Geo-Spatial Assessments of Flood Disaster Vulnerability of Benue and Taraba States

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ABSTRACT

Rainfall intensity, low terrain and the release of water from Lagdo Dam upstream of River Benue in the Republic of Cameroon have recently subjected the floodplains of River Benue to frequent and devastating flood occurrences. The havoc wrecked by the 2012 floods in this region and downstream of the Niger in Nigeria has challenged the government and her relevant agencies to seek for reliable and up-to-date data for proper flood control and management strategies. Suggestions were made to the government to relocate some of the settlements that are close to River Benue as well as those that are vulnerable to the floods, but earlier resettlements decisions in Nigeria were based on manually generated data which were subject to inaccuracies as a result of the use of incompetent hands for data generation and human influence, hence, the need for automated techniques such as remotely sensed data and GIS technique for data generation and decision making on the identifications of flood vulnerable areas and the communities that are subject to relocation. ArcGIS 9.3 was used in this paper to generate, classify and analyze the Digital Elevation Models (DEM) of Benue and Taraba States for assessment of flood vulnerability of the area. The coordinates of five hundred and seventy six (576) communities were also obtained by the use of GPS which were linked to the DEM map for identification of the communities that are located in flood vulnerable areas. Five and ten kilometers buffer as well as three and five kilometers buffer were generated along River Benue and the major tributaries respectively for immediate and long term flood management and planning. The study revealed that out of the total land area of 92.84km^2 of the two states, the Benue Basin which was classified as "highly vulnerable" to floods covered 48.69%, while the plain that was classified as "vulnerable" comprised 28.24%. Hence, a total land area of 77.71% of the two States is prone to flood. However, Benue State was discovered to be more vulnerable to flood than Taraba State as the state has 98% of its land area either highly vulnerable (Benue Basin with 77.37%) or vulnerable (Plains with 20.93%). The communities (including their names) that are located within each of the vulnerable classes and within some specific buffer zones were also identified and analyzed. A simple database was generated from the DEM data while spatial analysis based on the database for decision making was demonstrated. It was recommended that all the stake holders should embark on the use of remotely sensed data and GIS techniques for flood management and control.

Keywords: benue basin, DEM, flood, flood vulnerability, remote sensing, GIS

INTRODUCTION

River Benue, the second largest river in Nigeria passes through five states; that is, Adamawa, Taraba, Benue, Nassarawa and Kogi State before it joins River Niger at Lokoja and flows downward to the coast. Recently, rainfall intensity as well as the release of water from Lagdo dam upstream of river Benue at Cameroon has resulted to constant and annual floods in the

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states situated along the Benue River and thereby causing much havoc on the land, the people and the properties of the inhabitants. The severity of the floods in the Benue floodplains have been widely reported [1, 2, 3, 4, 5].Following the 2012 devastating floods in the country, the three tiers of government, non-governmental/religious organizations and private individuals assisted the flood victims in their different capacities [6, 3]. According to [7] the Federal Government gave a total amount of N17.6 billion package to compensate the flood victims and flood control measures, out of that amount, N13.3 billion had been allocated to affected states while Federal Government Agencies whose activities directly impact on the flood amelioration programme got N4.3 billion. Based on the flood severity assessment, the affected states were categorized into four groups, A to D. In Category A are eight states consisting of Adamawa, Oyo, Kogi, Anambra, Bayelsa, Delta, Benue, and Plateau who received N500 million each". Taraba State was grouped into category B. Based on reports, [8, 9], it is however unfortunate that the money given to the states were either embezzled, diverted or misappropriated. For instance, according to [9]Governor Gabriel Suswam of Benue State said the drainages in the state are being constructed by the Environment Ministry at the cost of N200 million which was derived from the N500 million flood relief subvention approved by the federal government, while, about N95 million was approved for an estate consultant to do an assessment of the houses that were destroyed by the floods in the state. It was also revealed that separate funding was made available for others to ascertain the level of devastations caused on the farmlands in the affected areas. Hence, residents of the affected communities have said that till now, government has failed to locate refugee camps and or provide an alternative accommodation for them. Rainfall season of year 2013 has barely started when the communities along River Benue were seriously destroyed by flood. [9] reported that precisely on Monday 24th June 2013, over 200 houses were flooded and property worth millions of Naira destroyed by a heavy downpour in Makurdi, Gyado Villa, Idye, Wadata, Wuruku and Agboul villages all in Benue State. The effect of the 2012 and 2013 flood is shown Figs. 1a and 1b respectively.

Fig. 1a Flood in Makurdi in Sept2012 Fig. 1b Flood in Makurdi in June 2013

Source: Ayado 2013

[5] and [7] have reported that since the Federal Government through the National Emergency Management Authority (NEMA) is planning resettlement of the affected communities in all the states to saver places, as suggestions were made by the general public to the government to relocate some of the settlements that are close to River Benue as well as those that are vulnerable to the floods. Earlier resettlements decisions in Nigeria such as the Kainji Lake resettlement scheme of the 60s [10] Jebba Dam resettlement scheme of the 80s [11] and the Loko flood resettlement scheme by Adamawa State Government [12] have always resulted in criticisms and conflicts partly because such decisions were based on manually generated data

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which might be subject to inaccuracies as a result of the use of incompetent hands for data generation and human influence. Therefore, if data generation and decision making of the vulnerable settlements to flood along River Benue are manually generated, the outcome may not be far from previous experiences as the communities that are located far from flood prone areas may be selected while those that really need resettlement would be abandoned. It is therefore necessary to employ automated means of data generation for decision making such as remotely sensed data and Geographic Information System (GIS) techniques which have been proved to be more accurate, reliable flexible and cheaper for flood monitoring and management [8, 13, 14, 7]. Adamawa and Taraba States in the North East geo-political zone as well as Benue, Nassarawa and Kogi States in the North Central geo-political zone were the five states that share boundaries with River Benue. In this paper, Taraba and Benue State were selected from each of the two geo-political zones to assess the vulnerability of the land and the communities in the two states to flood.

AIM AND OBJECTIVES

The aim of this study is to assess the vulnerability of the land and the communities of Benue and Taraba States to flood. The main objectives are:

(i) To assess the parts of the terrain that are vulnerable to floods in each LGA of Benue and Taraba States

(ii) To assess flood vulnerability of some selected communities in Benue and Taraba States based on their terrain locations and proximity to River Benue and the other major tributaries

(iii) To create database on flood vulnerability and demonstrate spatial analysis of the terrain and communities of Benue and Taraba States that are vulnerable to flood

THE STUDY AREA

Benue and Taraba States lie between latitudes 6.40^0N and 9.40^0N and longitudes 7.30^0E and 12.00^0E (Fig.2).

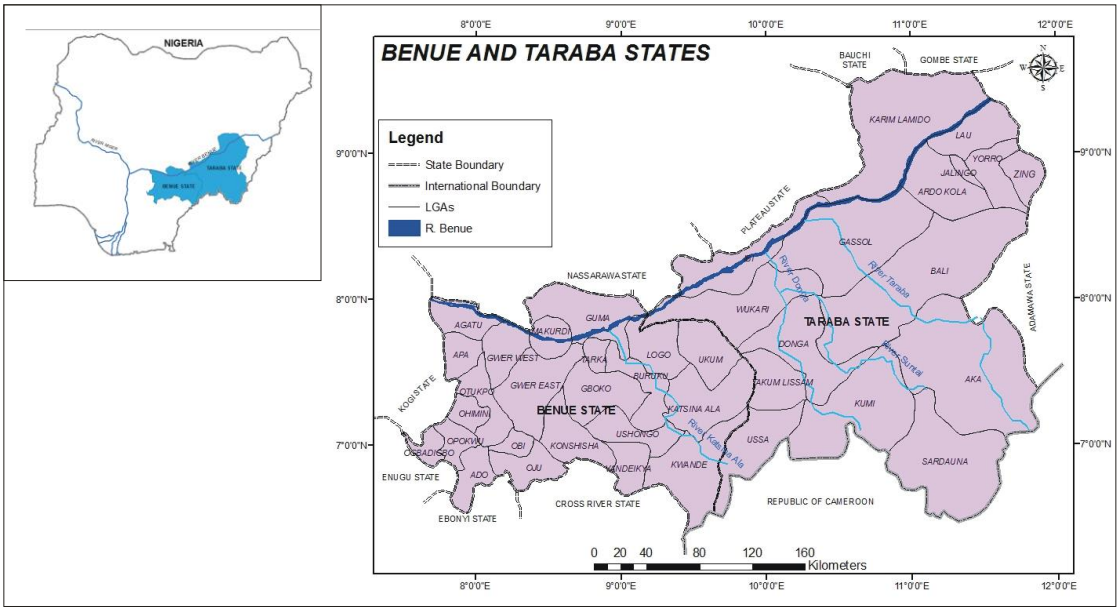

Fig.2. The Study Area

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Benue State was created on February 3, 1976 from the former Benue-Plateau State. The state which derives its name from River Benue has a population of 4,780,389 [15]. The state is made of several ethnic groups: Tiv, Idoma, Igede, Etulo, Abakpa, Jukun, Hausa, Akweya and Nyifon. The Tiv are the dominant ethnic group, occupying 14 Local Government Areas (LGAs), while the Idoma and Igede occupy the remaining nine LGAs (Mngutyo and Jonathan 2013). According to [5] most of the people are farmers while the inhabitants of the riverine areas engage in fishing as their primary occupation. Much of Benue State falls within the Benue Valley/trough (Fig. 3). The land is generally low lying (averaging 100m-250m) and gently undulating with occasional inselbergs, knolls, laterite capped mesas and buttes. Benue State has a tropical sub-humid climate, with two distinct seasons, that is, wet and dry seasons. The wet season lasts for seven months, starts in April and ends in October. The State lies in the southern Guinea Savannah. The grasses however grow very tall, coarse and tough on maturity. In the southern part of the State, particularly in Oju, Ado, Obi, Ogbadibo and Okpokwu LGAs, the vegetation is mainly oil palm. Dense forests are few and far apart, except in a few LGAs such as Vandeikya, Kwande and Okpokwu. [4] also reported that the soils of the state are mainly oxisols and ultisols (tropical ferruginous) which is significant for producing perched water table: an important source of capillary water, which keeps the surface moist long after the end of the rainy season.

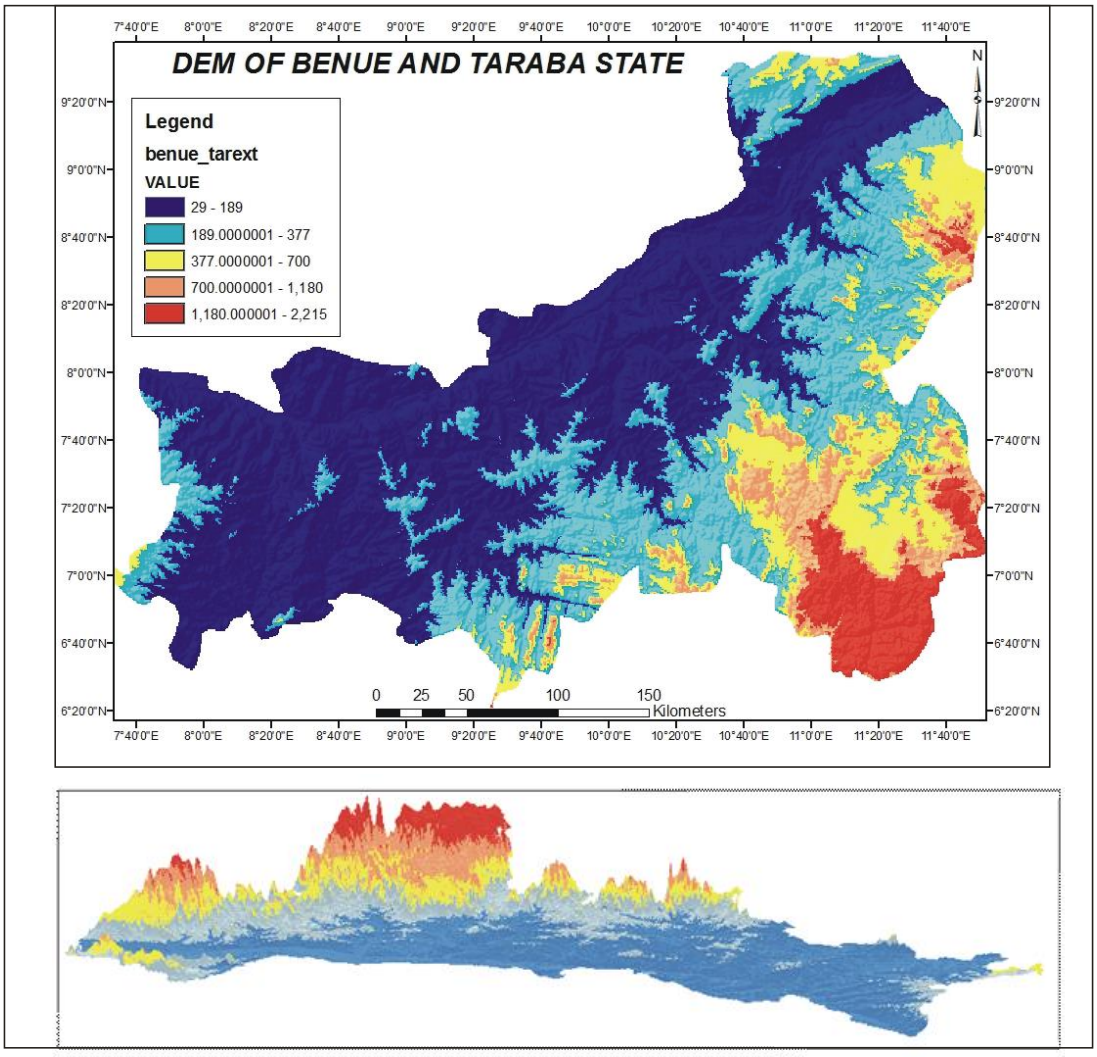

Fig. 3. DEM of Benue and Taraba State (above) 3-DView from the North of Benue and Taraba States

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Taraba state was created out of the former Gongola State on 27 August 1991. Taraba State is bounded in the west by Plateau and Benue States and on the east by the Cameroon (Fig.3). It has a population of approximately 2,300,736 and a population density of 27 people per square kilometer [15]. Mountains, which include Adamawa, Obudu Shebsi and Atlantika mountain ranges in the state's southern portion rise to more than 2,000m (Fig.3). Rivers Benue, Donga, Taraba and Ibi are the main rivers in the state. [2] reported that Taraba State is a multi-ethnic state and is home to about eighty ethnic groups speaking approximately seventy-three languages, making it one of the most diverse in Nigeria. Among its major ethnic groups are the Jukun, Mambila, Fulani, Jango, Kuteb and Mumuye. The major occupation of the people of Taraba State is agriculture. Cash crops produced in the state include coffee, tea, groundnuts and cotton. In addition, cattle, sheep and goats are reared in large numbers, especially on the Manbilla Plateau, and along the Benue and Taraba valleys. Communities living on the banks of River Benue, River Taraba, River Donga and Ibi engage in fishing all year round.

The River Benue has its origins in the Adamawa Plateau of Northern Cameroon. According to [7] the Lagdo Dam, a 40m high dam, has been built across the river about 50km upstream of Garoua, a major town on the river in Northern Cameroon. The water releases from this dam has continued to create floods in Cameroon and in Nigeria over the years and the resulting devastation reached all the way to the Niger Delta in Nigeria. River Katsina-Ala rises in the western region of Cameroon before entering Nigeria, it passes through Katsina-Ala before joining the River Benue about 40km east of Makurdi. The River Donga, which provides up to 20% of the Benue flow, starts in the Adamawa Highlands of Nigeria, adjacent to the Cameroon. The River Donga joins the River Benue at Jibu. The River Taraba also has its origins in the Adamawa Highlands and it joins the River Benue about 20km northeast of Jibu.The Rivers Katsina Ala, Donga and Taraba drain a part of the western region of Cameroon and an area in Nigeria south of the River Benue.[17] has reportedthat peak flow in the River Benue at Garoua is usually in the month of September. Average flow observed in the river at Garoua in September is about 1670 cubic meters per second, while a flow of 6130 cubic meters per second was observed in the river at Garoua in August 1948. If such a flow should occur now, the effects would be catastrophic on the Rivers Benue and Niger through to the Niger Delta

MATERIALS AND METHODS

Global Positioning System (GPS) Germin 76, Digital Elevation Dataset from Shuttle Radar Topographical Mission (SRTM), Thematic Maps, NPC 2006 Census, World Atlas from Googles as well as ArcGIS 9.3, CorelDraw 12 and Microsoft Excel 2007 software were the major materials and software that were acquired and used for this work. Since flood vulnerability of any place depends on the terrain and proximity to waterbody, Digital Elevation Modeling (DEM) of the study area is necessary so as to have a view about the terrain, while buffering is also needed for proximity assessment. Therefore, the terrain of the area was generated (Fig. 3) through DEM creation module of ArcGIS software, using Digital Elevation Dataset from Shuttle Radar Topographical Mission (SRTM) obtained on line. The boundary of the two states was then used to extract the exact position of the two states from the downloaded scene. The classified raster DEM was vectorized using the ArcGIS tool (Fig.4), while the areas in square kilometers of each of the classes were calculated through the area calculation module of ArcGIS software. The generated DEM was classified into five classes which include:

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(i) Benue Basin: The swampy valley of River Benue with heights ranging from 29 to 189m above sea level (Fig.3).

(ii) Plains: The plains are the lowland area bounding the basin with their heights ranging from 189 to 377m above sea level (Fig.3).

(iii) Uplands: Upland areas have their heights between 377and 700m above sea level (Fig 3). Uplands are rarely vulnerable to flood because of their higher elevation.

(iv) Mountains: The mountain areas' height ranges from 700 to 1180m above sea level. Mountain areas are not vulnerable to flood. They also have difficult terrain for human settlement

(v) Plateau: Plateaus are relatively "flat" hill tops. The Mambilla plateau at the South-Eastern part of Taraba State (red colour) is conspicuously seen on the DEM (Fig.3). The heights of the plateauranged from 1180-2215m above sea level.

Global Positioning System (Germin76) was used to obtain the coordinates of five hundred and seventy six (576) communities in the two states, that is, two hundred (200) communities in Benue State and three hundred and seventy six (376) communities in Taraba State. The coordinates were input into Microsoft excel and exported as "text delimited" to ArcGIS where they were retrieved and linked to the DEM map. Since the DEM were properly referenced and the coordinates correctly recorded, each of the communities automatically appear on their exact positions on the DEM image as they would have been on the ground surface (Fig.5). Finally, since River Benue and the three major tributaries of Rivers Katsina Ala, Donga and Taraba are the main flood prone areas, 10 and 5 kilometers buffer operations (for immediate and long term flood planning and control respectively) were performed on the floodplain areas of River Benue while the communities within the buffer zones were identified. The same operations were performed on the floodplains of the three main tributaries, but with 5 and 3 kilometers buffer. The SQL query module of ArcGIS was then used to query, identify and select desirable features for subsequent planning and decision making.

In order to assess the relationship between population distributions in each of the LGAs in the two states on the flood vulnerable areas (Figs.4a &4b), the 2006 population census (the most recent in Nigeria) was obtained from [10] where the populations of each of the LGAs were used to generate the population map of the two states.

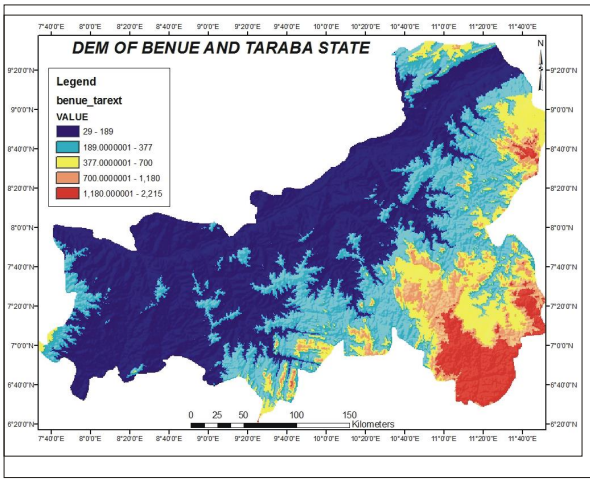

Fig. 4a DEM of Benue and Taraba States

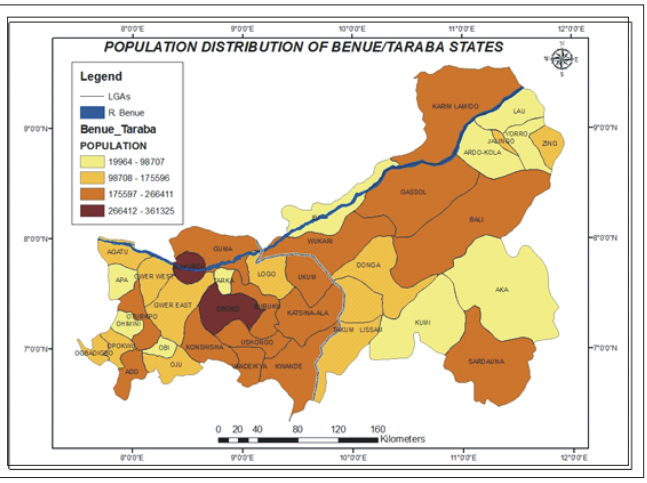

Fig. 4b. Population Distribution of Benue/Taraba States

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RESULTS AND DISCUSSION

The results in this study include: generation of DEM map classified into flood vulnerability map of four classes of highly vulnerable, vulnerable, marginally vulnerable and not vulnerable (Fig.5). Tables for illustration of flood vulnerability of the land and communities in each LGAs of both states were also generated (Tables 1&2), while a summary table for flood vulnerability of the terrain of the two states were also produced (Table3). Furthermore buffers of 10 and 5km distance along the main rivers in the states were generated for the identification of the communities in these buffer zones (Fig.5). Finally, a simple database was created to demonstrate the use of GIS techniques for decision making based on database query through selection by attributes and the use of Structured Query Language (SQL).

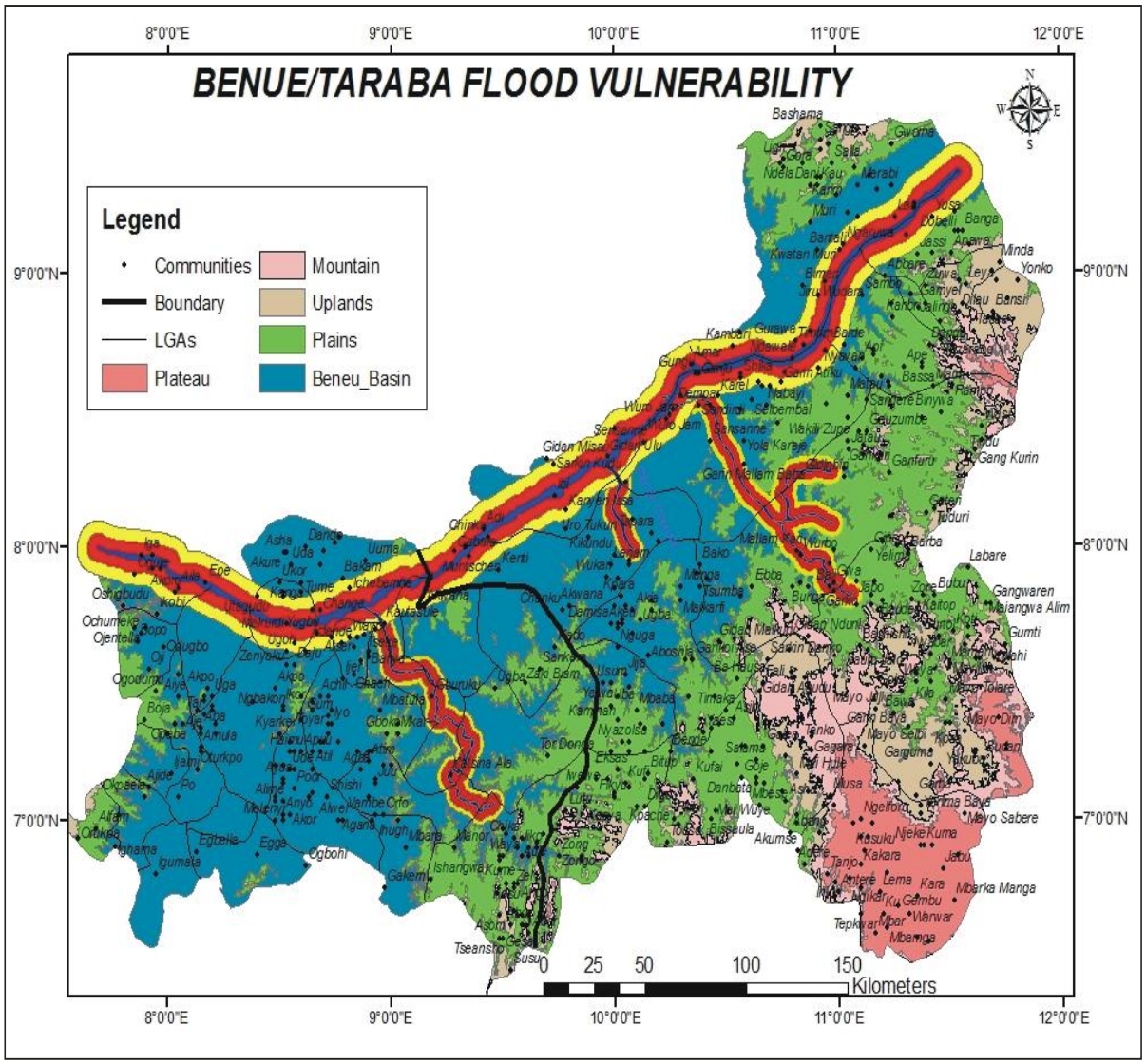

Fig. 5. Flood Vulnerability of the Land and Communities of Benue and Taraba States

Tables for illustration of flood vulnerability of each LGAs of both states were also generated from the terrain of each of the LGAs in each of the states as presented in Tables 1&2.

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Table. 1. Flood Vulnerability of the Land of Benue State

BENUE STATE		*TERRAIN VULNERABILITY*									
LGA	*LAND AREA (Km^2)*	*BENUE BASIN(HIGHLY VULNERABLE)*		*PLAINS (VULNERABLE)*		*UPLANDS (MARGINALLY VULNERABLE)*		*MOUNTAINS (NOT VULNERABLE)*		*PLATEAU (NOT VULNERABLE)*	
		Km^2	*%*	*Km^2*	*%*	*Km^2*	*%*	*Km^2*	*%*	*Km^2*	*%*
Ado	958.30	958.30	100	-	-	-	-	-	-	-	-
Agatu	1113.93	1026.88	92.18	87.05	7.81	-	-	-	-	-	-
Apa	822.36	473.71	57.60	348.65	42.40	-	-	-	-	-	-
Buruku	1454.9	1329.27	91.27	125.63	8.63	-	-	-	-	-	-
Gboko	1967.99	1662.5	84.48	305.49	15.52	-	-	-	-	-	-
Guma	2626.24	2584.14	98.40	42.10	1.60	-	-	-	-	-	-
Gwer East	2590.91	2456.09	94.80	134.82	5.20	-	-	-	-	-	-
Gwer West	1201.62	1185.52	98.66	16.10	1.34	-	-	-	-	-	-
Katsina/Ala	2613.11	1487.11	56.91	1126	43.09	-	-	-	-	-	-
Konshisha	1647.54	1639.63	99.52	7.91	0.48	-	-	-	-	-	-
Kwande	3420.5	638	18.65	2255.59	65.94	446.20	13.04	80.71	2.36	-	-
Logo	1707.37	1490.21	87.28	217.16	12.72	-	-	-	-	-	-
Makurdi	826.26	826.26	100	-	-	-	-	-	-	-	-
Obi	425	425	100	-	-	-	-	-	-	-	-
Ogbadigbo	518.93	88.50	17.05	322.88	62.22	107.55	20.73	-	-	-	-
Ohimini	611.62	451.74	73.86	159.88	26.14	-	-	-	-	-	-
Oju	1206.58	1128.81	93.55	68.94	6.11	8.83	-	-	-	-	-
Opokwu	707.55	520.31	73.54	187.24	26.46	-	-	-	-	-	-
Oturkpo	1230.2	913.21	74.23	316.99	25.77	-	-	-	-	-	-
Ukum	1683.32	1172.59	69.66	510.73	30.34	-	-	-	-	-	-
Ushongo	1418.94	1225.45	86.63	193.49	13.63	-	-	-	-	-	-
Tarka	392.53	378.67	96.47	13.86	3.53	-	-	-	-	-	-
Vandeikya	968.61	785.01	81.05	183.60	18.95	-	-	-	-	-	-
TOTAL	*32,114.31*	*24846.91*	*77.37*	*6624.11*	*20.63*	*562.58*	*1.75*	*80.71*	*0.25*	-	-

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Table. 2. Flood Vulnerability of the Land of Taraba State

TARABA STATE			*TERRAIN VULNERABILITY*									
S/N	*LGA*	*LAND AREA (Km^2)*	*BENUE BASIN(HIGHLY VULNERABLE)*		*PLAINS (VULNERABLE)*		*UPLANDS (MARGINALLY VULNERABLE)*		*MOUNTAINS (NOT VULNERABLE)*		*PLATEAU (NOT VULNERABLE)*	
			Km^2	*%*	*Km^2*	*%*	*Km^2*	*%*	*Km^2*	*%*	*Km^2*	*%*
1	Aka	9102.96	24.36	0.27	2841.59	31.22	3695.57	40.60	1885.90	20.72	655.54	7.20
2	Ardo Kola	2286.39	783.99	34.29	1308.18	57.22	140.92	6.16	53.30	2.33	-	-
3	Bali	8889.49	2097.54	23.60	4906.43	55.19	1401.48	15.77	412.56	4.64	71.48	0.80
4	Donga	3351.87	1964.12	58.60	1191.90	35.56	178.41	5.32	17.44	0.52	-	-
5	Gassol	5824.97	4288.81	73.63	1536.16	26.37	-	-	-	-	-	-
6	Ibi	2579.10	2579.10	100	-	-	-	-	-	-	-	-
7	Jalingo	222.03	36.51	16.44	178.31	80.31	7.21	3.25	-	-	-	-
8	K/ Lamido	6450.72	4130.04	64.02	1748.98	27.11	536.78	8.32	34.92	0.54	-	-
9	Kumi	5107.31	69.65	1.36	2164.97	42.39	1557.12	30.49	1273.40	24.93	42.17	0.83
10	Lau	1734.29	727.07	42	846.55	48.81	155.18	8.95	5.49	0.32	-	-
11	Sardauna	5177.52	-	-	91.74	1.77	394.37	7.62	834.35	16.11	3857.06	74.50
12	T/Lissam	1470.97	37.95	2.58	1046.24	71.13	313.41	21.31	73.37	4.99	-	-
13	Ussa	2622.51	125.41	4.78	1601.68	61.07	665.86	25.39	219.80	8.38	9.76	0.37
14	Wukari	3592.4	3491.08	97.18	101.32	2.82	-	-	-	-	-	-
15	Yorro	1415.84	-	-	285.45	20.16	723.66	51.11	290.28	20.50	116.45	8.22
16	Zing	901.03	-	-	20.81	2.31	716.38	79.51	146.55	16.26	17.29	1.92
	TOTAL	*60729.4*	*20355.6*	*33.52*	*19870.3*	*32.72*	*10486.4*	*17.27*	*5247.36*	*8.64*	*4769.75*	*7.85*

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Fig.4 and Table 1 revealed that in Benue State, Ado, Makurdi and Obi LGAs have all their land areas completely located in Benue Basin, while LGAs such as Agatu, Buruku, Gwer East and West, Konshashi, Oju and Tarka have more than 90% of their land area in Benue Basin which means that the LGAs are highly vulnerable to flood. The listed LGAs is similar to the 2012 flood affected LGAs as contained in the report of [8] that Makurdi, Apa, Agatu, Otukpo, Guma, Buruku, Tarka and Katsina-Ala LGAs of the state, left on its trail over 700,000 displaced persons with thousands of farmlands, houses and huts either submerged or washed away. In Taraba State, (Table 2), only Ibi LGA is completely located in Benue Basin while only Jalingo LGA has more than 80% of its land in the plain. This means that the land area of Benue state is more vulnerable to flood than that of Taraba State.

The summaries of the land and communities' vulnerability to flood was also computed and presented in Tables 3 and 4 respectively.

Table. 3. Summary of Flood Vulnerability of the Land of Benue and Taraba States

Terrain	*Benue State*		*Taraba State*		*Benue/Taraba States*	
	Area (km^2)	*Area (%)*	*Area (km^2)*	*Area (%)*	*Area (km^2)*	*Area (%)*
Benue Basin *(Highly Vulnerable)*	24846.91	77.37	20355.6	33.52	45202.51	48.69
Plains *(Vulnerable)*	6624.11	20.63	19870.3	32.72	26494.41	28.54
Uplands *(Marginally Vulnerable)*	562.58	1.75	10486.4	17.27	11048.98	11.90
Mountains *(Not Vulnerable)*	80.71	0.25	5247.36	8.64	5328.07	5.74
Plateau *(Not Vulnerable)*	-	-	4769.75	7.85	4769.75	5.14
TOTAL	*32114.31*	*100*	*60729.4*	*100*	*92843.71*	*100*

Table. 4. Summary of Flood Vulnerability of the Communities in Benue and Taraba States

Vulnerability	*Terrain*	*Benue State*		*Taraba State*		*Benue/Taraba*	
		No of Communities	*%*	*No of Communities*	*%*	*No of Communities*	*%*
Highly Vulnerable	Benue Basin	156	78	118	31.38	274	47.57
Vulnerable	Plains	40	20	163	43.35	203	35.24
Marginally Vulnerable	Uplands	3	1.5	47	12.5	50	8.68
Not Vulnerable	Mountain and Plateau	1	0.5	48	12.76	49	8.51
TOTAL		*200*	*100*	*376*	*100*	*576*	*100*

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Table 3 revealed that the terrain that was classified as "highly vulnerable" (Benue Basin) covers almost half of the two states (48.69%) which means that almost half of the land area of the two States are highly vulnerable to flood. However, the more populated Benue State was found to be more vulnerable as 77.37% of the land areas were found to be highly vulnerable to flood. Therefore, if "highly vulnerable" and "vulnerable" land areas are combined, only 1.88% of the land area of Benue and 33.76% of Taraba State remain either marginally vulnerable or completely not vulnerable.

Table.4 shows that in Benue State, only 4 (2%) out of the 200 communities are located outside the "highly vulnerable" or "vulnerable terrain" while Taraba State has about 25% of its terrain located in either "marginally vulnerable" or "not vulnerable" terrain. About 17.19% of the total 576 communities in the two States are located either in marginally or not vulnerable terrain living 82.81% of the communities in Benue and Taraba states located in either highly vulnerable or not vulnerable places. This has earlier been reported by [18] that most parts of States along River Benue are located in water lodged areas. Comparing the population distribution to flood vulnerable areas in the two states, it was discovered that (Figs.4a&4b) most parts of the highly populated areas especially in Benue State are also the highly vulnerable areas to floods.

The identified communities within 10 and 5 kilometers as well as the 5 and 3kilometers buffer zones along River Benue and the three major tributaries of Rivers Katsina Ala, Donga and Taraba respectively were used to generate the information in Table 5.

Table. 5 (Part-I). Flood Vulnerability Communities in the Buffer Zones of Benue and Taraba States

River Banks/Buffer Zones	*Benue State*		*Taraba State*	
	LGA	*Communities*	*LGA*	*Communities*
River Benue Bank	*Agatu*	Aburu, Epe and Iga	*Gassol*	Gungu, Ndawale and Gimju
			IBI	Chinka, Adi, Ibi, Amar and Gidan Ulu
	Makurdi	Makurdi	*Karim lamido*	Kanawa, Timtim
			Wukari	Mbashari, Mbashara
r/benue 5km buffer	*Agatu*	Ekwakwa, Aila, Akoro and Ogodama	*Gassol*	Sensanne, Wuro Jam, Wuro Shakan, Kishir, Shika, Yola Mbodewa, Sarkin Karofi, Garin Magaji, Garin Baba Galadin
	Gwer East	Yugbu	*IBI*	Gidan Adogo
	Makurdi	Tsuambu and Akaurer	*Karim Lamido*	Gurawa, Shangada and Ngaruwa
			Wukari	Muntscheri and Gabara
R/benue 10km buffer	*Agatu*	Ogule	*Gassol*	Taka Fulani, Garin Atiku, Gunduma and Garin Gada
	Buruku	Kuantasule	*IBI*	Kanyel Isaa and Sarkin Kudu

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River Benue Bank	*Agatu*	Aburu, Epe and Iga	*Gassol*	Gungu, Ndawale and Gimju
	Makurdi	Makurdi	*IBI*	Chinka, Adi, Ibi, Amar and Gidan Ulu
			Karim lamido	Kanawa, Timtim
			Wukari	Mbashari, Mbashara
R/benue 5km buffer	*Agatu*	Ekwakwa, Aila, Akoro and Ogodama	*Gassol*	Sensanne, Wuro Jam, Wuro Shakan, Kishir, Shika, Yola Mbodewa, Sarkin Karofi, Garin Magaji, Garin Baba Galadin
	Gwer east	Yugbu	*IBI*	Gidan Adogo
	Makurdi	Tsuambu and Akaurer	*Karim lamido*	Gurawa, Shangada and Ngaruwa
			Wukari	Muntscheri and Gabara
R/benue 10km buffer	*Agatu*	Ogule	*Gassol*	Taka Fulani, Garin Atiku, Gunduma and Garin Gada
	Buruku	Kuantasule	*IBI*	Kanyel Isaa and Sarkin Kudu
	Gwer east	Tyakaa		
	Logo	Akwana	*Karim Lamido*	Kambari, Garin Kufai and Gidan Usmanu
	Makurdi	Uyabashi, Yougu and Utagudu		
R/Katsina Ala Bank	*Buruku*	Gburuku, Kautasule		
	Katsina ala	Katsina Ala		
R/Donga 3km Buffer			*Gassol*	Gidan el-Haji
R/donga 5km buffer			*Wukari*	Bantagi and Hoyon
R/taraba bank			*Bali*	Bali, Gwar, Mallam Kari and Wurbo
			Gassol	Dempar
R/Taraba 3km Buffer			*Aka*	Garko
			Bali	Garin Maichibi
			Gassol	Sendirdi
R/Taraba 5km Buffer			*Aka*	Jabo and Maisuma
			Gassol	Garin Mallam Baba and Sensanne

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Table 5 revealed that Agatu, Makurdi, Gwer East, Logo and Buruku LGAs in Benue Stateas well as Gassol, Ibi, Karim Lamido, Bali, Wukari and Aka LGAs in Taraba State have many of their communities located within the highly vulnerable buffer zone areas. Therefore, the listed LGAs in both states are bound to be affected by flood than those communities that are not within the buffer zone as already being reported [19].Moreover,the 5km zone is likened to what White (2008) in [20] had classified as prohibitive (where there should be no further development except for essential waterfront facilities) and restrictive where certain development should be permitted, the 10km buffer zones is similar to what he classified as warning zone (where the inhabitants should receive warning of impending floods and regularly reminded of the flood hazards.However, [21]has identified remote sensing and GIS techniques as an excellent tools for monitoring flood vulnerability because it can help to identify the worst affected areas, and provide a guide for better planning.Taking the report of the Agatu flood victims [22] into consideration:

