environment and undeveloped plan. This study confirms the fact that the major cause of the flood in Jimeta is not just rainfall but dam failure and silted waterways and that the water spatial coverage and extent has been on the decrease since 2002 resulting to siltation of parts of the river. Using GIS analysis, the multiple buffering proximity analysis carried out shows that based on 0-50m buffer; less people were more vulnerable than when a buffer of 50-100m was applied. This study also shows that most part of the river has been silted (sand-filled: shallow) thus responsible for the inward flow of water that ultimately flooded the neighbourhood. The flood has claimed many lives, and millions of properties got lost due to its occurrence. One prominent feature about it is that flooding does not discriminate, but marginalizes whosoever refuses to prepare for its occurrence. From the Jimeta community case study, it is obvious that flooding, from whatever causes, does not go down well with anybody for varied reasons, including psychological effect.

As a recommendation for inundation management, effort should be made to develop 'early flood warning system' (EFWS); rapid response mechanism and outfit; strict adherence to zoning and building principle; evacuation of waste and maintenance of drainage systems; mass awareness campaign of flooding and other environmental hazard. Continuous rehabilitation and assistance of victims by the government, individuals and NGOs is also recommended hence the need for synergy in approach.

Acknowledgements:
Thanks to the anonymous reviewers of this article and the International Federation of Red Cross and Red Crescent Society (IFRCS) for flood data/information.

References

Abdul'Aziz, I. (2012), "Nigeria: 20 Corpses Recovered In Adamawa Flood". Daily Trust, 17 September, Nigeria. Retrieved from: http://allafrica.com/stories/201209170634.html. Accessed January 17, 2013.

Ahem, M., Kovats, R.S., Wilkinson, P., Few, R. & Matthies, F. (2005), "Global Health Impacts of Floods: Epidemiologic Evidence". *Epidemiological Review*. 27 (1):36-46. doi: 10.1093/epirev/mxi004

Bello, I. E., Adzandeh, A. & Rilwani, M. L. (2014), "Geoinformatics Characterisation of Drainage Systems Within Muya Watershed in The Upper Niger Drainage Basin, Nigeria. *International Journal of Research in Earth & Environmental Sciences*. 2(3): 18-36.

Bello, I. E., Onothoja, U. T. & Asikhia, M.O. (2013), "Application of GIS Technology in Floodplain Delineation and Risk Mapping in Some Communities in Upper Benue Catchment, Taraba State, Nigeria". *West African Social and Management Sciences Review* (WASMSR). 4(1): 79-89

*Center for Research on the Epidemiology of Disasters (2005). "EM-DAT: the OFDA/CRED International Disasters Data Base". Brussels, Belgium: School of Public Health, Université Catholique de Louvain. (*http://www.em-dat.net/*).*

Encyclopedia Britanica (2013), "Jimeta". Accessed January 18, 2013 from http://www.britannica.com/EBchecked/topic/303934/Jimeta,

Etuonovbe, A.K. (2011), "The Devastating Effect of Flooding in Nigeria". *FIG Working Week, 2011.* Bridging the Gap between Cultures Marrakech, Morocco, 18-22 May.

Fabiyi, O.O., Ige-Olumide, O. & Enaruvbe, O.G. (2012), "Spatial Analysis of Flood Plains in Nigeria from SPOT Satellite Elevation Data" in: O, Fabiyi and B. Ayeni (e*ds*.) Geospatial Technologies and Digital Cartography for National Security, Tourism and Disaster Management. *Proceedings of Joint Conference of GEOSON & Nigerian Cartographic Association (NCA)*. RECTAS, Obafemi Awolowo University Campus, Ile Ife, Nigeria. 19 – 22 November. Pp 239 – 252.

*Hajat, S., Ebi, K.L., & Kovats R.S. (*2003*), "The human health consequences of flooding in Europe and the implications for public health: a review of the evidence". Appl Environ Sci Public Health ;*1*:13–21.*`

IFRCS (2012a), "Emergency Appeal; Nigeria: Floods". 29th September, 2012. Retrieved from http://reliefweb.int/sites/reliefweb.int/files/resources/MDRNG01401.pdf Accessed January 10, 2013

IFRCS (2012b), "Emergency appeal operation updates". No 1, December 27, 2012; Nigeria: Floods. Retrieved from http://reliefweb.int/sites/reliefweb.int/files/resources/MDRNG01401.pdf Accessed January 15, 2013.

