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DEVELOPING A SUBJECT PLAN FOR MAPPING FLOOD PRONE AREAS IN NIGERIA (CASE STUDY OF ABUJA, THE FEDERAL CAPITAL TERRITORY)

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Abstract

A flood is an annual event that submerges buildings and its destructive tendencies are sometimes enormous claiming lives and properties annually. Floods occurrence in Nigeria are caused by extensive rainfall, drainage blockages and dam failures which subsequently overflow to other lowland areas. The increase in urbanization makes the land impervious to surface runoff during rainfall, rendering populations vulnerable to water inundation due to failure of natural streams and man-made drainage. Floods occur in Nigeria in three main patterns: coastal flooding, river flooding and urban flooding. The common type of flood occurring in the North Central Nigeria is the Pluvial flood and is known as invisible hazard, it occur as a result of short duration and high intensity rainfall flowing into water course and drainage channels. Urban pluvial flood occurs everywhere and it has the ability to damages and severe destruction in the urban areas which happens frequently. Flooding is therefore a perennial problem in Nigeria that consistently causes deaths and displacement of communities. Pluvial and Urban pluvial flood are the common flood types in Abuja which occurs annually due to heavy rainfall submerging buildings, affecting road pavements, and loss of lives. The areas worst affected by flood in Abuja are locations within Trademoore, Lokogoma, Gaduwa, Gudu, Dogon Gada, Damangaza, Lugbe and Gwagwalada. The study therefore seeks to assess flood occurrence in Nigeria and to prepare a subject plan for the mapping and control of flood prone areas, using Abuja FCT as a case study. Research methodology adopted for the study includes; the survey method, Interview, personal observation, base maps, satellite imageries and literature review. The study involves the use of GIS applications and other support tools as the research instrument. The study also revealed the sizes and locations of water reservoirs /dam within the Federal Capital Territory and dams located in others states at proximity with the possibility of causing flood in the FCT. The dams/ water reservoirs requires dredging, building along the floodplains should be regulated, drainages should be free from blockages of waste disposals, retention walls should be erected in flood prone areas and the general public should be sensitized on flood safety, prevention and mitigation.

Keywords: Urban flood, Flood mitigation, Mapping, Mitigation

1. INTRODUCTION

Floods remain one of the major causes of natural disasters affecting society. In a study of major natural hazards (excluding droughts) on a world-wide scale over the period 1947 to 1962, Schecham and Hewith

(1969) ranked floods first out of sixteen natural disaster types responsible for either 81 million damage or at least 100 persons killed or injured. Altogether floods accounted for about 30 percent of all natural disasters and 40 percent of the fatalities (Schecham and Hawith 1969). In addition, data from the sad statistics of past disasters in the world show that floods and drought for 54 percent of the significant damages, 65 percent of the persons affected and 29 percent of death (DHA, 1994).

Since man is unable to control the basic atmospheric processes which produce most floods, he has attempted to adjust to the hazard by means of flood alleviation projects concerned with land-based phase of the hydrological cycle. Through the application of high technological and the massive investment of capital, the flood threat to human life has decreased appreciably in most developed countries within recent decades (Smith and Tobin, 1979). For example, Geroghty et al (1973) estimated that annual deaths resulting from flooding in the USA average more 185 during the period 1931 to 1940 whereas Ward (1978) has indicated that fatalities were reduced to less than 83 per year between 1925 and 1971. It appears that the advanced countries are actually becoming more vulnerable to the loss of property and the social disruption associated with floods. The flood situation developing countries like Nigeria is problematic because of the level of poverty and lack of technological know-how on flood management.

Despite considerable investment in schemes designed to reduce the flood problem mean annual losses have continued to rise (Temi E.O, 2006). The year 2012 will remain forever in the minds of many Nigerians as the year when many lives were lost to the agony of flooding. Lagos state for instance, being about five meter below sea level, is prone to floods, thus, when it rained on three consecutive days sometimes the state experienced serious flooding, with residents still counting their losses (Okojie et al 2012) virtually all parts of the state from Victoria Island to Lekki, AbuleEgba, Ikeji, Apapa, Oshodi, Ikorodu, Agege, Okokomaiko and Ketu were flooded, forcing residents to stay indoors while those on the street battle to sail through the floods.

In Katsina State also, the people had to contend with the worst flood disaster in the State. According to records, about four Local Government Areas were affected by floods that claimed over six lives; three in Safana, two in Mai'aduan and one in Kurfi Local Government Areas of the State. This is even as hundreds of families have been rendered homeless, as the torrential down pour washed away over 1,000 houses, with scores of domestic annuals loss to the disaster (Ibid).

1.1 Statement Of The Problem

Kogi, Plateau, Benue and Gombe State are among the States in Nigeria extremely affected by flood, due to the proximity to the major rivers (Niger-Benue Rivers). The flood disaster of 2012 that occurred as a result of Lagdo dam burst that lead most settlements inundated destroying buildings and roads, rendering millions of people homeless, destroyed thousands of hectares of farmlands and livestock and also loss of aquatic animals. The destructive flood occur when water released from Ladgo dam flows into river Benue, and water released from Shiroro and Kanji dam flows into river Niger, as well as the effects of climate change itself leading to excess precipitation (NEMA, 2012). According to National Emergency Management Agency (NEMA), the flood killed 35 persons, while scores of persons were reported missing.

Flood epidemic is now a common phenomenon in many sub regions of Nigeria claiming lives and properties annually. According to Nasarawa broadcasting service (NBS) Lafia, the 2012 has been the year of great devastation by flooding. This flooding causes havoc in Lafia, Awe Nasarawa and Doma Local Government Area, of the State. This has led to loss of lives and property as well as loss of Agricultural land use in the affected area. Abuja has been experiencing flood disaster recently and there are many factors relating to the cause of flood in Abuja the Federal Capital Territory. The flood in Abuja occurs annually due to heavy down rainfall submerging buildings, destroying properties and loss of lives. The areas worst affected by flood in Abuja are locations within Trademoore, Lokogoma, Gaduwa, Gudu, Dogon Gada, Damangaza, Lugbe and Gwagwalada.

1.2 Aim And Objectives

The aim of the study is to assess the flood occurrences and prepare a subject plan for the mapping of flood prone areas in Nigeria. Using Abuja FCT as a case study.

Objectives are to:

- i. Examine the types of flood and the causality of flood
- ii. Identify flood prone areas within the Abuja Federal Capital Territory.
- iii. Examine the factors responsible for flooding in Abuja
- iv. Prepare a strategic plan for flood control within Abuja

1.3 Scope And Limitation

The scope of the study covers Abuja the Federal Capital Territory of Nigeria. The study focused on Identifying areas severely affected by flood in each of the study within Abuja with a view for remedial measures and management to curtail effects of flood regime.

2. LITERATURE REVIEW

2.1 Definition of Terms

Flood - A flood is an overflow of water that submerges land that is usually dry. In the sense of "flowing water", the word may also be applied to the inflow of the tide.

Disaster - A disaster is a serious problem occurring over a short or long period of time that causes widespread human, material, economic or environmental loss which exceeds the ability of the affected community or society to cope using its own resources.

Effect - The result of a particular influence; something that happens because of something else

Environment- The complex of physical, chemical, and biotic factors (such as climate, soil, and living things) that act upon an organism or an ecological community and ultimately determine its form and survival.

2.2 Types of Flooding

There are four broad flooding categories: Coastal flooding, Groundwater flooding, River (or fluvial) flooding, and Pluvial flooding (ActionAid, 2006; Sterna, 2012).

(i) *Coastal flood*: Occur in low-lying coastal areas, including estuaries and deltas, when the land is inundated by brackish or saline water. Brackish-water floods result when river water overflows embankments in coastal reaches. This overflow can be intensified when high-tide levels in the sea are increased above the normal level by storm-surge conditions or when large freshwater flood flows are moving down an estuary. Saline water coastal floods may occur when extremely large wind-generated waves are driven into semi-enclosed bays during severe storm (Smith and Ward, 1998).

(ii) *Groundwater flood*: According to Macdonald (nd), ground water flooding is the emergence of groundwater at the ground surface away from perennial river channels, or the rising of groundwater into man-made ground under conditions, where normal" ranges of groundwater level and groundwater flow are exceeded. The Problems with high groundwater levels mainly occur in floodplains or low-lying areas.