> *"When it became obvious that the waters would not go back, we had to raise the barn (mostly used for food storage) to a reasonable level above the waters. My family stayed on this barn for three days before a boat was brought to move us out of the place. We were evacuated into the primary school camp in September and remained there till November 29, 2012 when we were asked to return to our homes. While we were in the make-shift camp, some people brought a bag of gari and half bag of rice for all members of the 38 villages affected to share, which we rejected. All the hospitals were submerged in water. So we only relied on some local herbal concoctions to treat our sick babies and mothers. Our farms are in total ruin, houses have been destroyed and with no means of livelihood, we watch our sick children go pale praying for the worst not to happen. As you can see, hunger is everywhere. Our children and mothers are sick yet we are neglected.*

The plight of those affected communities in the two States bears similarity with the Agatu situation. Unfortunately, despite the release of money by the Federal Government, the state Governments, and NGOs, and according to [23] the North Central Zone Coordinator of NEMA, Mr. Abdulsalam Abubakar, said that food items supplied to the camps in Benue State that houses over 1,000 families includes over 250 bags of 50 kilogramme rice, 50 bags of 100 kilogramme maize and 50 bags of 100 kilogramme millet. Other items supplied the displaced persons include 50 bags of 100 kilogramme Guinea corn, 30 bags of 50 kilogramme garri and 100 cartons of noodles. The non-food items supplied to the camps include; 1,000 pieces of nylon mats, 200 pieces of foam mattresses, 1,000 pieces of blankets 800 pieces of wrappers and guinea brocade. Others include 100 pieces of children wears, 2,000 pieces of plastic buckets, spoons, plates, cups 50 cartons of detergent 50 cartons of bathing soap, 500 towels and 500 mosquito nets. The NEMA coordinator stressed that the food materials were being distributed to individual families and this is aside other aid being extended to them by NGOs and public spirited individuals." But yet, a bag of garri and half bag of rice could only reach 38 villages affected by the flood in the same Benue State. Hence government and its agencies should in future, device means of equitable distribution of items that are meant for the flood victims to the beneficiaries.

ANALYSIS OF GIS DATABASE FOR DECISION MAKING

[18] reported that GIS has a good database management subsystem that controls the creation of and access to the GIS data. Furthermore, it is capable of providing storage, integration and manipulation of large volumes of data types at various spatial scales and levels of resolution. In addition, GIS Dbase management function can perform spatial and non- spatial queries.

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The ability to manipulate and analyze spatial data through appropriate software, is an important characteristics of GIS and thus a major attribute that distinguishes it from computer mapping system. According to [18] GIS is a tool and that it is based on technological developments that facilitate the processing of all types of digital spatial information and capable of displaying the results cartographically and otherwise. GIS is applicable to all types of real life problems from a very wide range of disciplines that deal with societal organization. In this paper, database that contains the coordinates of the communities, the names, the terrain, LGA, State and buffer zone locations were taken as fields while the individual information of each community on each of the field serve as the records. The generated database was used to demonstrate some GIS operations for decision making. For instance, if one knows the name of a particular community and has interest in knowing all the necessary information of that community, the use of "find" and "identify" tools in ArcGIS can bring out the desired information as displayed in Fig. 6.The use of remotely sensed data and GIS techniques for flood monitoring and management has already been reported by [24] that the information provided by these technologies can significantly improve strategic decision-making processes in floodplains and river corridors worldwide such as demonstrated in Fig.6.

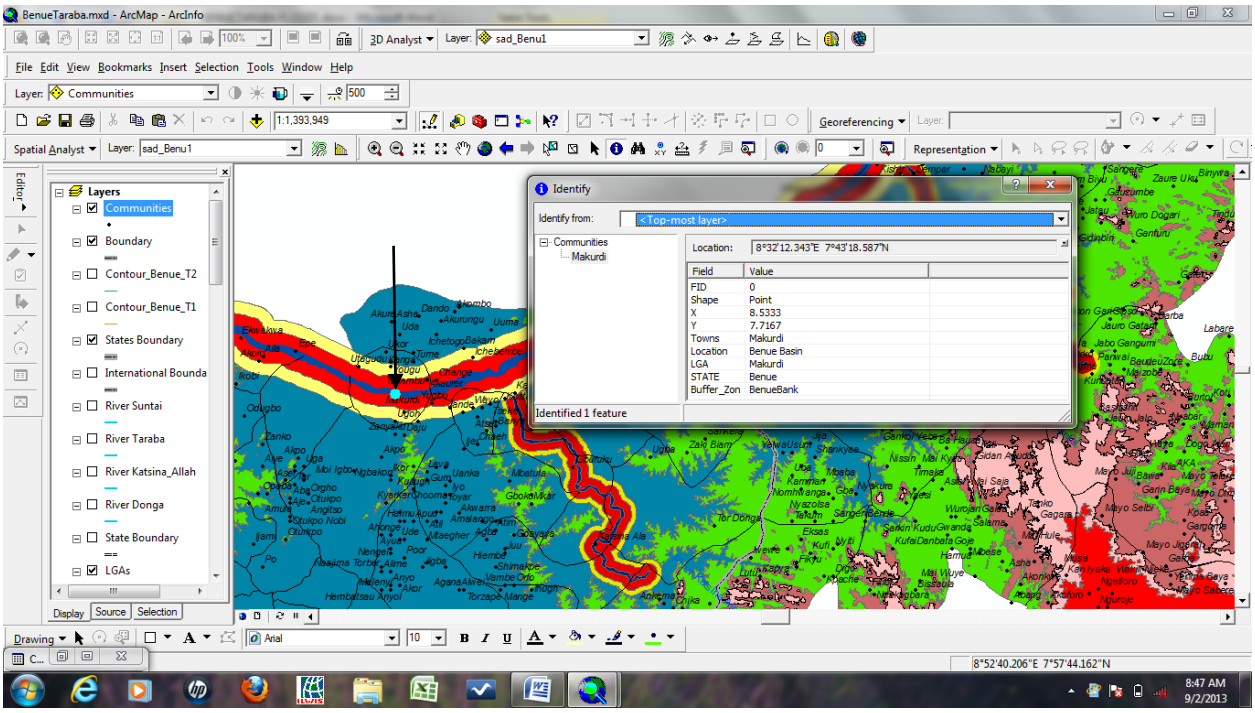

Fig. 6. Spatial Search for Makurdi, Benue State

In Fig. 6, the "find" module was used to find the location of Makurdi in Benue state which was highlighted in light blue colour (arrowed) , while the identify tool was used to bring out the necessary information of Makurdi as follows: Makurdi is located on latitude 7°43'6.564"N (7.7167) and longitude 8°32'0.316"E (8.5333), It is in Benue Basin terrain, situated in Makurdi LGA in Benue State and at the bank of River Benue.

Moreover, specific data can be derived from the data instead of creating a separate data set. For instance, the communities (including their names) that were located at the bank of River Benue only were selected from the entire data through the select by attribute module of ArcGIS as displayed in Fig. 7.

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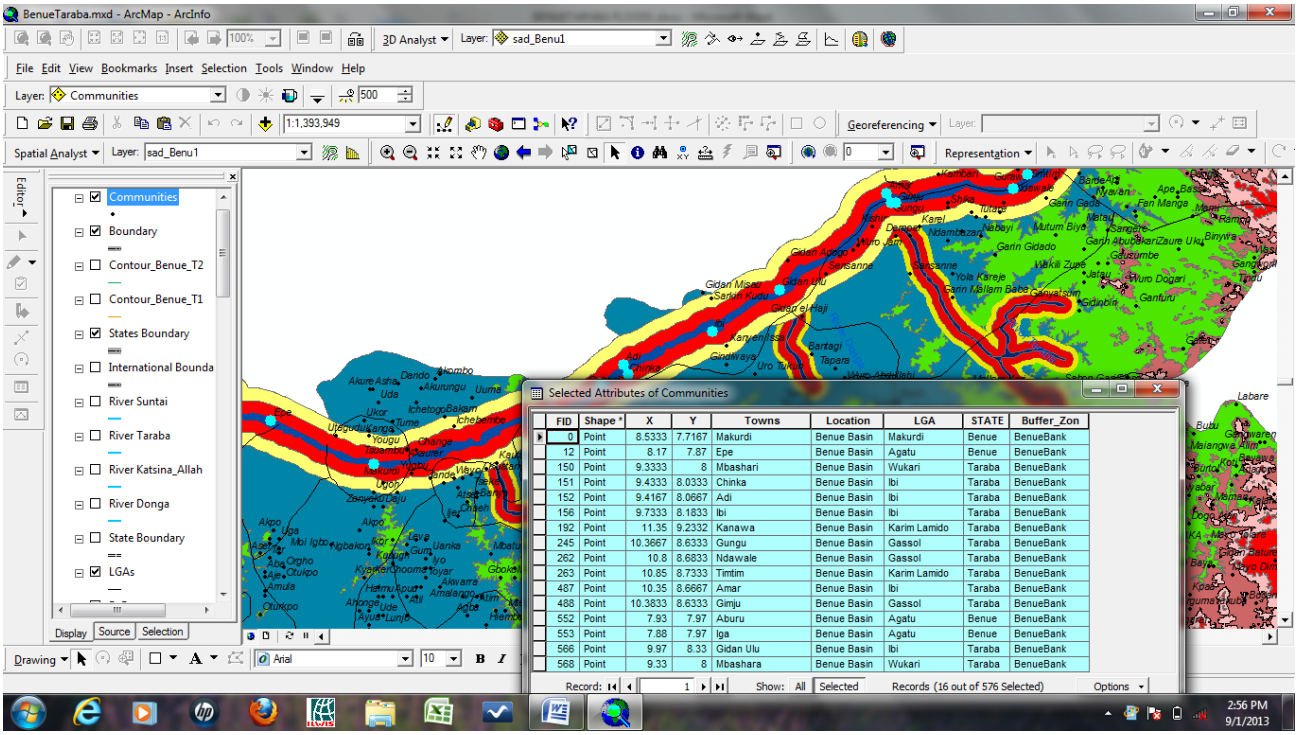

Fig. 7. Selected Communities that are located at the Bank of River Benue

Fig 7 shows the coordinates, names, LGA, State and the terrain locations of all the sixteen communities that are located at the bank of River Benue. Interestingly the actual positions of each of the communities and their names are also highlighted (in light blue dots) on the map alongside the table. These communities as well as others within the buffer zones need urgent relocation or at least urgent flood control strategies. Other complex operations such as extractions of a smaller unit such as State or LGA from the DEM dataset can be performed. In fact, extraction operation was used to extract each LGA from the data for calculating the areas of the DEM classes in each of the LGAs to develop Tables 1 and 2

CONCLUSION

Since the flood incidence of 2012, suggestions have been made by the general public to the government to relocate some of the settlements that are so close to River Benue as well as those that are vulnerable to the floods. The Federal Government through the National Emergency Management Authority (NEMA) is planning resettlement of the affected communities in all the states to saver places. However, the selection of the communities that are supposed to be compensated or relocated needs automated means of data generation and decision making so as to generate a reliable data in a short time and in a cheaper way. One of the major problems confronting decision makers in the developing countries today is lack or inadequate information that can be reliably used for decision making. The dearth of information is a direct effect of no comprehensive, reliable, flexible and up-to-date data from the different sectors of the economy. Hence decision-makers are found to be gambling, which allows parochial factor to be in play in their decision making processes. Most countries especially in the third world countries still depend on records based on filling system that are very difficult to be kept (space problem), not easy to assess, difficult to maintain or up-date and most especially, the loss of a single file is the loss of the total information that contained in the file forever. All these problems and many more result to wrong decision making or difficulty in making decision by the managers on assessment, monitoring and evaluation of both natural and cultural phenomena. The edge of GIS over all other DBMSs is the ability to

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integrate both spatial and attribute data because GIS is the only technology that has the capability of automatic data generation and decision making ability on spatially and non-spatially referenced features. The capability of GIS techniques for identification and delineation of the land and the communities' vulnerability to floods in Benue and Taraba States has been demonstrated in this paper. It has also been proved that remotely sensed data and GIS technique has the capability of data generation and analysis with minimal human influence and yet with accurate, reliable, flexible and cheaper output. Remote Sensing and GIS techniques for environmental monitoring may be late in Nigeria, but it has come to stay. The Geographers have to push it up, popularize and enforce it for proper monitoring, management and for major decisions making in environmental management.

RECOMMENDATIONS

The Nigerian governments should honour the 1980 agreement between the country and Cameroon by revisiting the construction of Dasin Hausa Dam in Fufore LGA of Adamawa state to curtail the gushing water released upstream from Lagdo Dam and curb annual flooding and attendant destruction of property and loss of lives. Dredging of River Benue should also be a priority now if we need to control floods along River Benue. There should also be proper monitoring of donated items to the flood victims to ensure that the items reach the actual people. All the government, private and non-governmental organizations that are involved in flood monitoring and management should imbibe the use of GIS for data generation and decision making so as to minimize the problems of human interventions in major decision makings. This entails that the staff of such organizations should be well trained in the use of GIS for data generation and decision making. Finally all the villages that are located at the banks and within the buffer zones of River Benue and its major tributaries and which are prone to floods should be urgently relocated while enacting legislation that would ban new development in floodplains of the major towns such as Makurdi and Katsina Ala.

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