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Assessment of the Environmental Effects of Flooding in Makurdi Area of Benue State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author MI wrote the protocol, managed the literature searches, reviewed the manuscript and supervised the study. Author AJK designed the study, carried out the field survey, analysed the results and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

Makurdi town of northcentral Nigeria is drained by River Benue, River Katsina-Ala and the smaller tributaries of the Cross River. The people of the town depend on the land and water resources for sustenance. However, a large portion of the area is flooded annually leading to loss of life and destruction of properties. This study assessed the environmental effects of flooding in the area with a view to identify the causes of flood and areas that are vulnerable to flood, for proper flood disaster preparation and mitigation in the future. The study used questionnaire survey to acquire primary data. The questionnaires were administered randomly to the residents and purposively to government/environment officials in the area. The information obtained through the questionnaire included causes and severity of flood in the area, environmental effects and control measures of flood. In addition, secondary data was obtained from the Ministry of Water Resources and Environment, population report from the National Population Commission, report of registered voters in the study area from the State Independent Electoral Commission. Findings revealed that although physical factors influence flooding in the town, anthropogenic factors are also very influential in the severity of flood in the area. The environmental effects of flood include destruction of houses and displacement of people, disruption of livelihood of the people in the flood prone

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areas, pollution of domestic water supply causing health problems to the people in the area.This paper recommended strategies to check flooding in Makurdi, which requires a combination of engineering and spatial planning measures; as well as a synergy among all stakeholders for proper flood management in the area.

Keywords: Flood; flood mitigation; environmental effects; Nigeria.

1. INTRODUCTION

Flood is a natural hazard like drought and desertification which occurs as an extreme hydrological event [1]. Similarly, flood has been defined as a large volume of water which arrives at and occupies the stream channel and its flood plain at a time too short to prevent damage to economic activities including settlements [2]. The accumulation of excessive quantity of water in an area without flowing away easily is referred to as flooding. According to [3], flood is said to occur when significant amount of water stands at or inundates in a usually dry area and is unwanted for a long period of time. It involves the covering of dry land, settlements, crops, and infrastructure, by large volume of water which leads to the destruction of lives and properties.

Floods are the most common natural disasters that affect societies globally [4]. It is estimated that more than one-third of the world's land area is flood prone affecting about 82 percent of the world's population. Globally, about 196 million people in more than 90 countries are exposed to catastrophic flooding, and that some 170,000 deaths were associated with flood between 1980 and 2000 [5]. These figures show that flooding is of a major concern in many regions of the world. According to [6], floods are the most devastating natural disasters, claiming more lives and causing damage to properties than any other natural phenomena.

In Nigeria, from mid October 2012, 26 of the 36 states in the country experienced severe floods. That level of rainfall and flooding has been unprecedent and resulting to damage of property, farmlands and infrastructure and the number of death and injuries are considered as the highest in recorded history of the country [7]. In contemporary time, flooding has become a common feature and part of life in Nigeria, not only in the low lying coastal areas, but also in the hinterlands [8]. Floods are caused by three factors namely: anthropogenic, climatic and coastal factors. Likewise, flooding is attributed to the reduction of soil infiltration capacity as consequence of anthropogenic factors, thereby causing disequilibrium between the precipitated volume in an area and the run off discharge process [9].

Samarasinghea et al. [10] used GIS and remote sensing technology for flood risk analysis in Kalu-Ganga river of Sri Lanka. Their study integrated satellite, meteorological, field survey and census data for the hazard and vulnerability analyses. Based on these, the flood risk analysis was carried out to assess the population vulnerability and physical vulnerability of the lowest administrative division subjected to floods in the area. Moreover, [11] employed GIS to map the flood zones in the plain and coastal areas of Thanjavur district on the East coast of Tamil Nadu. The study also integrated meteorological data to assess damages on agriculture, settlement, infrastructure, as well as the biological organisms in the area. Similarly, [12] utilized GIS for flood hazard zonation mapping in Papanasam Taluk of Thanjavur District, India. They also identified causes of flood which include changes in landuse and waterways; urbanization, concretization of streets and constriction of natural river channels. They also found that the effect of the flood disaster on agriculture and houses is very severe. Furthermore, [13] discovered that Asa River catchment has a very high precipitation and sediment yields based on yearly analysis for a period of seven years. They also found that the high amount of sediment yield is directly related to the amount, duration and intensity of rainfall, as well as stream discharge, which often increases the river water level and finally causes flooding in the basin area in Ilorin City of Nigeria.

Makurdi town of northcentral Nigeria is situated on a land that is generally low lying and drained in the north and east by River Benue and River Katsina-Ala respectively; and in the south by the smaller tributaries of the Cross River. The people of the state depend on the land and water resources for sustenance. However, due to the general low relief of the town, sizeable portions of the area is waterlogged and flooded during heavy rainstorm [14]. The Ministry of Water Resources and Environment has reported a

situation of annual flood events in the town, leading to loss of life and destruction of properties worth millions of dollars. It is reported that in 1996, 2000, 2005, 2007 and 2008, flooding has occurred in different parts of Makurdi town [15]. Ayado [16] also reported that over 300 houses in the town were flooded as a result of heavy downpour which rendered many homeless, and also halted socioeconomic activities in the area. In addition, several flora and fauna species were destroyed by the flood. Observation and field survey revealed that flooding is one of the environmental hazards that have not received adequate attention in Benue State. In particular, no major flood control project can be observed in Makurdi town in spite of constant floods in the area. Seasonal floods especially in Wurukum, Fiidi and Wadata areas of the town adversely affect property and commercial activities. This is compounded by rapid expansion of the town without adequate planning efforts to mitigate the situation. In addition, the release of water from Lagdo Dam in Cameroun, during the 2012 rainy season caused the most hazardous flooding ever recorded in the town and its environs. Also, the likely event of burst of Lake Nyos up Cameroun Mountains whose drainage pathway runs through Katsina-Ala and Makurdi flood plain might complicate the problem of flooding if the right measures are not taken to prevent the hazard. There is however the need to carry out a detailed study to assess the environmental effects of flooding in the area with a view to identify areas that are vulnerable to flood for proper flood disaster preparation and mitigation in the future. The study is also aimed at recommending possible solutions to guide policy makers and stakeholders in urban and regional development of the town.

1.1 The Study Area

Makurdi is found in Benue State of northcentral Nigeria as shown in Fig. 1. The town is located on latitude $7^{o}38'$N to $7^{o}50'$N and longitude $8^{o}24'$E to $8^{o}40'$E, and it is one of the local government areas of Benue State as shown in Fig. 2. The area can be described as the gate way of the state to both the northern and southern Nigeria. The Makurdi rail bridge provides the only link between the northern and the eastern parts of Nigeria. The town covers an area of 800 km^2. It started as a small river port in 1920s and gained prominence in 1927 when it became the headquarters of Benue Province. The town became the capital of Benue State and today, doubles as the headquarters of Makurdi Local Government Area. It is divided by River Benue into north and south banks, which are connected by the railway bridge and the new dual carriage way commissioned in 1978.

Makurdi Local Government Area is politically divided into 11 council wards which include: Ankpa-Wadata, Central South Mission, Modern Market, Clerk Market, Wayomaya, Fiidi, Mbalaagh, North Bank I, North Bank II, Agan and Bar Wards. The area falls within the heart land of Guinea Savannah Zone of Nigeria and it is Balkanized by rivers, streams, hills, valleys and swampy areas. The land is expansively flat, while the soil is swampy and muddy clay. The town is divided by River Benue which causes flooding at the south bank and erosion at the North bank of the local government areas because the Northern part is on higher ground. The area falls within the AW climates (Tropical wet and dry) according to Koppen's Classification. The temperature of the area is typical of the entire middle belt region of Nigeria. It is at its lowest during the peak months of Harmattan (January and December). This trend shows that an average mean temperature fluctuates between 17.5°c – 18.5°c in December and January, and its maximum between 28°C in July and 37°C in March and April. The mean temperature range is 32°C. Dominant winds are NE-SW direction during the dry season (December). The wet season lasts for seven months. It starts from April when there is northward movement of inter-tropical discontinuity (ITD) and ends in October when ITD moves to the southern parts of Nigeria. The dry season, with low relative humidity lasts between November and March. The annual rainfall in the area ranges from 1200 mm to 1300 mm.

The area has a population of 297,398 comprising of 157,295 males and 140,103 females in 2006; and projected to about 500,000 people in 2013. The dominant economic activity in the state is farming, both on the uplands as well as low-lying swamp lands along the river valleys [17]. Crops grown in the area include grains, tubers and fruits. The Local Government Area has established markets to promote trade and commerce and in turn, earn revenue to execute its projects. Private airlines provide service between Makurdi and the rest of the country including banks services. The beautiful beaches of River Benue can be exploited to provide good site for relaxation and tourist opportunities for boating, angling and swimming. Mineral deposit such as glass sand, Barites and clay are found in

the area. Also, the availability of some basic infrastructure such as good road network, telecommunication services, electricity and water supply makes investment in this area attractive and conducive.

Fig. 1. Map of Nigeria showing Benue State (2013)

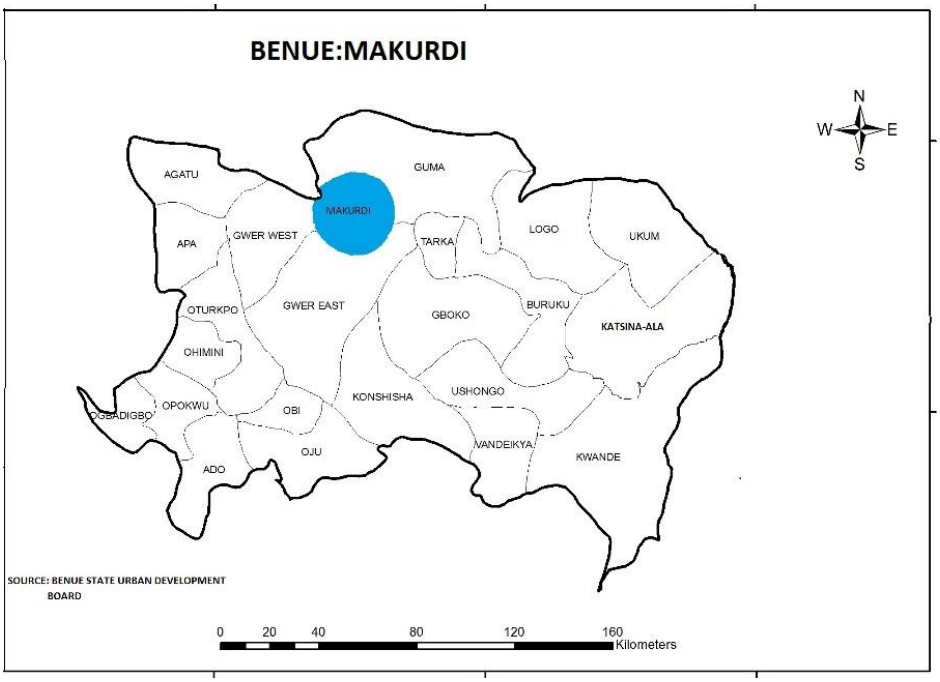


Fig. 2. Map of Benue State showing Makurdi Local Government Area (2013)

1.2 Scope of the Study

This study covers the following wards: Ankpa-Wadata, Wayomayo, Bar, and Fiidi in Makurdi area of Benue State as shown in Fig. 3. The study was delimited to the above mentioned areas due to the fact that Ankpa-Wadata and Wayomayo wards are located along the banks of River Benue; while Bar and Fiidi wards are areas with extensive watershed and they experience yearly flooding. Moreover, interactions with elderly people, middle aged, and government officials during the reconnaissance survey informed the choice of these 4 wards. Out of eleven council wards that make up Makurdi LGA, the four wards selected are considered as the most vulnerable and the worst hit by floods in the area. Fiidi and Bar wards are in rural areas, while Wayomayo and Ankpa-Wadata are in urban areas south of River Benue as shown in Fig. 4.

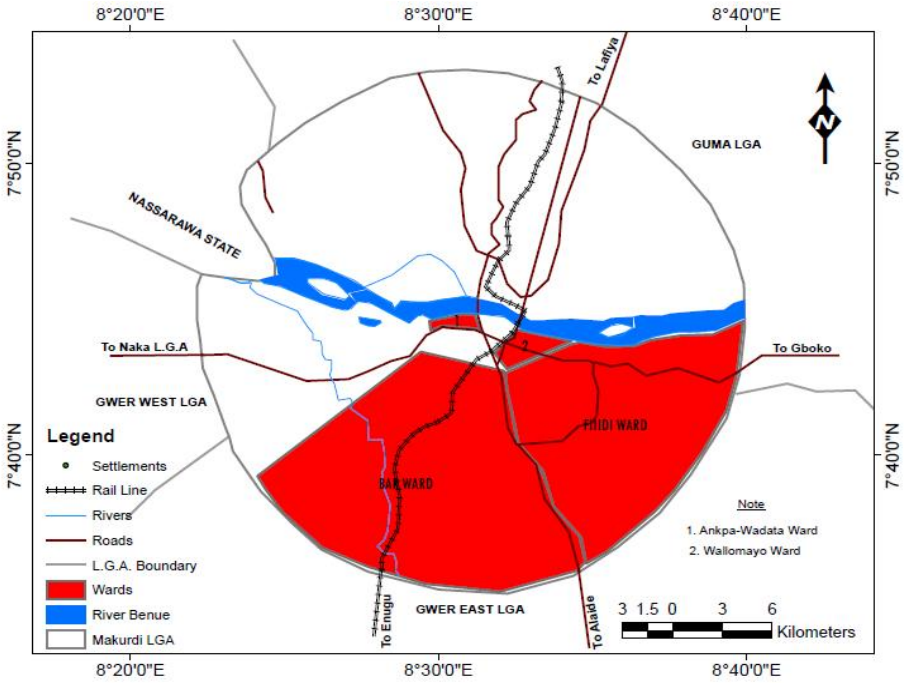
2. MATERIALS AND METHODS

2.1 Types and Sources of Data

The study used both primary and secondary data. The main primary data was acquired through questionnaire survey. The questionnaires were administered to the residents and government/environment officials of the study area. A total of 300 questionnaires were administered to obtain the primary data. This comprises of 260 questionnaires administered to residents and 40 to government officials. The information obtained through the questionnaire included causes, vulnerability and severity of flood in the area, environmental effects and control measures of flood, as well as flood mitigation strategies in the area. A reconnaissance survey was first carried out to determine the sampling frame and appropriate sampling techniques for the area of study. Other sources of secondary data used include papers from the Ministry of Water Resources and Environment, population report from the National Population Commission, report of registered voters in the study area from the State Independent Electoral Commission.

2.2 Sampling Frame and Sampling Technique

Makurdi local government area had a population of 297,398 according to the 2006 population and housing census of Nigeria. The population is therefore projected to about 500,000 in 2013 [19]. The record of the population distribution



SOURCE; Modified from Administrative Map of Benue State.

Fig. 3. Map of Makurdi showing Bar, Fiidi, Wallomayo and Akpa-Wadata Wards

Fig. 4. Satellite image of Makurdi town
Source: Google Earth (2013) [18]

of the study area was unavailable at the time of the research, and therefore, voters' registration record was used. The number of registered voters in each council ward during the 2011 voters' registration was used as the basis for the distribution of the questionnaires as shown in Table 1. The questionnaires were administered proportionally to the 4 council wards in Makurdi. Random sampling method was used because it gives the members of the population an equal chance of being selected.

Table 1. Distribution of Questionnaires among Council Wards in Makurdi

Wards	No. of registered voters	No. of questionnaires
Ankpa-Wadata	23,556	62
Fiidi	37,800	69
Wailomayo	37,740	69
Bar	17,855	60

But the government officials' questionnaires were distributed uniformly as shown in Table 2. This is due to the fact that each ministry or agency has a stake in flood hazard management in the state. In this case, purposive sampling was used in the administration of the questionnaire.

Table 2. Distribution of questionnaires to Government officials

Government ministries/agencies	No. of questionnaires
Ministry of Water Resources and Environment Makurdi	8
Ministry of Agriculture and Natural Resource Makurdi	8
Ministry of Works and Transport Makurdi	8
Urban Development Board (UDB)	8
State Emergency Management Agency	8

3. RESULTS AND DISCUSSION

3.1 Socioeconomic Characteristics of the Respondents

The socioeconomic characteristic of the respondents is presented in Table 3. The table indicates that about 57% of the respondents were males and about 43% were females. The age distribution of the respondents showed that about 47% of them fall in the category of 35-55 years and have had a long time experience of flooding in the area. While those of 55-65 years and above represent 17%. Whereas, those between 15-25 years represent 15%, and those of 25-35 years represent 21%. Table 3 also

indicates that the literacy level of the respondents is high with more than 50% of them having higher educational qualification. It is observed that the respondents comprise of farmers, traders, politicians, retired public office holders and students. But, findings showed that farming and trading are the major economic activities of the people in the area. However, the environmental conditions are unfavorable for these socio-economic activities during flooding season in the area.

The socio-economic characteristics of the respondents suggest that they are well experienced and have knowledge of the environmental conditions of the area.

3.2 Flooding in Makurdi

3.2.1 Causes of flood in Makurdi

There are many anthropogenic factors causing flood. About one-fourth of the respondents agreed that flood events are caused by climate change resulting to heavy rainfall (see Table 4). Close to 19% of the respondents indicate that flooding is caused by absence of drainage channels in the area. This is followed by poor level of public awareness campaign on flood hazards based on the views of 14% of the respondents. About 13% and another 12% of the respondents believe respectively that flooding is caused by high percentage of defective drainages, and blockage of flood paths with litter and sediment deposits. Occupation of floodplain with human settlement and economic activities is another significant cause of flood in the area. Other factors include urbanization and absence of vegetal cover in the environment. This is compounded by the general low relief of the town thereby making it waterlogged and vulnerable to flood during heavy downpour [14].

3.2.2 Flood prone areas in Makurdi

Vulnerability to flood is a function of physical, climatic and human factors. According to the respondents, some socio-economic and anthropogenic activities have been found to intensify flood within these areas; in addition to the general low relief and nature of drainage network in the area. The respondents were asked to classify the wards based on the degree of vulnerability. They classified Ankpa-Wadata as the most vulnerable, Fiidi as more vulnerable, while Bar and Wayomayo wards as vulnerable.

3.2.3 Severity of flood in the area of study

The intensity of flood hazard ranges from severe to moderate, and mild. About 45% of the respondents classified the flood in the area as severe, 30% see it as moderate; while about 25% of the respondents view it as mild.

Table 3. Personal data of the respondent in the study areas

S/No			Percentage of respondents
1.	Sex	Male	56.6
		Female	43.4
		Total	**100**
2.	Age	15-25 years	15.1
		25-35 years	20.8
		35-45 years	22.6
		45-55 years	24.5
		55-65 above	17.0
		Total	**100**
3.	Education	Primary Certificate	26.4
		SSCE	22.6
		NCE/ND/HSC	31.2
		B.sc & above	20.8
		Total	**100**
4.	Occupation	Students	17.0
		Farmers	24.5
		Traders	22.6
		Politicians	17.0
		Retired public office holders (pensioner)	18.9
		Total	**100**

Table 4. Causes of flood (Respondents and Government officials in the study area)

S/No	Causes of flood	% of Responses
a.	Climate change resulting to heavy rainfall	24.7
b.	Absence of drainage channel	18.8
c.	High level of streets with defective drainages	12.9
d.	Blockage of flood path with litter and sediment deposits	10.6
e.	Occupation of flood plain with human settlement and economic activities	11.8
f.	Poor level of public awareness campaign on flood hazards	14.2
g.	Increased impermeability due to urbanization	3.5
h.	Absence of vegetal cover in the environment	3.5
	Total	**100**

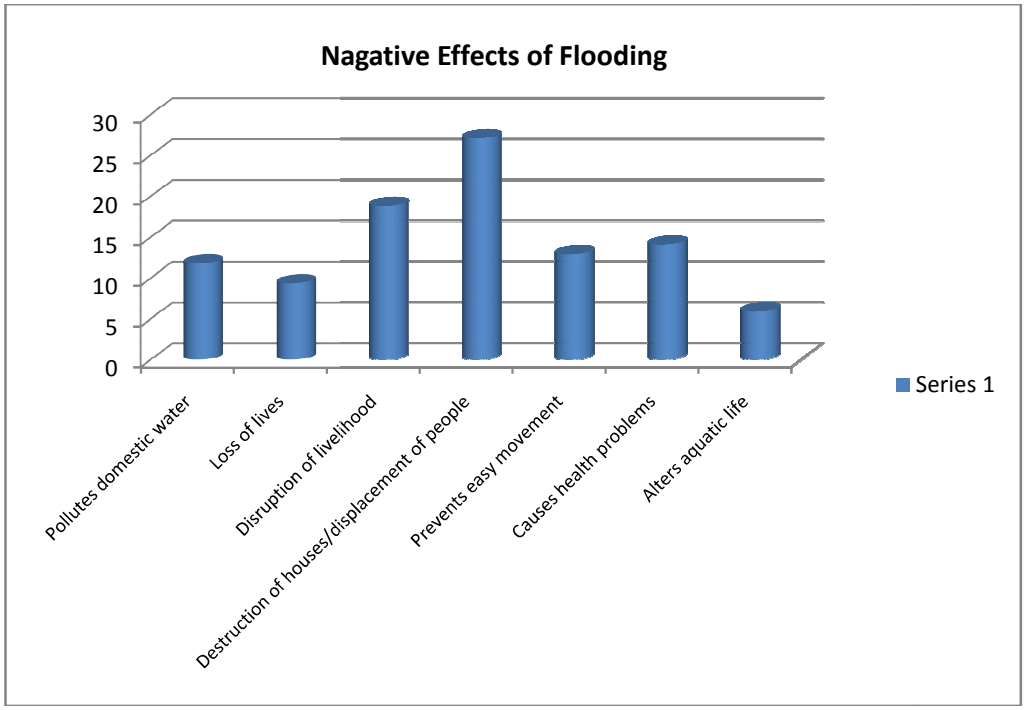


Fig. 5. Environmental effects of flooding in Makurdi

3.3 Environmental Effects of Flooding in Makurdi

In view of the fact that majority of the people classified flooding in the area as severe; the environmental effects is also severe. The environmental effects, as presented in Fig. 5, include destruction of houses and displacement of people in the affected areas, disruption of livelihood of the people in the flood prone areas, obstruction of movement and flow of people and goods, as well as pollution of domestic water supply causing health problems to the people in the area. Flooding also alters aquatic life and brings about loss of life and property in the area.

3.4 Flood Management in Makurdi

A look at Table 5 indicates that a combination of engineering and spatial planning measures is required in addressing the challenges of flooding as suggested by 70% of the respondents. This is particularly important because of the present un-coordinated spatial planning and engineering measures taken by the policy makers as reported by BESEPA [20]. Other control measures as outlined in Table 5 are also important.

A look at Table 6 suggests that there must be a synergy among all the relevant stake holders in addressing continuous flooding in the area.

Table 5. Flood control measures

S/No	Flood control measures	% of Responses
a.	Engineering measures like embankment/levees, flood control dams/reservoirs, drainage channels, river dredging, channel modification, detention pond etc	17.6
b.	Spatial planning measures like Government policy Behavioral change Community participation Environmental control measures	11.8
c.	Combination of engineering and spatial planning measures	70.5
	Total	**100**

Table 6. The role of stakeholders (government officials) in flood management in the area

S/No	Stakeholders
a.	Ministry of water resource and environment Makurdi: provide policy framework on environmental related issues; award contract on ecological projects; carry out Environmental Impact Assessment (EIA).
b.	Ministry of agriculture and natural resources: provide policy frame work on agricultural matters/farm inputs to farmers.
c.	Ministry of works and transport: provide policy guidelines on structural works and maintain same.
d.	Urban Development Board: Control urban planning/development; demolish structures on floodplains and those without planning permit/structures not observing building code/standard.
e.	State Emergency Management Agency (SEMA); provide relief materials in disaster management especially on flood, fire, communal crises, etc.

3.5 Flood Mitigation Strategies for Makurdi Town

Flooding events and impacts have become one of the major issues of concern to the people and the government of Benue State. In view of this, the State Government created Benue State Environmental Protecting Agency (BESEPA) in 1986 now Benue State Sanitation Authority (BENSESA), Benue State Water Board (BENSWB) in 1992, Benue Rural Water Sanitation Agency (BERWASSA) in 1996. In June 1999, the Benue State Government established the Ministry of Water Resources and Environment (MWRE) to give greater attention to the provision of portable water to the growing population of the State and also address the issues of ecological and environmental problems by providing the necessary policy framework. Another spirited effort being put up by the state Government toward containing flood hazards is the construction of new drainage channels along inland streets in Makurdi town. In this case, where drainages have been absent, new ones are constructed, and where existing ones are damaged or blocked they are being rehabilitated.

In addition, since the early 1990s, complaints by traders and residents of Wurukum market and its environs about continuous damage of property by floods led to the relocation of Wurukum market from it former location close to the new Bridge to its present location. Besides, adjustment in building arrangements have also been made at the Wadata rice mill which has been losing commercial items due to River Benue over spilling its banks. It is hoped that the adjustment made will be sufficient enough to forestall further damage of property.

Recently, contracts have been awarded for the following projects in Makurdi:

- The construction of roads covering about 66.91km and other major towns in the state.
- Construction of 187.34km of roadside drainages and channelization of 4km length of some streams to check flood and gully erosion.
- Construction of Ohimini Bridge in Ohimini Local Government Area.
- The gully erosion project at Eric Street in North Bank Makurdi was achieved.

- Construction of 2000 meter long Lobi stream re-informant concrete drainage channel as well as Benue River Ultra modern Beach Park contract awarded. It is hoped that the construction of drainage channels in Makurdi town would cover the town entirely.

The above measures are aimed at mitigating the effects of flooding in Makurdi town.

Moreover, residents have avoided marshy areas for a long time, but with the increase in population in Makurdi town, the demand for land has overridden the importance to avoid these areas, also known as watershed areas. The importance of these marshy areas is their ability to soak up and hold large amount of water from heavy down pours due to their spongy characteristic nature. However, these areas are beginning to disappear as they are being given out for the construction of buildings for different purposes. Typical examples of marshy areas that have been sand filled and built up exist in the industrial layout, Idye and Wurukum areas of the town.

4. CONCLUSION

Flooding phenomenon is one of the environmental hazards that have not received adequate attention in Benue state until recently. In Makurdi town, no major flood control project can be observed, however some flood mitigating strategies of lesser significance are ongoing. The major flood risk control strategy according to Digby [21] includes embankments, compartments, river dredging and flood forecasting. The most important measure being taken so far is the construction of a large drainage channel to contain stream water that passes through Makurdi town on wards to the River Benue. Typical examples are the drainage channels recently constructed to channelize the Urudu and Idye streams with a confluence around the Wurukum roundabout into River Benue. However, more effort is required by all stakeholders to address flooding in the area.

5. RECOMMENDATIONS

In view of the various environmental effects of flooding in the study area, the following recommendations were proposed:

- The government and the people should recognize the need and importance of environmental impact assessment (E.I.A). This would help to indicate how any project would affect the environment;
- in order to check flooding in the area, a combination of engineering and spatial planning measures is required;
- there should be a synergy among ministeries/agencies as well as NGO's in flood disaster management in the area;
- there is also the need to harmonize the operations of all the relevant agencies for greater efficiency;
- flood disaster management should be handed by one agency to ensure efficiency in service delivery. Alternatively, central coordinating machinery should be put in place to oversee the implementation and management of flood prone areas;
- maintenance of drainage system should be put in place in both rural and urban areas;
- since inadequate financing by government is one of the major hindrances to flood management as observed by [20], alternative sources of financing flood management should be sought;
- for good governance and fair play, politics should not be allowed to becloud government's good judgment in mitigating flood menace. All sections of both urban and rural areas should be treated equally on need basis;
- public awareness campaign should be intensified to educate the people on the danger associated with living on flood prone areas and management of drainage channels;
- flood forecasting and early warning system should be provided in order to help in warning people of an impending flood well ahead of time;
- the Federal Ministry of Environment should control the release of water from Ladgo Dam. The agreement between Nigeria and Cameroun on the release of water from Ladgo Dam should be strictly adhered to in order to minimize loses to Makurdi and beyond.

6. SUGGESTION FOR FURTHER STUDY

Scientific studies of the impact of physical features such as topography, river discharge, drainage system, rainfall intensity and its return period on flooding in Nigerian cities are inevitable. In addition, studies on flood disaster management are required in the area.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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