Damage due to high groundwater levels occurs if there is a considerable (sudden or long-term) change in the groundwater levels. Such changes can be a result of high infiltration rates (due to flooding or heavy precipitation) into the aquifer or a reduced withdrawal of groundwater (Kreibich and Thielen, 2008).

(iii) *River flood*: Flooding (Fluvial) in river valleys occurs mostly on floodplains as a result of flow exceeding the capacity of the stream channels and over spilling the banks. Most river floods result directly or indirectly from climatological events such as excessively heavy and/or prolonged rainfall (Smith and Ward, 1998).

(iv) *Pluvial flood*: Falconer et al. (2009) describe pluvial flooding as “the result of rainfall-generated overland flow and pond before the runoff enters any watercourse, drainage system or sewer, or cannot enter it because the network is full to capacity”. Pluvial flooding is typically associated with short duration high intensity rainfall, but can also occur with lower intensity prolonged rainfall. The pluvial flood extent can be worsened if the ground is saturated, frozen, paved or otherwise has low water permeability (Falconer, 2009).

Pluvial flooding often occurs unexpectedly in locations not obviously prone to flooding and with minimal warning and is not well understood by the general public – hence the term „invisible hazard“ (Houston et al., 2011). It is a characteristic of urban areas where large areas of impervious ground exist and inadequate drainage systems abound. As urban growth increases, the impervious surface area also increases; thereby rendering populations vulnerable to water inundation as natural streams and human-made drainage fails to cope with increased runoff subsequent to heavy rainfall (Youssef and Pradhan, 2011).

Urban pluvial flooding frequency is expected to increase not only due to urbanisation but also to expected climate changes (Ugarelli et al., 2011 and Simes et al., 2014). This type of flooding can happen virtually anywhere and has the potential to cause significant damage and disruption in highly urbanized areas, where the density of properties, critical infrastructure and population is usually high. The volumes involved and the risk related to pluvial flooding often result in consistent economic losses and consequent damage in the long term due to the high frequency of this kind of event (Freni et al., 2010).

Related consequences of pluvial flooding mainly consist of economic losses such as damage to buildings and their contents and to infrastructure and intangible damages due to traffic delays, road, public and commercial function closures, and evacuation of people. (Plate 2).

2.3 The Causes Of Flooding

According to Smith and Ward (1998), most floods in the humid tropics result directly or indirectly from climatologically events, either extremely heavy or prolonged rainfall. Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity (IPCC, 2001). The major factor that influences flood is the climatic condition of a particular geographic location, and this manifests in the form of amount, duration and intensity of precipitation (rainfall).

Flooding are common features in Nigeria during Urban flooding which occurs in towns, on flat or low-lying terrain especially where little or no provision has been made for surface drainage, or where existing drainage has been blocked with municipal waste, refuses and eroded soil sediments (Folorunsho and Awosika 2001). Floods that occur in Nigeria are as a result of extensive rainfall, drainage blockages and dam failures (Jeb and Aggarwal, 2008) Plate 1.

As urban growth increases, the impervious surface area also increases; thereby rendering populations vulnerable to water inundation as natural streams and human-made drainage fails to cope with increased runoff subsequent to heavy rainfall (Youssef and Pradhan, 2011). Urban pluvial flooding frequency is expected to increase not only due to urbanization but also to expected climate changes (Ugarelli et al., 2011; Simes et al., 2014) Plate 2.

Flood is an overflowing of a great body of water over land not usually submerged. Abam (2006) defined flood as large volume of water which arrives at and occupy the stream channel and its flood plain in a time too short to prevent damage to economic activities including homes and infrastructures. In another development, Nwafor (2006) expressed flood as a natural hazard like drought and desertification which occurs as an extreme hydrological (run off) event. Flooding is the most common environmental hazard in Nigeria (Etuonovbe, 2011). Plate 4.

Flood disaster is not a recent phenomenon in the country, and its destructive tendencies are sometimes enormous. The major flooding that struck Nigeria was in 1940s. According to Adedeji, Odufuwa and Adebayo (2010), the first flood ever recorded stroke Ibadan, the then headquarters of old western region of Nigeria but now the capital of Oyo State, in 1948 and afterwards the city observed shocking flood misadventures in 1963, 1978, 1980, 1985, 1987 and 1990 respectively. Floods occur in Nigeria in three main patterns: coastal flooding, river flooding and urban flooding (Folorunsho and Awosika 2001; Ologunorisa, 2004). Coastal flooding occurs in the low-lying belt of mangrove and fresh water swamps along the coast (Folorunsho and Awosika, 2001; Ologunorisa, 2004).

River flooding occurs in the flood plains of the larger rivers, while sudden, short-lived flash floods are associated with rivers in the inland areas where sudden heavy rains can change them into destructive torrents within a short period (Folorunsho and Awosika, 2001; Ologunorisa, 2004).



Plate 1: Drainage Blockage in Urban areas



Plate 2: Effects of Flood on Road and Buildings

2.3.1 Factors leading to flood in three main categories:

- (a) Meteorological – relating to extensive torrential rainfall, cyclones, storms and tidal. surges;
- (b) Hydrological – relating to floods caused by increased surface run off as a result of ice and snow melt, land saturation, impermeable surfaces and land erosion;
- (c) Anthropogenic – concerned with human and natural activities such as population growth, urbanization, climate change, land use and degradation (ADPC, 2005).

2.4 The Effects Of Flood In The Environment

According to UN-Water (2011) floods, including urban flood is seen to have caused about half of disasters worldwide and 84% disaster deaths in the world was attributed to flooding. Flooding is the most frequent and costly natural disasters in terms of human suffering and economic loss in the United States and worldwide (Mason 1995; Smith and Ward, 1998; Parker, 2000).

Floods regularly account for nearly one-third of all global disasters arising from geophysical hazards (Smith and Ward, 1998). They now appear to be more prevalent and destructive than centuries ago and are projected to increase both in frequency and amount of devastation in the future (Parker, 2000). People are now living in flood prone areas, despite efforts in many countries to restrict development in floodplains there is substantial evidence that exposure to floods is growing rapidly as human occupation of floodplains intensifies in many parts of the world (Jha et al., 2012).

Flood in several parts of the Netherlands, is caused by intense rainfall mostly in autumn. The 1998 flood caused damages to 2470 houses, 1220 premises and 350 governmental agencies (Jak and Kok, 2000). Similarly, in the summer of 2007 the City of Hull (United Kingdom) suffered from severe pluvial flooding, causing damage to over 8600 houses and 1300 premises (Coulthard and Frostick, 2010).

African nations too have had their own share of flood disasters. For example in West and Central Africa more than 1.5 million people were affected by floods between the months of July and August 2012 following heavy rainstorm in which more than 11,400 homes were destroyed in Senegal; more than 94,000 in Chad and 24,000 homes in Niger (UN-OCHA,2012). When severe floods occur in areas occupied by humans, they create natural disasters which involve the loss of human life and property plus serious disruption to the activities of large urban and rural communities (Smith and Ward, 1998) Plate 3 and 4, Figure 1 and 2.

In Nigeria, aside from droughts, floods cause almost 90 % of damages resulting from natural hazards (Adeoye et al., 2009). The pattern of flood is similar with the rest of world. Flooding displaces more people than any other disaster, perhaps because about 20 per cent of the Nigerian population is at risk of flooding (Etuonovbe, 2011). Flooding is therefore a perennial problem in Nigeria that consistently causes deaths and displacement of communities. For instance, in 2010, about 1,555 people were killed and 258,000 more were displaced by flooding (Babatunde 2011). Similarly in 2012, floods claimed 361 lives, and displaced 2.1 million people(Tokunbo and Ezigbo,2012). Plate 3 and 4, figure 2.



Plate 3: Effects of Flood on Farmlands



Plate 4: Effects of Flood on Road Pavement

Table 1: Trends Of Flood Disasters / Hazards In Nigeria

S/ NO	STATE	DISASTER	ASSOCIATED HAZARD	NO OF PEOPLE AFFECTED	DATE & YEAR
1	Lagos	Flood	Buildings collapsed, arkets submerged, Properties destroyed.	Over 300,000 affected	Early 1970's Till Date
2.	Niger	Flood & Rainstorm	Houses, Schools, animals & farmland affected	200,000 displaced	1999, 2000 & 2017
3	Abia	Rainstorm	Houses	500	July 2001
4	Kogi	Flood & Rainstorm	Houses, Schools & Farmland destroyed	1500 displaced	March, May 2001
5	Adamawa	Flood	Houses & Farmlands destroyed	500	April 2001
6	Taraba	Flood	80 Houses totally swept off. 410 houses extensively destroyed	More than 50,000 displaced	August 2005
7	Akwa - Ibom	Flood & Rainstorm	367 houses washed away	4000	March 2001
8	Jigawa	Flood & Windstorm	Houses, farmlands & animals destroyed	35,500 displaced in 1988; 450,150 displaced in 2001	1988, March, April & August 2001
9	Kano	Flood & Windstorm	Schools, Houses, Farmlands & animals destroyed	300,000 displaced in 1988, 20,445 in 2001	1988, 2001
10	Ondo	Rainstorm	Houses & schools destroyed	800 affected	April 2001
11	Osun	Rainstorm	Houses & schools destroyed	1700 affected	April 2001
12	Bauchi	Flood	750 Houses washed away, Farmlands destroyed	Not available	August 1988
13	Bayelsa	Flood	Houses, Schools, Markets & Farmlands submerged	2/3 of the population	1999 & March 2001
14	Borno	Flood	Houses & Farmlands	Not available	August 1988

Source: Durotoye (1999). Edited 2017

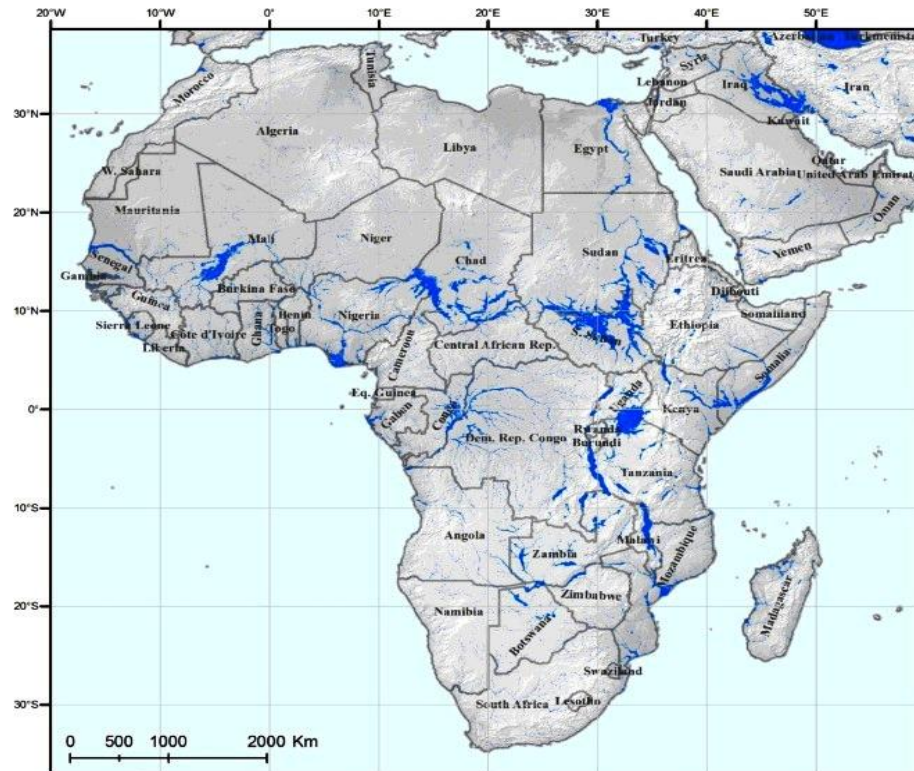


Figure 1: Drainage Flow Pattern Of Africa

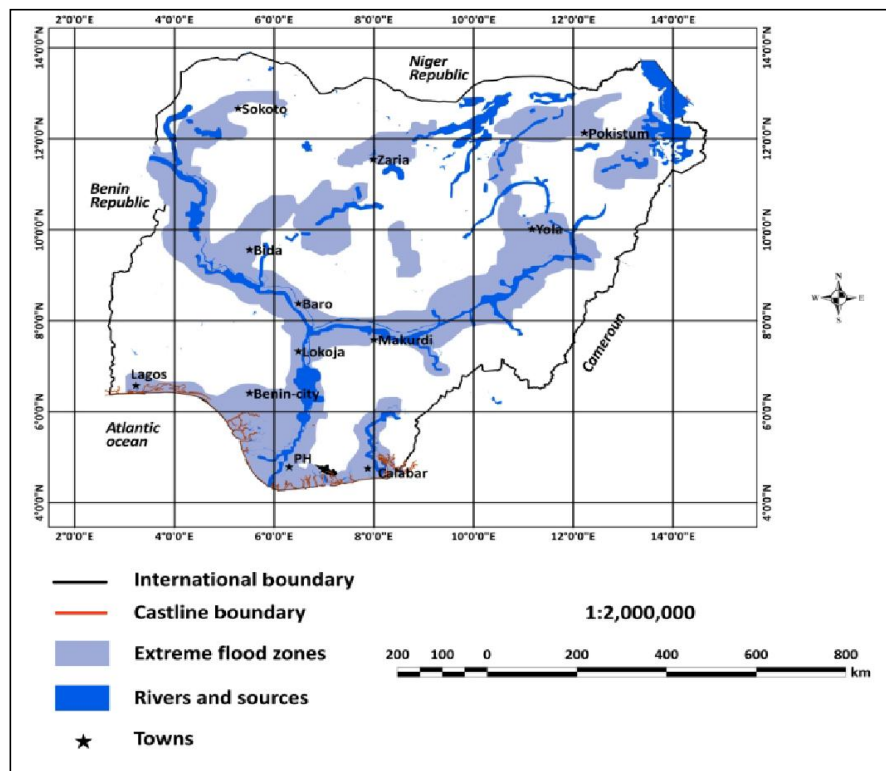


Figure 2: Extreme Flood Region In Nigeria

3.0 THE STUDY AREA AND RESEARCH METHODOLOGY

3.1 Study Area And Location

The history of Abuja FCT started in August 1975 Late General Murtala Muhammed convened a panel of experts, under the Chairmanship of the Honourable Justice T.A. Aguda, to study and advice on the suitable location of the Federal Capital of Nigeria. The panel recommended alternative locations like Okene, Kafanchan, Markurdi, Ile, Auch, Abuja and Agege. Abuja was selected among the list under Decree number 6 of 1976 and officially became Nigeria's capital on 12 December 1991. Figure 3.

The Federal Capital Territory (FCT), Abuja was formed from parts of former Nasarawa, Niger, and Kogi States. Abuja is geographically located in the centre of the country, lying between latitude $9^{\circ} 4'20.15''$ North of the equator and longitude $7^{\circ} 29'28.68''$ East of Greenwich Meridian. The Federal Capital Territory has a landmass of approximately 7,315 km², of which the actual city occupies 275.3 km² with a density of 190/km² (500/sqm). The main area for this study is within the Abuja FCT. figure 4.

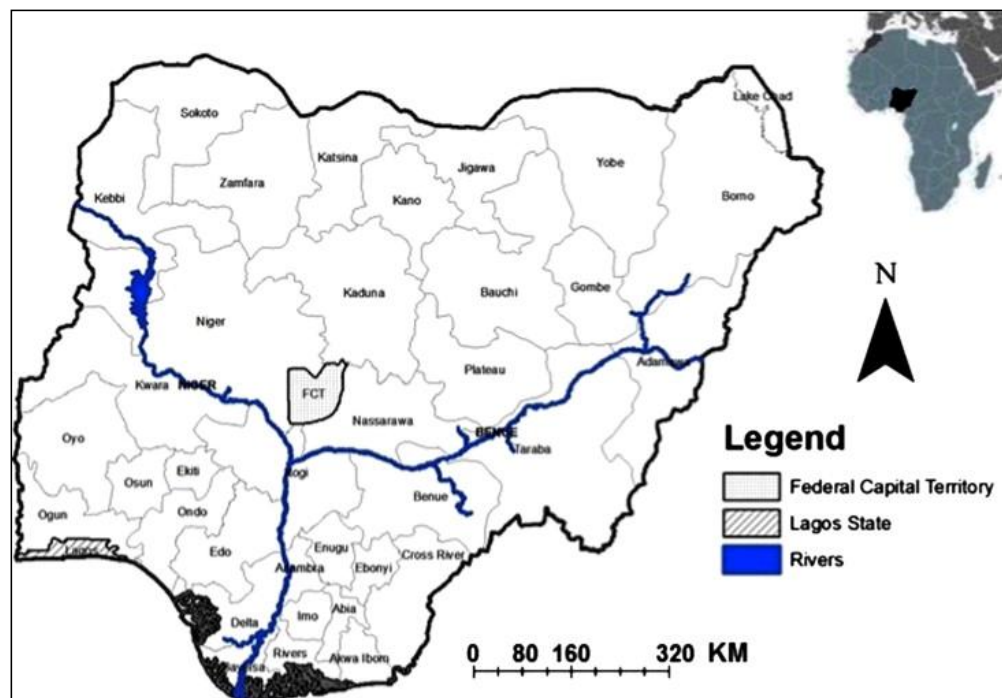


Figure 3: Nigeria Showing Fct

The indigenous languages are: Gbagyi, Gade, Gbari and Nupe. (Figure 1 and 2). Farming and trading is among their major source of income and the major farm produce of the region are maize, yam, cocoyam, beans, soya beans, groundnut, cassava, cashew, orange and mango. The inhabitants have different religious such Muslims, Christian and traditional/ cultural believers.

The master plan for Abuja and the Federal Capital Territory (FCT) was developed by International Planning Associates (IPA), There are Six Area Councils namely: Abuja Municipal Area (AMAC), Abaji, Gwagwalada, Bwari, Kuje and Kwali Area Council.

The geology of the study area has been described by many workers, including (Ajibade 1985 and Mc-Curry 1983). The study area is underlain by Precambrian rocks of the Nigerian Basement Complex which cover about 85% of the land surface and cretaceous sedimentary rocks belonging to the Bida Basin which cover the remaining 15%. The major lithological units found in the study area are: Migmatite-gneiss; Biotite granites; Quartzites / Quartzite-schists; Amphibolite-Schists/Amphibolites.

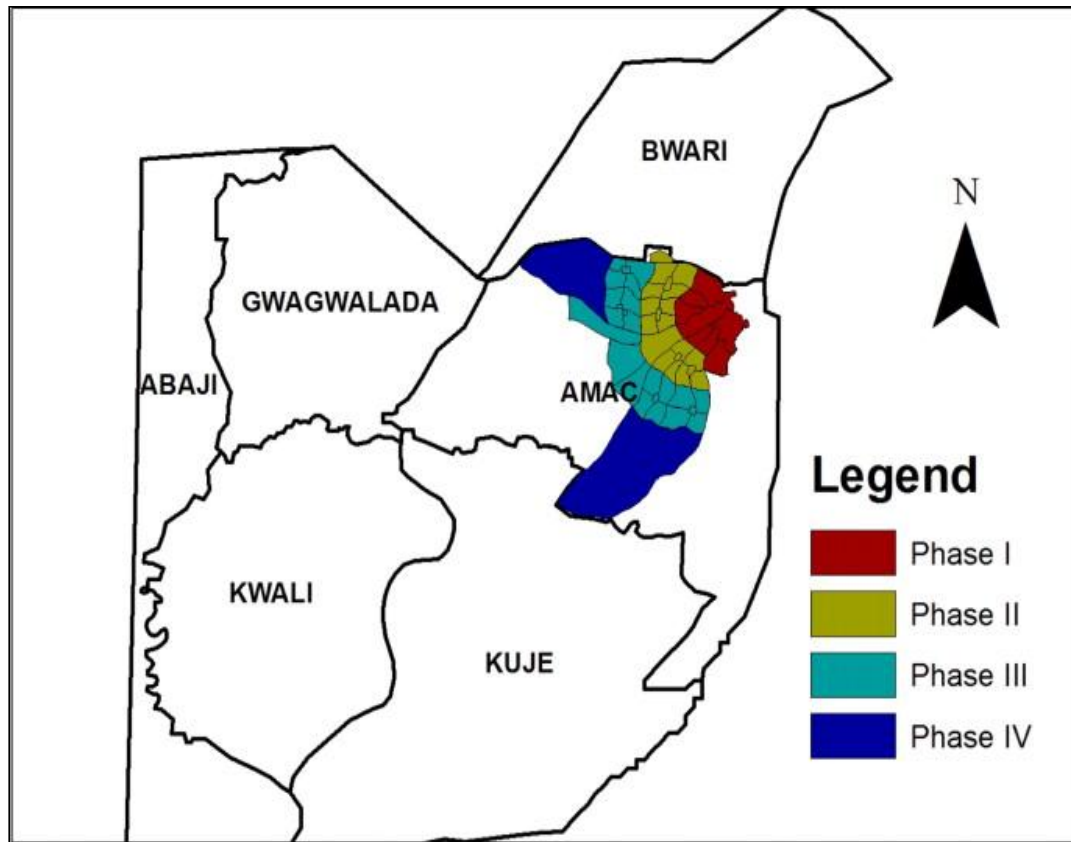


Figure 4: Six Area Councils Of Fct And Abuja Phase I - IV In AMAC

Climate Data: The climate of the area has its highest temperature of about 36 C during the dry season, November to March. During the rainy season April to October, the temperature drops to a maximum of 24 C. The average daily high temperature above 90°F and the hottest month of the year in Abuja is March, with an average high of 93°F and low of 70°F. The cool season lasts for 3.5 months, from June 22 to October 7, with an average daily high temperature below 83°F. The coldest month of the year in Abuja is December, with an average low of 61°F and high of 87°F. Figure 5 and 6.

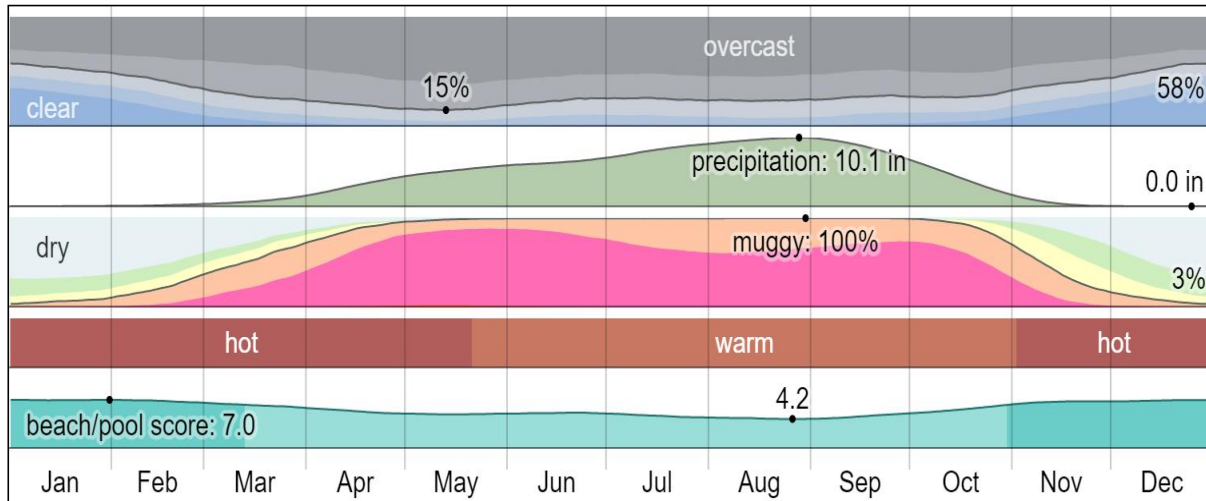


Figure 5: Climate Data Of Abuja

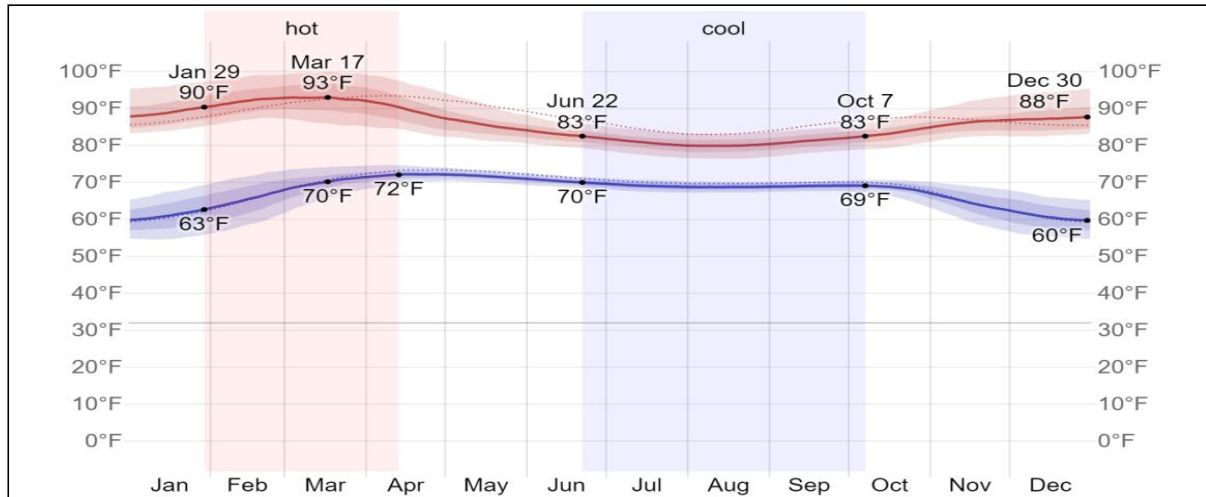


Figure 6: Average Temperature Of Abuja

Rainfall Data: Abuja experiences extreme seasonal variation in monthly rainfall and the rainy period of the year lasts for 8.2 months, from March 8 to November 13, with a sliding 31-day rainfall of at least 0.5 inches. The month with the most rain in Abuja is August, with an average rainfall of 9.8 inches. The rainless period of the year lasts for 3.8 months, from November 13 to March 8. The month with the least rain in Abuja is December, with an average rainfall of 0.0 inches. Figure 7.

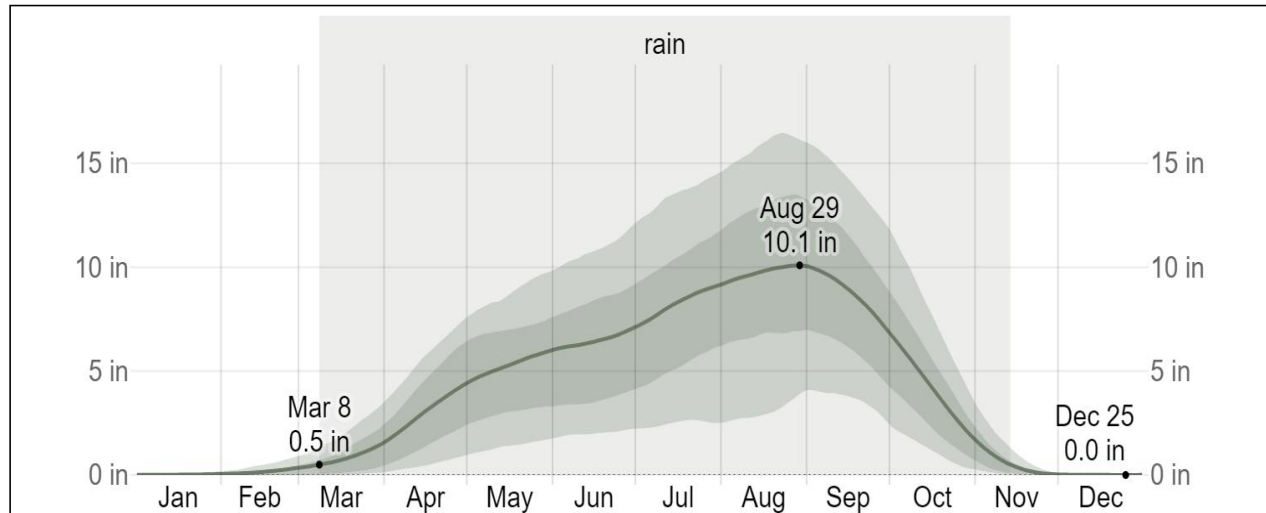


Figure 7: Average Monthly Rainfall Of Abuja

The Solar Radiation: The average daily incident shortwave solar energy experiences some seasonal variation over the course of the year. The brighter period of the year lasts for 3.9 months, from November 11 to March 7, with an average daily incident shortwave energy per square meter above 5.5 kWh. The brightest month of the year in Abuja is February, with an average of 5.8 kWh.

The darker period of the year lasts for 4.2 months, from May 4 to September 10, with an average daily incident shortwave energy per square meter below 4.5 kWh. The darkest month of the year in Abuja is July, with an average of 4.3 kWh. Figure 8.

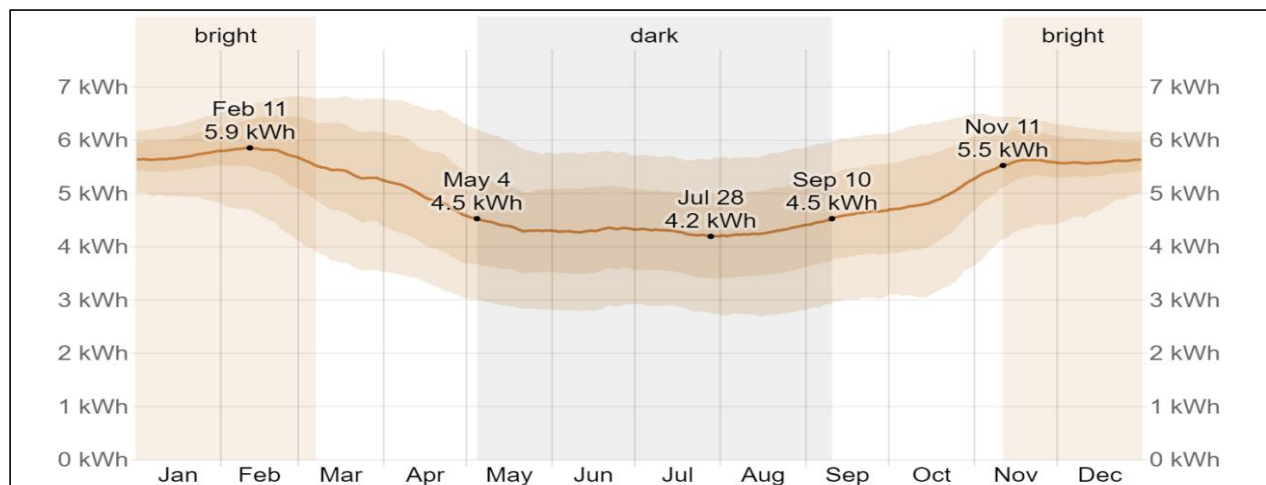


Figure 8: Average Monthly Solar Energy Of Abuja

3.2 Research Methodology

3.2.1 Sources of data

The collection involves the use of both primary and secondary sources of data.

The primary source of data involves Field investigation, personal observation, questionnaire administration, Focus Group Discussions, use of camera and GPS, in obtaining relevant information on Abuja flood regime and flood epidemic. Relevant data is acquired from Base Maps / Satellite Imageries, literature, journals, conference papers and other internet materials, which forms part of the secondary sources of data.

3.2.2 Materials / Methods

Research processes involved logical steps and sequential procedures in data collection and analysis for a better understanding of the phenomenon within our environment. The sources of data involved both primary and secondary sources of data collection for the study. The data collection technique encompasses site visit, personal observation, oral interview with some individuals and Focus Group Discussion (FGD) with relevant authorities and stake holders. The exercise was achieved with the use of project vehicle, GPS, tapes and camera for both pictures and video recording of the study area.

However, other addition sources of information were obtained from literature in the form of journals, thesis, conference papers, maps and discussions with other relevant authorities and stakeholders of each state of the study areas in Nigeria.

3.2.3 Data collection processes

The Research team visited the each of the flood prone communities in the affected state for the data collection process. There was a direct contact with the inhabitants and stakeholders where information as flood history, number of casualties and early warnings from the Government / Non Governmental Organizations were obtained and recorded.

Personal observation was conducted in the affected states and pictures were obtained with recorded videos of the flood scenery and also the flood inhabitants.

The required GIS and Remote sensing data on the related subject on flood of the respective study areas will be acquired, digitized, analysed, geo-referenced and processed by Lithospace Nigeria Ltd. The process requires the application of GIS and Remote Sensing on the acquired thematic imageries to determine the sizes , locations, drainage flow and the possibility of proposing strategic locations of additional dams that will collect excess water during flood regime.

4.0 RESULTS AND DISCUSSION

4.1 Site Location And Assessment

The Urban Planning Research Group conducted a reconnaissance survey to obtain relevant information on the study area that is annually and constantly prone to flood in Abuja the Federal Capital Territory (FCT).

The Abuja drainage map shows the existence of river tributaries across the entire FCT but the study on areas within Abuja that is liable to flood. The flood prone areas visited during the exercise are: Lugbe Tradmore, Lokogoma, Galadimawa, Giri, Karu, Gwarinpa – Life Camp, Gudu, Gosa and Gwagwalada among others. Figure 9 and 10..