*Intergovernmental Panel on Climate Change (*2001), "Climate Change: im*pacts, adaptation, and vulnerability". Cambridge, United Kingdom: Cambridge University Press.*

*Malilay, J. (*1997), "*Floods". In: E. Noji (ed). The public health consequences of disasters. New York, NY: Oxford University Press.* Pp *287–301.*

Nwilo P.C., Olayinka, O.N., & Adzandeh, A.E. (2012) Flood Modelling and Vulnerability Assessment of Settlements in the Adamawa State Floodplain Using GIS and Cellular Framework Approach. *Global Journal of Human Social Science.* 12(3):11-20.

Ogba, C.O. & Utang, P. (2008), "Integrated Approach to Urban Flood Adaptation in the Niger Delta Coast of Nigeria". FIG working week 2008. Integrating Generations. Stockholm, Sweden. 14-19 June.

Ojigi, L.M. (2012), Modeling Flood Water Kinematics Using Numeric Terrain Descriptors in Minna and Environs, Nigeria, in: O, Fabiyi and B Ayeni (*Eds*.) Geospatial Technologies and Digital Cartography for National Security, Tourism and Disaster Management. *Proceedings of Joint Conference of GEOSON & Nigerian Cartographic Association (NCA)*. RECTAS, OAU Campus, Nigeria. 19 – 22 November. Pp 220 – 238.

Saharareporters (2012), "Flood in Jimeta". Accessed December 23 from http://saharareporters.com/news-page/flooding-hits-jimeta-adamawa-state

*Seaman, J. (*1984), "*Epidemiology of natural disasters". Basel, Switzerland: Karger.*

UNFPA (na) "UNEPA in Adamawa State". Retrieved from: http://nigeria.unfpa.org/adamawa.html. Accessed January 19, 2013.

USAID/FEWS-NET (2012), "Climate Prediction Center's Africa Hazards Outlook". October 25 – October 31, 2012.

*Western, K. (*1982), *"Epidemiologic surveillance after natural disaster". Washington, DC: Pan American Health Organization.*

Authors:

Innocent E. Bello obtained a Bachelor of Science (B.Sc.) degree in Geography and Regional Planning from the University of Benin. He also obtained various Post Graduate degrees (including Pg.D and M.Sc). His studies include: Geoinformation Production and Management (GIS specialization) at the United Nations ECA's RECTAS, Obafemi Awolowo University Campus, Ile-Ife; Image Processing and Analysis at Canfield University, United kingdom; Earth Observation and Geoinformation Science – geoinformatics domain at University of Twente, (Faculty ITC), The Netherlands, and Cartography and Geoinformation Science at RECTAS. Mr. Bello is a geoinformation scientist and a researcher at the National Space Research and Development Agency (NASRDA), Federal Ministry of Science and Technology, Abuja, Nigeria. His expertise is in geoinformatics (Aerospace Surveys/Remote Sensing, Geographic Information Analysis/GIS, Cartography, GNSS, SDI and Database Management). His research interest spans across 3D cartographic modeling, SDI/VGI, disease and crime mapping, urban and environmental studies (EIA/SIA). Mr. Bello is a registered member of the Geoinformation Society of Nigeria (GEOSON), the Nigerian Cartographic Association (NCA), and the International Society for Development and Sustainability (ISDS), Japan.

Dr. Steve O. Ogedegbe obtained his B.Sc., M.Sc. and Ph.D in Geography and Regional Planning (specialization in cartography, remote sensing and GIS). He is currently a senior lecturer at the College of Education, Igueben, Edo State, Nigeria. His research interest spans across urban planning, environmental studies (EIA/SIA) and topographic mapping. Dr. Ogedegbe is a registered member of the Nigerian Cartographic Association (NCA).

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

Academic conference: http://www.iiste.org/conference/upcoming-conferences-call-for-paper/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar