Managing Flood Disasters in Nigerian Cities: Issues and Strategies towards Meeting the Challenges in the Modern World. (A Case Study of Owerri Metropolis Imo State Nigeria)

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Keywords: Flood Disaster, Mitigation, Awareness, GIS, Owerri Metropolis

SUMMARY

Floods are among the most devastating natural disasters in the world, claiming more lives and causing more property damage than anyone would imagine. 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. At least 20 per cent of the population is at risk from one form of flooding or another. More often, sovereign states and national governments adopt remedial reaction, that is, a post-disaster reaction where relief materials are supplied to the affected victims. The paper emphasizes on prevention/mitigation than post-disaster measure. Causes of flooding in Nigeria and by extension Owerri the capital city of Imo State, Nigeria are discussed. The approach in this study also attempt to describe the application of remote sensing and GIS in an environmental issue such as flooding in a developing country. A database was created using both cartographic and attributes data collected from these and other sources. Spatial analyses were carried out using ArcGIS Desktop 10.1 and its Arc Hydro extension. In Nigeria, flood disaster has been perilous to people, communities and institutions. Between July and October 2012, flooding in Nigeria pushed rivers over their banks and submerged hundreds of thousands of acres of farmlands. By mid-October, the floods had forced 1.3 million people from their homes and claimed 431 lives, according to Nigeria's National Emergency Management Agency (NEMA) Oguta LGA and Ohaji/Ebgema LGA in Imo State were among the areas that were affected by the said floods. It shattered both the built-environment and the undeveloped areas. One prominent feature about flood is that it does not discriminate, but marginalizes whosoever refuses to prepare for its occurrence. The results obtained in this study implicated that dumpsites within the river channel as well as structural development within the floodplain and high amount of rainfall are the major causes of inundation in the city, especially, in the wet season. The study concluded that the use of geoinformation technology, if well implemented, would provide adequate decision support information to planners and decision makers. Recommendations are made toward flood disaster management in Owerri metropolis.

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1.0 INTRODUCTION

There is no doubt that the world is under serious threat from the environment: From China to Mexico, Indonesia, United States of America, United Kingdom and Nigeria, analysts have argued that the environment was only responding to the abuses heaped on it by man's activities (Christopherson, 1997 p.423). The concern is that the world may be getting close to extinction through natural disasters unless immediate actions are taken; and the signs are just too apparent to be ignored (Christopherson, 1997 and Oyegbile, 2008). Specifically, in May 2008, floods triggered by torrential rains killed dozens of people across China, while thousands of others were victims of landslides caused by the downpours. China is not alone. In the United States of America, the Mississippi River caused damages put at several millions of dollars when it over flew its banks, flooding some cities, towns, farmlands and major industrial installations over a distance of about 250km and ravaging Iowa before it heaped downstream. Apart from the Mississippi-Missouri River Systems of 1993, and that of 1995, world records of flood have it that recently severe floods were experienced in Norway, China, Bangladesh, Ghana, The Netherlands and South Florida, (Christopherson, 1997). In February 2000, a cyclone swept across Mozambique which left some 950,000 people homeless as floods devastated huge areas of low-laying lands. Roads, homes, bridges and crops were destroyed. Journalist, Greg Barrow, as quoted by Kerski and Ross 2000, flew over the striking area and filed this report for BBC, London, United Kingdom.

It is over 14 million Indians that were victims to the flood of August 2007 in Sathya Sai Baba, a major human settlement, of that region. The nation's government could not organize any emergency relief immediately. Rather, it spent over $1.6 billion on Hawk Jets. Hunger and diseases stalked the India children and the poor in the region. In a similar writing, Wright (2011) reports the devastating flood of Lahore, Pakistan in July 2011 where transportation systems were halted and businesses were closed down for days.

With increase in constructions along rivers and concentration of population around submergible areas, the flood-induced damages are increasing. The complete flood protection with installation of great flood control structures like flood dams are not justified due to its high cost. It is not environmentally, socially and economically an optimum idea either. For this reason, the flood forecasting system can have a considerable role in flood management through logical utilization of weir gates and dam reservoirs. In this direction, different systems have been innovated in different countries around the world (Williams, 1994; Xiaoliu, 2000).

Preventing river floods is important to prevent probable loss of life and to reduce damage to sites of high economic importance. Floods occur when soil becomes saturated and its infiltration

capacity is zero; runoffs cannot be contained in stream channels, natural ponds and constructed reservoirs, and the land surface becomes submerged, sweeping away all its content. Periodic floods, resulting during heavy rains, occur naturally on many rivers, forming an area known as the flood plain. The river floods often cause the rivers to overflow their banks, sometimes with a velocity and enormously destructive surge. History has also recorded that flood disaster is not recent, and its destruction are sometimes enormous. For instance, the Johnston flood of May 31, 1889 in Johnston, Pennsylvania, USA left about two third of Johnstown submerged under water, its rail and telegraph lines washed out.

In Nigeria, apart from the Ogunpa Stream in Ibadan that killed several people and completely grounded socio-economic activities in 1980. In August 2008, the residents of Makurdi were thrown out of their residences and their farmlands left impoverished after two days of heavy down pour of rainfall. It was described as very disastrous, (Taiwo, 2008).

Occurrences of floods in the cities and towns of Nigeria in recent times have been a great concern and challenge to the people, Governments and researchers, (Akintola, 1982, Aderogba, 2012 and Aderogba et al., 2012). There have been journalistic and non-quantitative reports of flood for several parts of Nigeria. But they are superficial and lack directions for professionals and policy makers (Aderogba, 2011). The works of Adeaga (2008), Oyegbile (2008) and Oyebande (1990 and 2005) are paraphrasing, disjointed or sectional. The flood events in most southern cities in Nigeria are so prominent that some inhabitants in many of these settlements have often described it as 'an act of God'. However, flood events in many capital cities in Nigeria, are mostly due to the poor consciousness of the inhabitants on environmental information, inadequate (or sometimes absolute lack) of spatial information on the flood prone areas, waste dump and construction of buildings (both commercial and residential, even public offices) on river channel without adequate measure for water flow.

On the other hand, floods are natural returning hydrological phenomena that affect human lives. Hazards of flash floods, chiefly in urban regions, are vital from both human settlement and economical perspectives. Recently, the estimation of flood hazardous impacts and the development of GIS-based flood inundation maps have been considered a crucial demand. (Khalid A. AL-GHAMDI *et al.,* 2012).

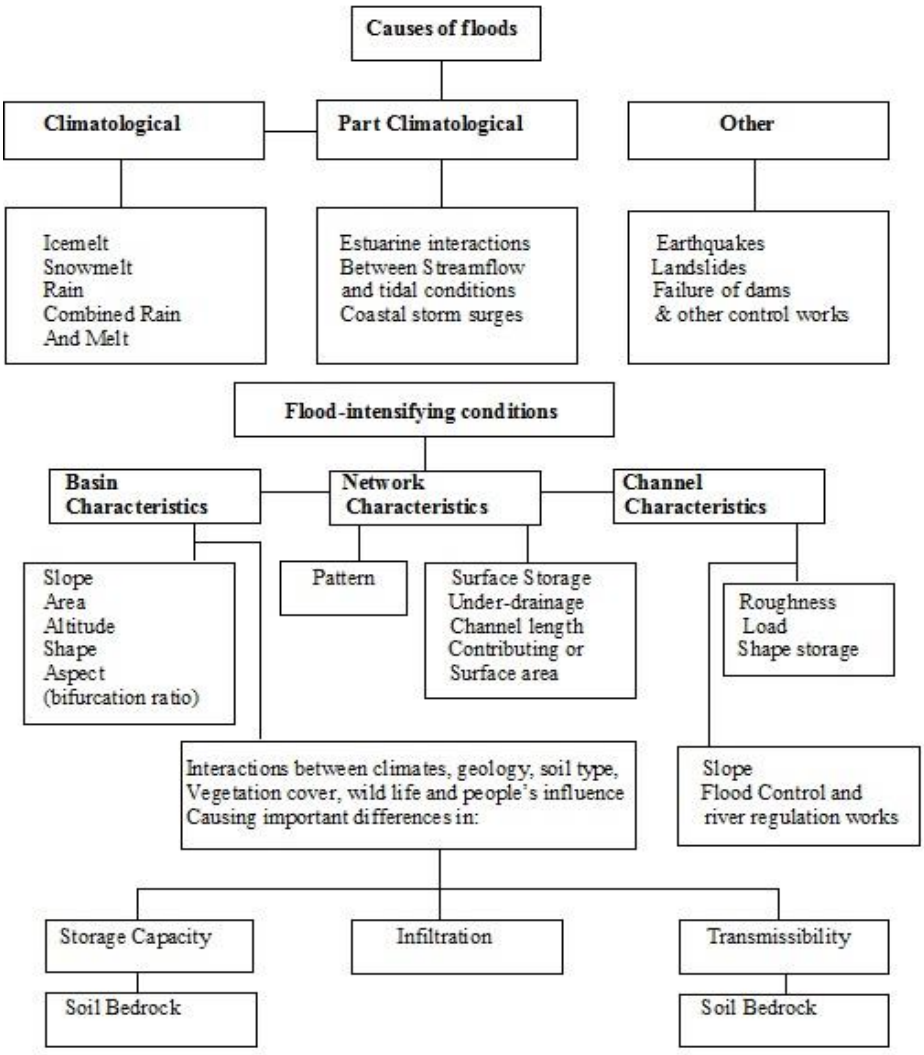

Fig. 1. The causes of floods and flood-intensifying conditions
Sources: Pickering and Owen (1995) in M.O. Ibitoye (2006)

A Review of some flood disaster cases in Nigeria

Year	Location	Cause	Estimated Damages	Source
2001	Abia, Adamawa, Akwa-Ibom States	Rainfall	5000 people affected	Famous Obebi 2012
2001	Zamfara State	Rainfall	12,300 persons displaced	
2005	Taraba State	Rainfall	50,000 people displaced	
2008	Imo State (Awo-idemili)	Rainfall	12,250 people displaced	Vanguard newspaper 24/9/08
2008	Edo State (Benin City)	Rainfall	20 houses collapsed & four dead	Vanguard newspaper 23/9/08
2008	Benue State	Rain Storm	Destroyed 350 houses	Vanguard newspaper 27/9/08
2012	Plateau State (Jos)	Rainfall leading to overflow of Lamingo dam	39 people died 200 homes submerged 3000 people displaced	Wikipedia downloaded on 19/10/14

DISASTER MANAGEMENT PROCESS:

Disaster management involves many diverse activities. These activities can be grouped into five main stages viz: assessment, mitigation, preparedness, response, and recovery, Lemons, (2005). The first three activities are performed before the occurrence of disaster, while the fourth and fifth take place during and after the occurrence of disasters respectively.

Assessment: This involves inventorying (identification and recording) the sensitivity and vulnerability of a region to certain types of hazards. At this stage the levels of risks, the danger to human life, environment and structures are considered and determined. The assessment will provide identification of development that increase them, thus establishing the culture of prevention.

Mitigation: This entails making necessary provisions to ensure that the region is less vulnerable to known risks and danger. Mitigation activities may include; land use and planning; moving settlement away from areas susceptible to such risks and dangers such as flood and storm areas; and the establishment and enforcement of building code etc.

Preparedness: This involves planning of emergency aid, development of scenarios and monitoring systems, and establishment of early warning system, public information and awareness of likely hazards, community involvement in disaster management programmes, establishment of disaster management and reduction at local, state and national levels and establishment of proper communication channels.

Response: This happens after the occurrence of the disaster which would have caused untold human suffering and damages to the environment. At this stage rescue teams will attempt to save lives, injured people will be cured and nursed and relief will be supplied to traumatized survivors. This is the most sensational stage of disaster reduction and management system.

Recovery: This stage involves assessment of damages, rehabilitation, cleaning of the environment and social and economic reconstruction. It also entails the first three stages of disaster management process viz; assessment, mitigation and preparedness, all of which are central to strategic development aimed at preventing or minimizing the effect of future disasters.

2.0 STUDY AREA

This study area is Owerri Municipal, the capital of Imo State. It is located in the South-Eastern geopolitical zone of Nigeria. The native language is Igbo it lies between Latitudes $5^0$24'N and $5^0$33'N and Longitudes $6^0$58'E and $7^0$06'E. Owerri municipal is found in the tropical rainforest region of Nigeria. It is according to (NEST 1991) the natural rainforest (Riparian forest and Low land forest). The city is drained mainly by River Nwaorie and River Otamiri and their tributary streams. Like most towns in Nigeria, it experiences two distinct climatic seasons; namely dry (October to March) and wet (April to September) seasons. A period of cold, dry, dusty winds known as "Harmattan" occurs from December to February annually. Owerri has a mean temperature range between 240^C to 340^C with a relative humidity of 70% in dry months and 90% in wet months. With a projected 2010 population of 610,211 people (NPC, 2007) unevenly distributed over a total land area of 57.966783km^2. A well-developed network of major roads, access roads and streets also exist in the town. This assemblage of infrastructure makes Owerri the hub of economic and industrial activities generating different types of solid wastes. With the upsurge in the number of institutions, volume of activities, and in fact, the increasing trend in migration from surrounding rural communities towards Owerri.

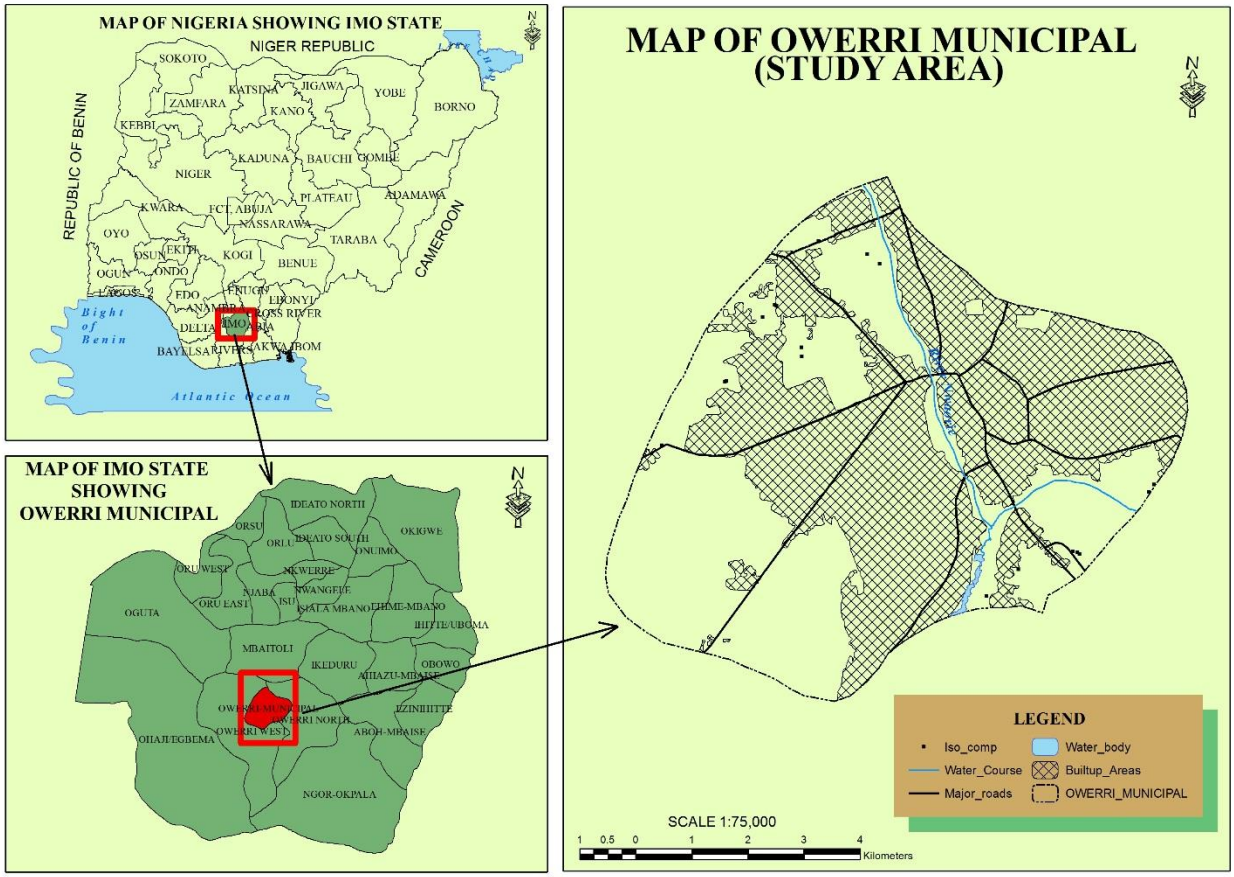

Fig. 2 Study Area

Source: Boundaries of State and L.G.A's clipped from the Admin Map of Nigeria obtained from The Office of the Surveyor General of the Federation (OSGOF) Nigeria.

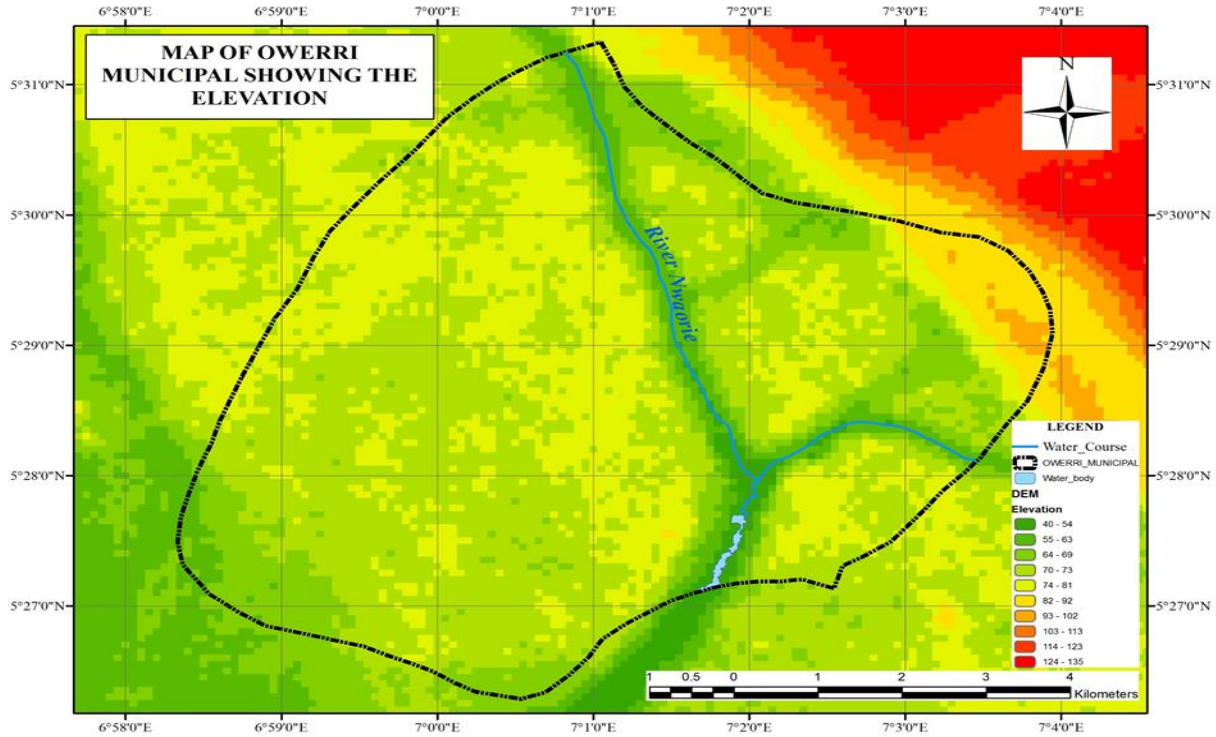

Fig. 3 Elevations of Owerri Municipal
SOURCE: 20m SPOT5 DEM covering the study area

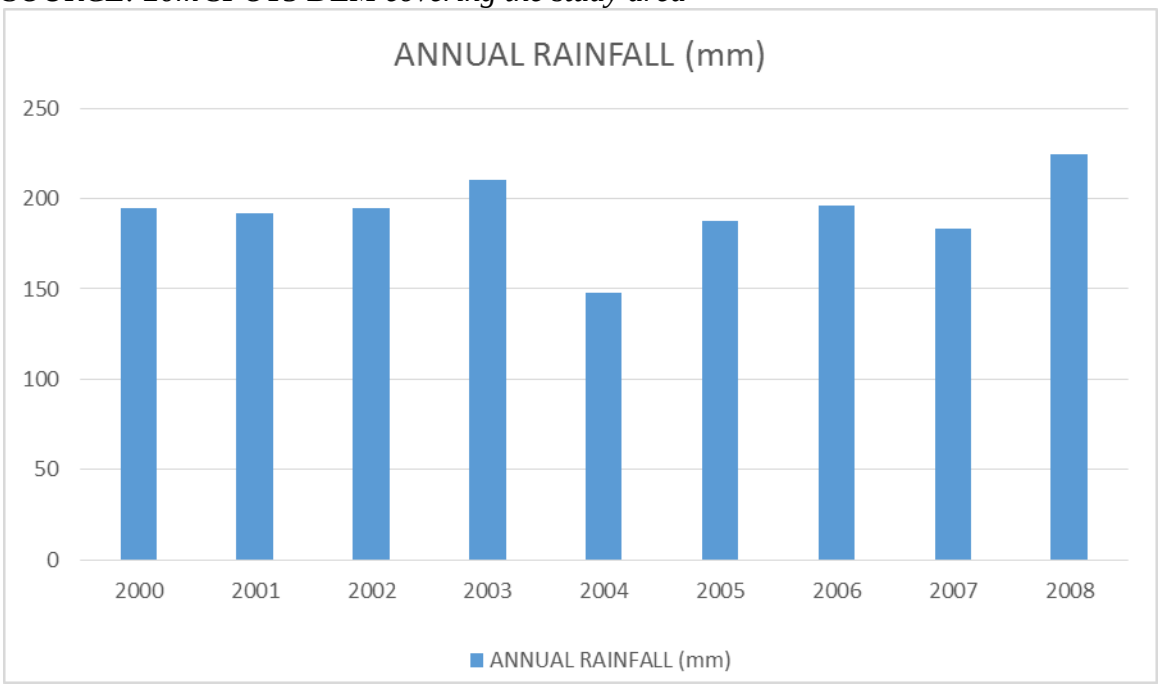

Fig. 4 Annual Rainfall in Owerri Municipal from 2000 to 2008
Source: Nigerian Meteorological Agency (NIMET) 2008

3.0 DATA AND METHODOLOGY

A SPOT 5 (2.5m resolution) satellite imagery covering the study area was digitized in the ArcGIS Desktop 10.1 environment to extract the road networks, built-up areas, water courses and water bodies in the area. In addition, geographic coordinates (X, Y, Z) of some sites, including road junctions, drainages, culverts and sites of indiscriminate waste disposal along the river channel were collected using a handheld GPS. The grid coordinates acquired were converted from geographic grid to UTM standard coordinates, using GEOCALC software, for universality. Additionally, a 20-meter resolution Digital Elevation Model (DEM) for the study area was obtained from The Office of the Surveyor General of The federation (OSGOF). The Arc GIS Desktop 10.1, along with the Arc Hydro extension, has been used in this present study to combine all obtainable data in a unique environment, and to delineate the flow accumulation and subsequently watershed in the study area. The processing phase includes: enhancing the satellite imagery, digitizing, unifying the spatial reference frames for all datasets, performing statistical and spatial analysis; and flood estimation. Analysis and queries were then permitted on both databases at the same time. In creating the tables however, a relational database structure was adopted. Relational database structure is adequately explained by Dale (1995).

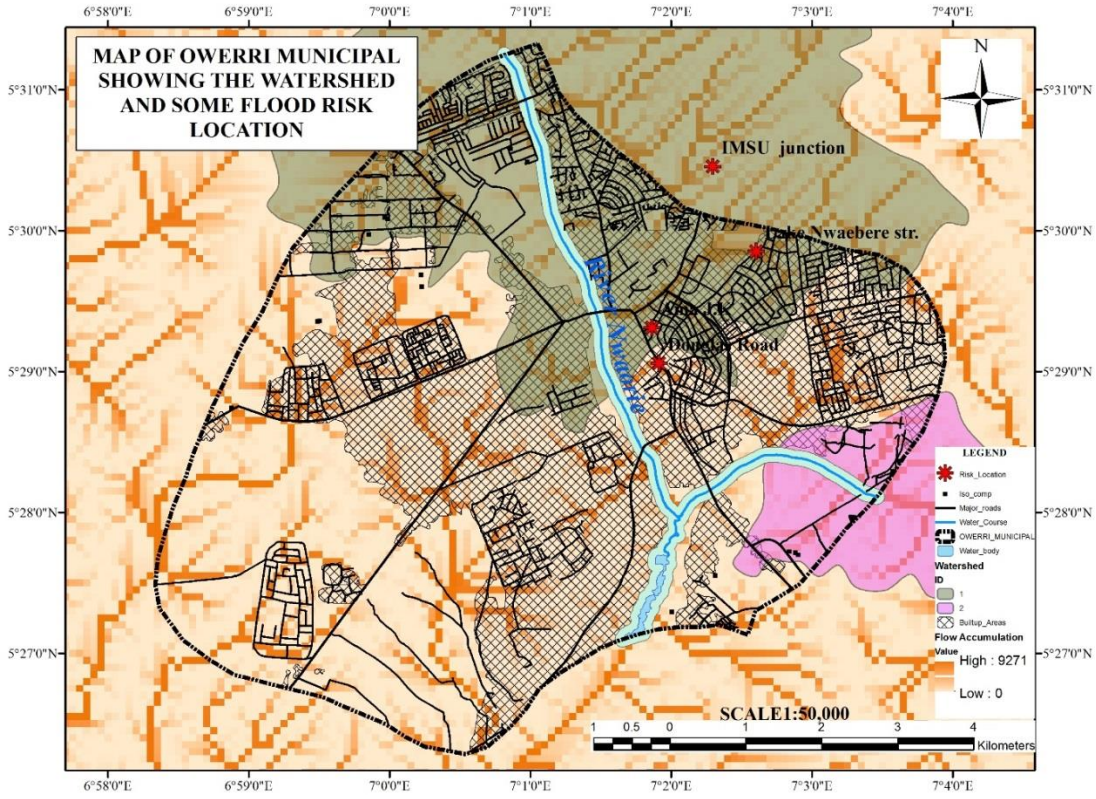

Fig. 5 Map of Owerri Municipal showing the watershed and risk location
Source: Digitized from the SPOT5 satellite image covering the study area

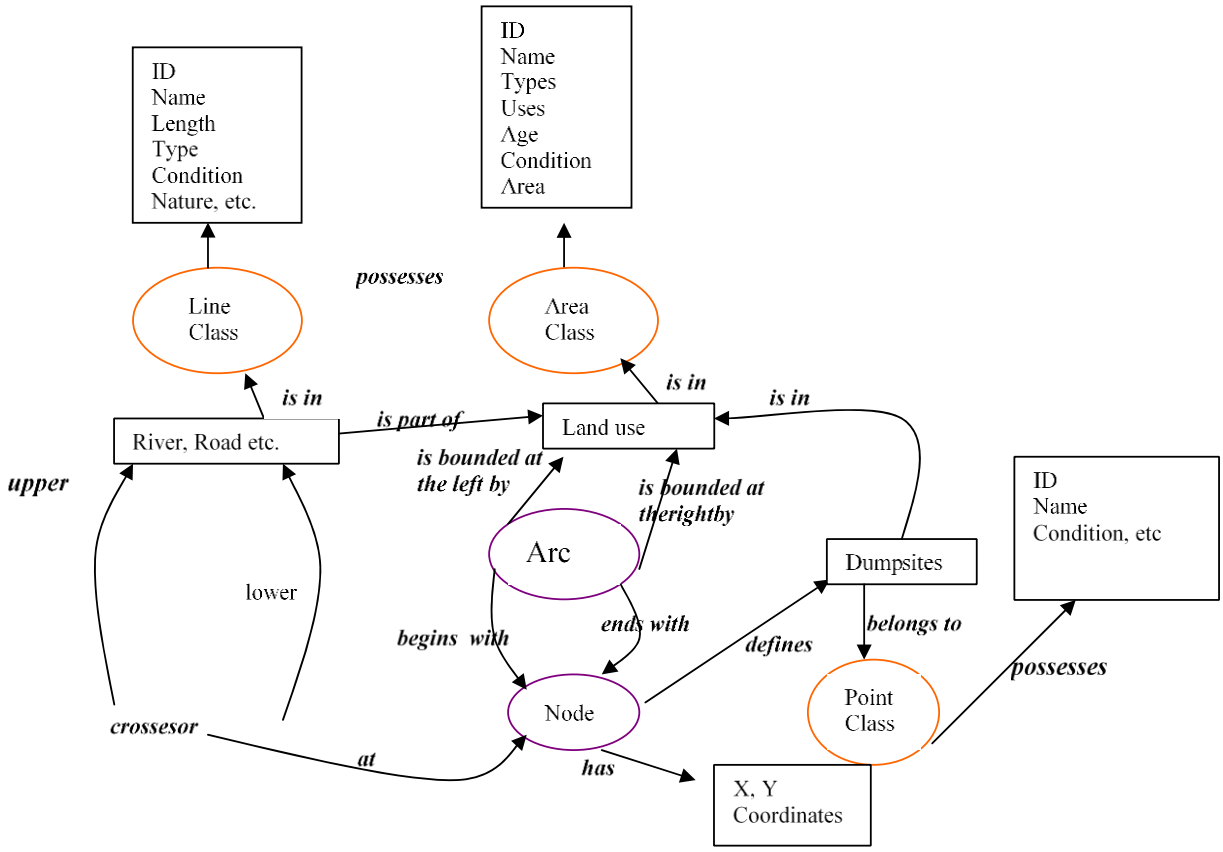

Fig 6: Diagram representing the data structure format for the study

Source: Adopted from A. O. Eludoyin et al.,(2007).*Combating Flood Crisis With Geographical information System: An Example From Akure, Southwestern Nigeria* 12-14 September 2007, UNESCO Paris

4.0 RESULTS AND DISCUSSION

Analysis involved in this study includes map calculation, buffering, and to a lesser extent, process modelling. Database querying and simple map overlay was also performed. All these were targeted at displaying some application of the technology in land planning, especially for decision support programmes. Different scenarios were created using a customised cartographic model for products generation. The essence of the study was to identify the causes of flood, the areas that are at risk as well as suggesting to the planners and policy makers what must be done to solve the problem created by the menace of flood in the area study. Simonovic (1993) expressed that flooding of River Red in Winnipeg City, Canada was related to population and structural growth, which obstructed the natural flow of water runoff in the area. Thus, such flooding could be combated if policy could be enacted to disallow dumping of refuse into the river channels and the invasion of the floodplains with development structure. The use of a GIS

technology will allow areas liable to flood to be demarcated, monitored and protected from misuse. Protection of this area will curb incessant flooding in this area. Further, zones of risk could be identified (Fig. 4) using a GIS technology, and protected by enactment and enforcement of planning rules other areas of application of the technology in similar experiments and regional applications are many. For example, Kienzle (1993) viewed the application from the disaster relief issue. An environmental manager well guided with a GIS will have a good knowledge of the villages and routes, including other properties and relationships of properties within the disaster zone. Farrisier and Givone (1993) expressed the use of the technology to determine flood risk areas such as obtained in this study.

It is also necessary to observe that a GIS visualisation capability improves comparison of the spatial and temporal information useful in flood management. Similarly, Eludoyin (1999) attempted an application of GIS in early warning system for impending flood disaster in River Osun floodplain in Southern Oshogbo, Nigeria.

In general, GIS and its complimentary technologies including Remote Sensing and Photogrammetry, Digital Surveying aid researchers, environmental planners and decision makers to collect, store, analyse, manipulate and present informed scenarios of events for informed decisions involving effective, non-structural and environmental friendly ways to make optimal choice of environmental hazards prevention alternatives.

NEED FOR FLOOD DISASTER MANAGEMENT

In view of the frequency and devastating nature of flood disaster worldwide, emphasis is now being shifted from post disaster reaction or response to pre-disaster reaction. This means that National Governments are shifting focus from relief (money and materials) distribution to flood disaster victims to prevention and/or mitigations.

This is in response to the United Nations (UN) DECLARATION in 1989 which designed 1989 to 2000 as international Decade for Natural Disaster Reduction (IDNDR) [Verstapen, 1991, Adeniran, 2001]. The intention of the UN is that member countries within the space of ten years should have put in place:

- Assessment of risk posed by environmental hazards (such as flooding)
- Long term preparedness and prevention plans and
- Warning systems

The recent decisions of the Federal ministry of Water Resources under the auspices of the Hydrological Services Agency (NIHSA) to organize a colloquium in 2012 on flood disaster in Nigeria amongst stakeholders on environmental issues is a welcomed development.

However, there are tools needed to mitigate flood disaster in Owerri. These are:

- Topographical Maps for the terrain configuration
- Land Use Map for land use pattern and
- Meteorological map for climate factors such as rainfall, temperature etc.

Topographical Maps

Topographical maps on a scales of 1:10,000, 1:5,000 or less are very necessary for a meaningful and result oriented flood disaster management.

If possible to use terrain information from satellite imageries with high resolution. Igbokwe (2005) in the study of Onitsha used the Nigerian Sat 1 with ground resolution of 32m to update the existing topographical map.

Land Use Maps

Maps that will show land use pattern are very essential tools for flood disaster management. This could be in either analog or digital form. However, the latter is more preferable.

Meteorological Data

Floods occur either as a result of high rainfall intensity within a few hours or low rainfall intensity for a longer period (Ward 1978). Other factors such as surface characteristics and the mobility of the ground surface to absorb precipitation as rapidly as the rate of rainfall contribute to the degree of flood occurrence.

(Ward 1978) says that real time weather information can be readily provided from meteorological satellites (SMS) a proto-type of the Geostational Environmental Satellites (GOES). Isoyet maps also produce rainfall data (quantity).

5.0 CONCLUSIONS

Thus far, effort has been made in this paper to establish the fact that it is better to mitigate flood hazards than supplying relief materials to affected victims of flooding. Decision-making is effective when it is adequately informed. The flooding in Owerri the capital of Imo State is increasing with the passage of time. Reliable spatial data for the mitigation should be taken seriously. There is need for total commitment on the part of Government and citizens of Imo State particularly the urban dwellers to achieve a sustainable environmental development. In this study, geographic information system has been identified as knowledge based technique with the capacity to collect, store, analyse and present information for decision-making process. Here, waste dumpsites within the river channel and drainages as well as structural development within the floodplain were identified as possible causes of inundation in Owerri Municipal, especially in the wet season.

It is concluded that the utilization of GIS in flood hazard estimation is quite powerful and provides an effective technical tool that helps in analyzing and understanding such phenomena.

6.0 RECOMMENDATIONS

This paper seeks to recommend certain planning and management measures which can be employed to mitigate flooding in Owerri.

- Governments should continuously monitor on annual basis of flood areas through satellite mapping of the potential floodplains in order to enable the identification of long term historical record of flood prone areas for prediction and development planning purposes.
- Imo State Government in collaboration with the Ministry of Lands, Survey and Urban Planning, Ministry of Agriculture should ensure an up-to-date large scale topographical maps in analog and digital form.
- Governments should establish appropriate number of rainfall stations within each hydrological basin in order to enable the quantification of , not only the effective rainfall intensity and duration within the drainage area, but also the spatial and temporal distribution within the catchment area.
- Development of extensive public awareness programmes by the Ministry of Information and Orientation to inform the public about flood hazards. Measures such as:
    a) Proper disposal of solid waste and not building structures to the block run-off should be maintained.
    b) Avoid known flood plains or green belt such as that of Nwaorie and Otamiri rivers for housing projects.
- Establishment of restrictive development regulations to ensure that any development meets stipulated standards that take flood hazards into consideration.
- Timely evacuation of materials scooped from the gutters will help instead of allowing the refuse stay unattended to which results in pushing back into the gutter when it rains

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BIOGRAPHICAL NOTES

Augustine Chukwuma Emeribeole received his Master degree from Enugu State University in 1996 and his Ph.D from Imo State University Owerri in 2012. He works, now, as a senior lecturer and acting head of department of Surveying and Geoinformatics, in Imo State University, Owerri. Additionally, he is a member of Imo State University's committee on master plan, he is also a member of the environmental protection board of Imo State University amongst other committees in the institution, a fellow of the Institute of Corporate Administration (FCAI) and a member of the Nigerian Institution of Surveyors (NIS). Furthermore, he published three books and more than ten papers.

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