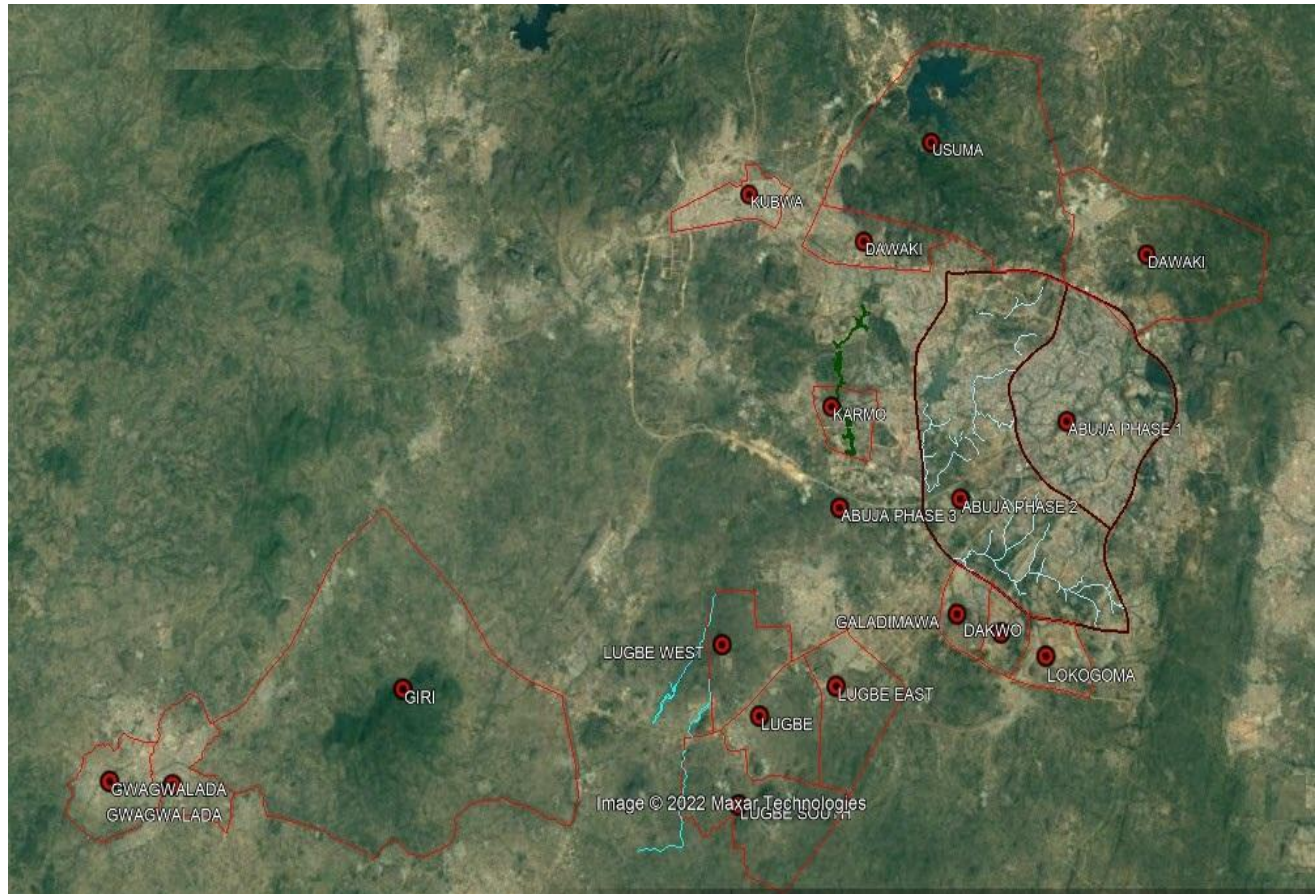


Figure 9: Study Area Locations Of Abuja FCT

Source: Lithospace Nig. Ltd (2022)

4.2 Observations Made During The Exercise

However, during the exercise the observations made were:

- The construction of buildings and fence in flood prone areas and some of the open space / green areas were converted for commercial and residential buildings constructions, which will eventually collapse due poor foundation or general construction. (Plate 8).
- There are indiscriminate solid waste disposal in drainages and water bodies which also contributes to flooding affecting buildings and road pavements.
- The Abuja Master Plan has not achieved main purpose in-spite of the numerous deviations of the landuse of the initial Master Plan.
- There is increasing number of trees within the city centre with also a decreasing number of trees at the outskirts of the Abuja city centre.
- The trees plays major role in temperature control, reducing soil erosion and serving as buffer zones protective shields against high wind, rainfall and flood impact.

- Embankment for flood control existed in some parts of the study area and the embankment or retention wall is very effective against flood impact, if properly constructed by the professional engineers. (Plate 7).
- The study further revealed that some of the surrounding dams are gradually reducing in sizes of its initial capacity due infiltration and accumulation of sediments, which calls for dam dredging.
- There is lack of proper management of the dams, lakes and river for ensuring sanity and sustainability of the reservoir resources. The public must be educated on the contributory factors causing flood and the proper management of the environment.



Plate 5: Trademore Bridge under re-construction caused by Flood



Plate 6: Trademore Bridge under re-construction caused by Flood



Plate 7: Flood Retention wall at Trademore Estate



Plate 8: Buildings along the flood prone areas at Galadimawa



Plate 9: Part of Galadimawa with poor drainage system



Plate 10: A typical Flood Prone Area in Gwagwalada

4.3. Drainage Flow And Water Reservoir Within The Abuja Fct

Flood normally occurs during the rainy seasons and excessive rainfall usually leads to flooding when the ground is fully saturated with water and as a result, the dams and rivers overflow its bank. Study revealed that there are 323 large, medium and small dams, which have been constructed and are being operational in Nigeria.

The biggest dam in Nigeria is the Kainji Dam which is attached to River Niger, situated between Niger State and Kebbi State within the North Central Region of Nigeria. However, other dams within the same region includes Shiroro Dam, Gurara Dam, Impressit Dam, Jimade Dam and Numwi Dam. The initial sizes of the dams is being reduced by the inflow of debris and other eroded materials carried by flowing rain water during the rainy season.

