# NIGERIA HYDROLOGICAL SERVICES AGENCY

*(Water Resources Data for Sustainable Development)*

# 2020 ANNUAL FLOOD OUTLOOK (AFO)

**NIHSA**

**MAY 2020**

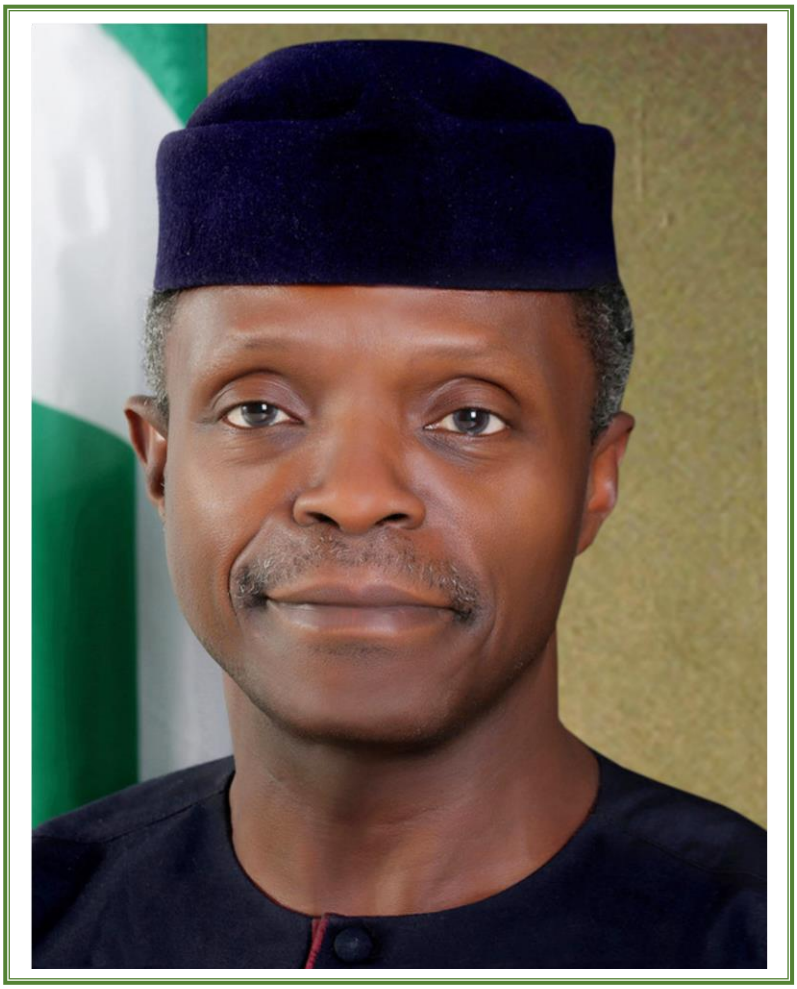
# TABLE OF CONTENTS

TABLE OF CONTENTS

*His Excellency*

**MUHAMMADU BUHARI (GCFR)**

PRESIDENT, FEDERAL REPUBLIC OF NIGERIA



**PROF. YEMI OSINBAJO**, SAN, GCON
VICE PRESIDENT, FEDERAL REPUBLIC OF NIGERIA

**ENGR. SULEIMAN H. ADAMU, FNSE, FAEng**
**HONOURABLE MINISTER**
**FEDERAL MINISTRY OF WATER RESOURCES**

**EKARO COMFORT C. (MRS)**
**Permanent Secretary**
**Federal Ministry of Water Resources**

**ENGR. ATIKU A. AHMED DUNGURAWA, MNSE**
**Board Chairman**
**Nigeria Hydrological Services Agency (NIHSA)**

**ENGR. CLEMENT ONYEASO NZE**
**Director General**
**Nigeria Hydrological Services Agency (NIHSA)**

# FOREWORD

The Nigeria Hydrological Services Agency (NIHSA), charged by Act to issue forecasts for floods and droughts, has for the past eight years been supplementing its efforts on flood prevention by means of production and publication of the Annual Flood Outlook (AFO). The publication of AFO came into force following the disastrous flood of 2012. The aim of the AFO is to present probable flood scenarios in a given year and a practicable means of preventing the reoccurrence of the 2012 flood disaster with its resultant loss of lives and property, devastation of agricultural and industrial areas, disruption to infrastructure and communication facilities, and interruption of highway traffic and river navigation, and socio-economic well-being.

Over the years, the Federal Government has been putting many flood control measures in operation which have proved to be effective. However, building resilience to natural disasters is one of the most pressing challenges for achieving sustainable development in the country. Flood is one of the most frequent natural disasters in Nigeria, with devastating impacts on the poor and vulnerable populations who live along river courses and are dependent on the productivity of the river ecosystem and the fertile floodplains for their livelihoods. According to NEMA, in 2012 alone, floods caused more than N2.6 trillion in economic damage, much of which could be attributed to large-scale transboundary floods (from rivers Niger and Benue). In 2019, about 126 deaths were recorded, over 48,000 people were displaced and property worth millions of Naira destroyed across the country.

Flood forecasting and early warning are among the most effective flood risk management strategies to minimize the negative impacts of floods. Recognizing this, NIHSA, in addition to expanding its telemetry system and upgrading its hydrological models for early warning of floods, developed a Flood Mobile App to

enhance the operational capacities of flood forecasting and early warning systems in the riparian communities. It is believed that if the riparian dwellers and the grassroots could effectively utilize this new tool, more lives and livelihoods would be saved from flood disasters.

The Flood Mobile App which will provide information on flooding events in the country has been developed to supplement the AFO publication and to provide operational back-up for more effective flood forecasting. I would like to point out that the Flood Mobile App is still undergoing review so as to achieve the much-desired real time flood information and update. To this end, valuable feedbacks would be highly appreciated.

It is my hope that this 8th edition of the Annual Flood Outlook and the new Flood Mobile App would be of practical value to water managers, technical experts, disaster risk managers, policy makers, and the flood forecasting community for flood prevention and for enhancing flood early warning systems in Nigeria.

**Engr. Suleiman H. Adamu,** ***FNSE, FAEng*****.**
Honourable Minister of Water Resources
May 2020.

# ACKNOWLEDGEMENT

This 8th edition of Annual Flood Outlook (AFO) is a product of the support of the Honourable Minister for Water Resources, Engr. Suleiman H. Adamu, *FNSE, FAEng,* to the Agency and his firm belief in the Agency to present, in line with its mandate, consistent and accurate forecasts of flooding events in the country to the acceptance and admiration of the general public and stakeholders in the water sector.

I wish to put on record the huge support and the understanding of the Governing Board of the Agency under the Chairmanship of Engr. Atiku A. Ahmed Dungurawa, *MNSE*.

I am indebted to the Permanent Secretary, Federal Ministry of Water Resources, Ekaro Comfort C. (Mrs.) for encouraging the Agency's activities and the publication of this Annual Flood Outlook.

The commitment of relevant technical experts, consultants and key stakeholders for their immeasurable contributions and insights to giving each edition of AFO an in-depth analysis is highly commendable. I thank our collaborating Agencies like the National Space Research and Development Agency (NASRDA), National Water Resources Institute (NWRI), Nigerian Meteorological Agency (NiMet), Nigeria Integrated Water Resources Management Commission (NIWRMC), Office of the Surveyor General of the Federation (OSGOF), River Basin Development Authorities (RBDAs), to mention but a few, and professional organizations for their unquantifiable support.

The Agency appreciates the intervention of the Nigeria Erosion and Watershed Management Project (NEWMAP) in upgrading the Hydromet system in the project targeted basins. The data from the installations have been valuable. In a similar vein, the Hydromet Component of the Transforming Irrigation Management in Nigeria (TRIMING) Project has also boosted the hydrological activities in the northern part of the country.

Let me thank, most sincerely, the management and staff of Nigeria Hydrological Services Agency (NIHSA) for giving me the much-needed support for the success of this publication.

I am optimistic that this 8th edition of the Annual Flood Outlook will go beyond borders and defer all barriers to reach the needy and it will achieve its sole purpose of providing information on flood early warning which is required for mitigating the flood risks in the country.

**Engr. Clement Onyeaso Nze**
Director General
May 2020.

# EXECUTIVE SUMMARY

The Annual Flood Outlook (AFO) by the Nigeria Hydrological Services Agency (NIHSA) is in line with its' statutory mandate which amongst other functions is to issue forecasts on flood, sensitize Nigerians on flood management towards mainstreaming disaster reduction efforts for sustainable socio-economic development. This is intended to sensitize the general public particularly those living in the coastal and riverine areas, including cities and communities along the trans-boundary Rivers Niger and Benue that are often at high risk of flooding. The AFO which was first published in 2013 after the devastating flood of 2012 in Nigeria, has the primary intent of creating awareness and proffering mitigation measures. The 2020 edition is the eight in the series.

The AFO and its sensitization exercise by NIHSA have yielded positive results through tremendous reduction in loss of lives, quantum of damages to goods and property, infrastructure and socio-economic activities.

The flood scenarios as presented in the AFO are derived from the application of two reliable models: Geospatial Stream Flow Model (GeoSFM) and the Soil and Water Assessment Tool (SWAT). These models utilize hydrological and hydrogeological data, topographical and soil/water balance index, as well as Digital Elevation Model (DEM).

The results shows that 102 LGAs in 28 States fall within the highly probable flood risk areas, while 275 LGAs in the 36 States of the Federation including the FCT fall within the moderately probable flood risk areas. The remaining 397 LGAs fall within the low probable flood risks areas.