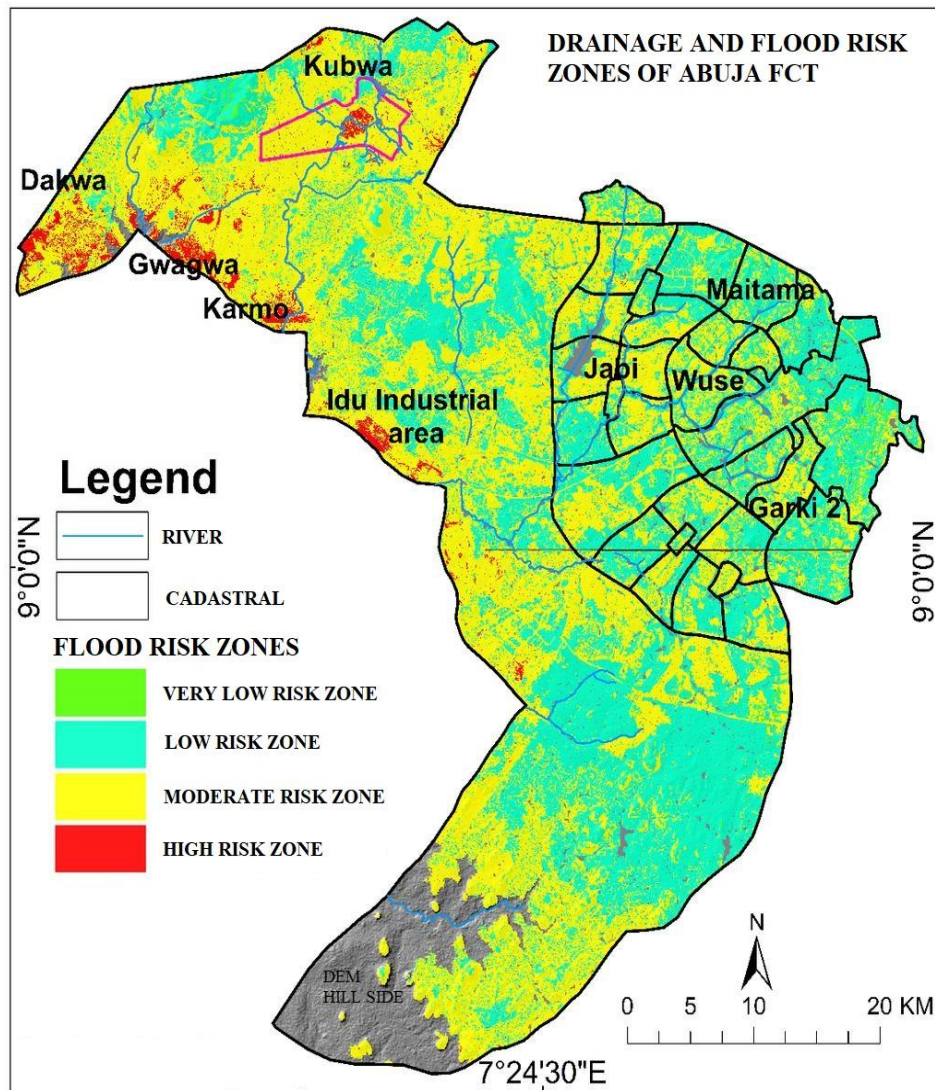


Figure 10: Drainage And Flood Risk Map Of Abuja FCT

Table 2: Dam Locations Within The North Central Region

S/ N	DAMS	CURRENT SIZES (Ha)	INITIAL CAPACITY (Ha)	USE	DIST. TO ABUJA (Km) CROWFLY	COORDINATES	LOCATION	REMARK
1	KAINJI DAM	111,380.15	130,000	Hydro Electricity	351.73	10°19'39.27"N 4°31'4.45"E	NIGER STATE KEBBI STATE	Requires Dredging
2	SHIRORO RESERVOIR	29,449.57	31,200	Hydro Electricity	123.04	9°59'12.10"N 6°51'55.44"E	NIGER STATE +KADUNA STATE	Requires Dredging
3	GURARA DAM	5,942.63	6,100	Hydro Electricity	76.04	9°41'43.83"N 7°43'44.91"E	KADUNA STATE	Requires Dredging
4	USUMA DAM	841.98	1,050	Reservoir	18	9°11'42.12"N °25'32.54"E	ABUJA - FCT	Requires Dredging
5	JIMADE DAM	684.22		Reservoir	96.26	9°13'41.92"N 6°35'57.53"E	NIGER STATE	Requires Dredging
6	KOFA DAM (IMPRESSIT)	521.06		Reservoir	31.26	9°13'50.79"N 7°14'8.19"E	NIGER STATE	Requires Dredging
7	NUMWI DAM	368.11		Reservoir	105.46	9°34'38.74"N 6°39'33.66"E	NIGER STATE	-
8	PROPOSED TAKUNDA DAM	326	-	-	64.63	8°53'38.31"N 6°53'0.90"E	ABUJA - FCT	
9	PROPOSED GWAU DAM	261	-	-	19.52	8°52'52.56"N 7°22'8.67"E	ABUJA - FCT	-
10	JABI LAKE	116.37	1,300	Reservoir	5.16	9° 4'23.23"N 7°25'11.04"E	ABUJA - FCT	Requires Dredging
11	PEDAM DAM	46.27		Reservoir	8.78	9° 3'36.23"N 7°31'50.28"E	ABUJA - FCT	Requires Dredging

Source: Field Survey & Lithospace Nig. Ltd (2022)

4.4. The Role Of The Adjoi Ning Water Reservoirs / Dams

The existence of the dams plays major roles in the sustainability of the region but when the dams are filled to maximum capacity by excess water, the dams overflows its bank and floods the entire region. The excessive water flows to fill up the dams within the FCT and it eventually floods the FCT Environs causing havoc and damages to loss of lives and properties (Table 2), Figure 11 – 17.

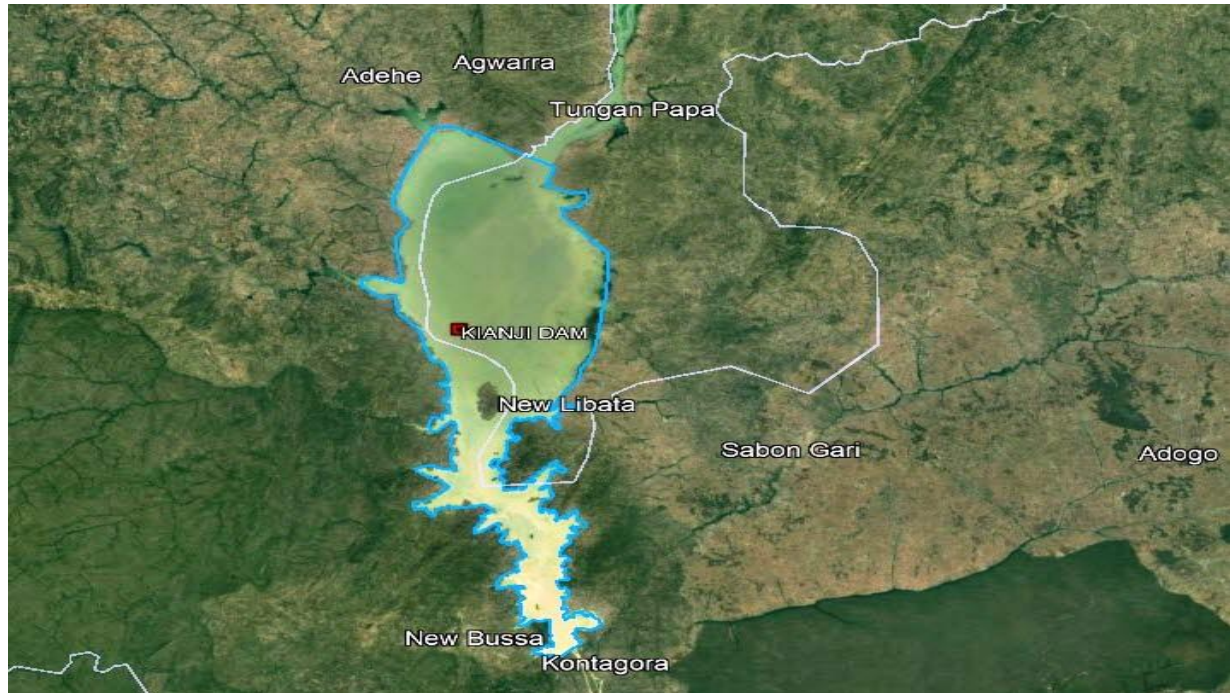


Figure 11: Kainji Dam

Source: Lithospacenig. Ltd (2022)



Figure 12: Detailed View Of Kainji Dam

Source: Lithospacenig. Ltd (2022)

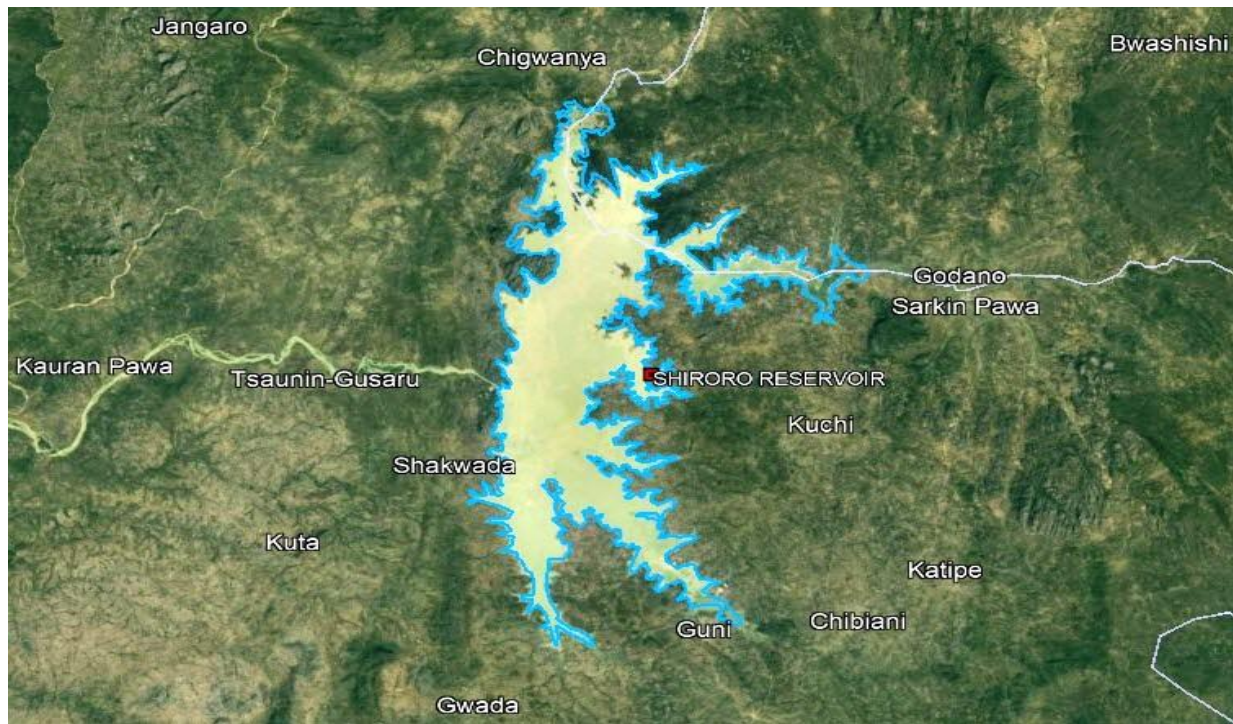


Figure 13: Shiroro Dam

Source: Lithospacenig. Ltd (2022)



Figure 14: Detailed View Of Shiroro Dam

Source: Lithospacenig. Ltd. (2022)



Figure 15: Detailed Numwi Dam

Source: Lithospacenig. Ltd. (2022)

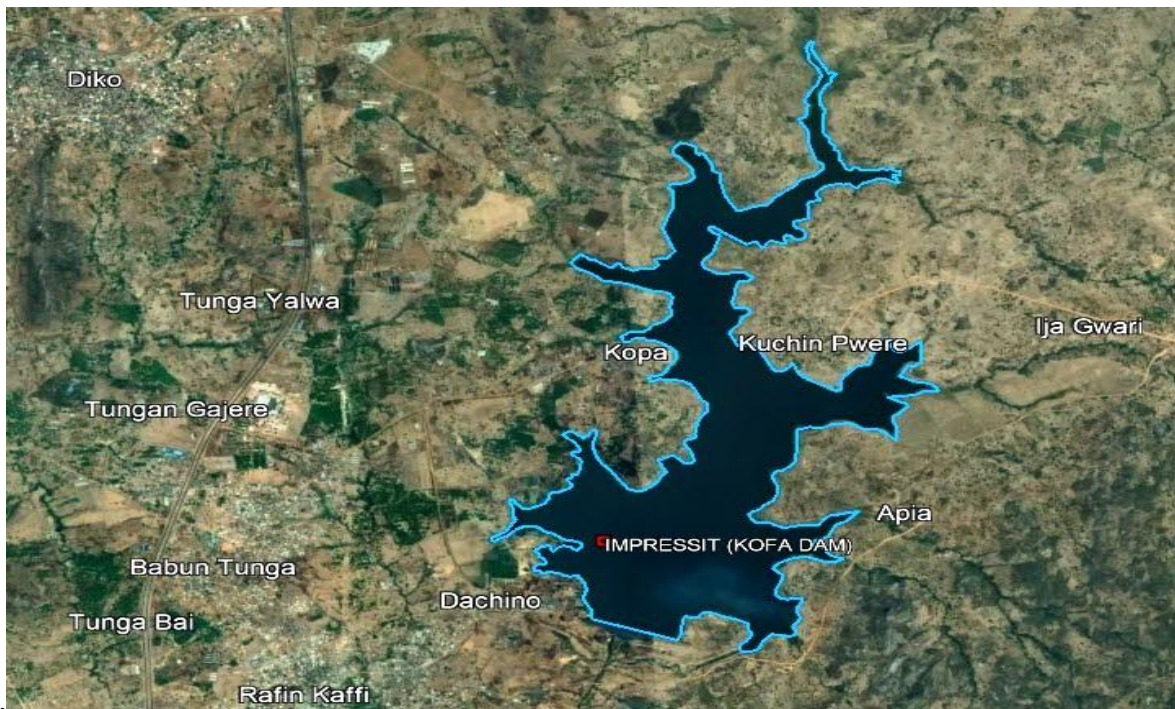


Figure 16: Impressit Dam

Source: Lithospacenig. Ltd. (2022)



Figure 17: Jimada Dam

Source: Lithospacenig, Ltd. (2022)

4.5 Existing Dams Within The Federal Capital Territory (Abuja)

There are three major dams existing within the Abuja Federal Capital Territory and the dams are being used for domestic, agricultural, industrial and other essential purposes. The Abuja Water Board strongly depends on the dams for the provision of water to the general public and a source of income to the Federal Capital Territory.

The existing dams are Usuma dam, Jabi Lake and Pedam dam, which usually gets flooded by excessive rainfall during the rainy season. The dams within the FCT get recharged by excessive water flow from other dams located at the upper-stream or higher region.

The rain water and excess water from other dams carried eroded and sediment materials or particles along its path which is being deposited at the bottom of the dams to reduce the initial sizes of the dam overtime. The dams at upper stream in the neighbouring states to include Niger, Kebbi and Kaduna State. See (Table 2), Figure 18,19 &20.



Figure 18: Usuma Dam

Source: Lithospacenig. Ltd. (2022)



Figure 19: Jabi Lake

Source: Lithospacenig. Ltd. (2022)



Figure 20: Impressit Dam

Source: Lithospacenig. Ltd. (2022)



Figure 21: Dams In North Central Nigeria

Source: Lithospacenig. Ltd. (2022)

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Flood is a global phenomenon that has a direct effect on lives and properties and flood epidemic usually during flood regime in different parts of the world mostly during the rainy season. Flood disasters usually occur as a result of negligence and non compliance to early warning for immediate relocation. However, the flood in most urban centres occur as a result of anthropogenic activities cause by human activities such building constructions on flood plains, construction of fence across water ways, indiscriminate refuse disposal being washed to drainage channels, poor drainage systems and lack of maintenance culture among others.

There have been several cases of flood disaster in the Abuja FCT with loss of lives and properties which is attributed to the same factors mentioned above. The phenomenon of flood requires an immediate intervention approach of physical planning assessment, design and sustainable measures of combating flood disaster in the urban environment to curtail loss of lives and properties.

The sustainable measures encompasses effective preventive measures for flood prone states, such as Community Based Disaster Management (CBDMD), which is a human intervention strategy for sustainable development bridging the gap between relief and development for human benefit and environmental sustainability. The process is a proactive measure of human aid, kept-in-place which prevents fire-brigade in rendering immediate assistance to flood victims.

5.2 Recommendations

1. The use of modern technology and social media can be effective in reducing the effects of disaster. Such means are the use of radio, TV, mobiles phones of various networks to send early warning messages to the public.
2. There should be awareness and sensitization campaigns through seminars and workshop on disaster preparedness strategy of averting hazards, rather than waiting for the disaster to occur.
3. Flood risk mapping can be achieved with the use of GIS Base technology for mapping out all the flood prone areas within the Abuja FCT to give early warning signals.
4. Environmental corrective measures should be practiced all over the Country and flood control is part of the environmental corrective measures. The flood control measures involve the construction of reservoirs, levees and walls, channeling of streams and construction of drainage systems.
5. A flood control measure also encompasses urban management strategy for the prevention of waste disposal in drainage channels within the urban environment. Abuja Environmental Protection Board (A.E.P.B) should strengthened its enforcement capacity and also provide adequate solid waste collection containers at strategic locations to ensure sanitary environment.
6. The existing dams at the upstream of FCT such as the Kianji Dam and the Shiroro Dam should be dredged to a certain capacity to hold large volume of water. Similarly, water reservoirs should be constructed within the FCT to drain excess water as a strategy for flood prevention during the rainy season.
7. There should be a regular consultation or collaboration between the FCT and Nigerian Meteorological Agency, on early warning of the weather conditions to enhance early disaster preparedness.

8. There should be sensitization on tree planting campaign within the FCT stating the role of trees as buffer zones, erosion control, protection buildings & roads. The Department of Development Control should include tree planning in designs as requirement for building plan approval in FCT.
9. The authority saddled with the responsibility of environmental management in FCT should collaborate with NBRRI to ensure that adequate drainage channels are constructed and retention walls are erected using durable construction materials in the flood prone areas of Abuja FCT.
10. Protecting and preserving the environment is a collective responsibility and the general public must form a unified will for the sustainability of the environment.

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