Some coastal States, like Rivers, Cross River, Delta, Lagos, Ondo, and Bayelsa are expected to experience coastal flooding due to rise in sea level and tidal surge which would impact on fishing, habitation and coastal transportation.

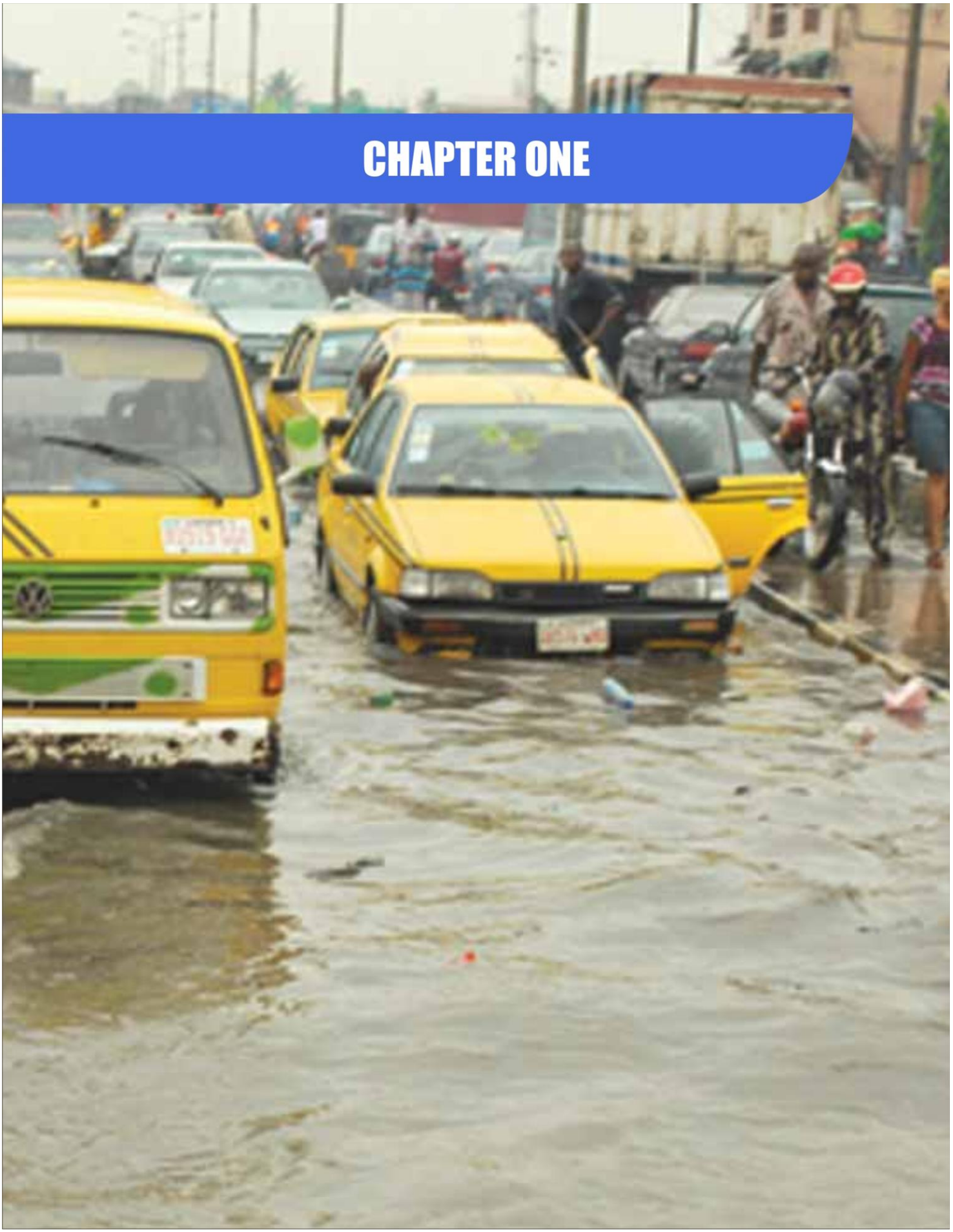
Flash and Urban Flood are also expected to occur in some locations such as Birnin–Kebbi, Sokoto, Lokoja, Kaduna, Suleja, Gombe, Yola, Makurdi, Abuja, Lafia, Asaba, Port Harcourt, Yenagoa, Lagos, Ibadan, Abeokuta, Benin City, Oshogbo, Ado-Ekiti, Abakaliki, Awka, Nsukka, Calabar, Owerri, Maiduguri, Kano, and major cities with poor drainage systems.

The simulated hydrographs of gauging stations at Tiga, Kainji, Ologbo, Kende, Geidam, Ikom, Lokoja, Malabu, Okitipupa, Onitsha, Siluko, Zungeru, Abeokuta, Dadin Kowa, Hadejia, Kafin Gana, Katsina-Ala, Makurdi, Shiroro, Afikpo, Ebba,Gassol, Baro, Kurawa, Umaishia, Otuocha, Wuya, Donga, Chokocho, and Ogun, show gradual increments in flood discharge, however, the predicted probable flood areal coverage in 2020 is expected to be lower than that of 2019.

This AFO contains useful information on the areas that are likely to be flooded and the severity of the expected flooding in 2020. The need to carry out aggressive sensitization and awareness campaigns cannot be over-emphasized. Similarly, consistent clearing of our water ways and maintenance of hydraulic structures such as dams and reservoirs are very essential as this will ensure free flow of runoff into the provided drainages.

Stakeholders, decision and policy makers, relevant federal and state government departments and agencies should take note of the information contained in the 2020 AFO and prepare in advance. Finally, it is advised that the predictions of flood for 2020 AFO be adhered to and all recommendations heeded.

# CHAPTER ONE



# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 PREAMBLE

According to the World Meteorological Organisation (WMO) "No one is surprised by a flood". However, it is also true conception that natural hazards such as floods and droughts cannot be eradicated, but a timely and accurate prediction of hydrometeorological extremes help societies to prepare for, mitigate disasters and reduce damages to infrastructure and socio-economic activities.

Flood is the most devastating natural disaster affecting many regions of the world every year. According to the World Meteorological Organization (WMO), there has been an exponential increase in the damages caused by flood during the past decades mostly as a consequence of the effects of climate change. Nigeria is not an exception to this trend and has experienced several flood disasters. The most notable incidences are 2012 and 2018 devastating floods in which many lives were lost, property damaged and general disruption of livelihood with attendant adverse socio-economic consequences. The 2012 flood for instance led to the displacement 387,153persons, destruction of infrastructure, disruption of socio-economic activities valued at US Dollars 16.9 billion (1.4% GDP) and sadly the loss of 363 lives (Post Disaster Needs Assessment- PDNA,2012).

The Nigeria Hydrological Services Agency (NIHSA), a parastatal of the Federal Ministry of Water Resources, is saddled with the responsibility amongst others, to advice the federal and state governments on all aspects of hydrology. NIHSA in fulfillment of its mandate over the past years has steadily continued to inform the Nigeria public on the flood outlook with an improvement on the quality and quantity of data as well as the models used in producing the AFO. This has led to

improved flood forecast leading to reduction in the harmful effects of flood on the communities that have heeded the warnings and carried out remediation actions contained in the past editions.

In its effort to address the challenges posed by perennial flooding in Nigeria, the current administration, through the unrelenting efforts of the Honourable Minister of Water Resources, *Engr. Suleiman H. Adamu*, *FNSE, FAEng,* has consistently advanced steps at mitigating the effects of flooding across the nation. It is pertinent to state that series of erosion control and various urban infrastructural development projects have been undertaken, early warning and sensitization on flood risk areas and efforts of the stakeholders on mitigation have also reduced and prevented negative impacts of flooding in some areas of the country.

In line with the earlier publications, this year's AFO contains useful information on the areas that are likely to be flooded and the severity of the expected flood. Furthermore, clear advice on measures to take before, during and after flooding are enshrined herein. These important initiatives should continue to be deployed to implement appropriate counter-measures (structural and non-structural) to alleviate the persistent threats of water related disasters.

The Annual Flood Outlook serves as an important guide in reducing flood risks and vulnerabilities, thereby contributing to economic growth and national sustainable development.

## 1.2 THE PHYSICAL SETTING

**Location and Spatial Extent**: Nigeria is located within the western coast of Africa, slightly north of the Equator. The Atlantic Ocean washes its entire southern part while the fast encroaching arid zone south of the Sahara Desert borders its northern part. It lies approximately between latitudes 4°N and 14°N and between

longitudes 3°E and 15°E, encompassing a vast geographical area of contrasting landforms, climatic conditions and vegetation belts.

The surface area of the country is approximately 923,800 sq. km and, with about 200 million people. It is bordered by the Republic of Cameroun to the east, Niger Republic to the north and Benin Republic to the west. The southern boundary is formed by the 800 km Atlantic coastline, which includes the eastern sector of the Gulf of Guinea.

Nigeria is naturally divided into three regions, the north, west and east, by the valleys of its two principal rivers, the Niger and the Benue.

The three regions consist of distinctive relief features including highlands and plateaux, uplands and plains, escarpments and valleys, and coastal wetlands and delta (Figure 1.1). Thus, the north has the Jos Plateau located in its eastern central area. It also has the Adamawa Mountains along the eastern border, north of the Benue valley. The west has the uplands and plains studded with inselbergs, while the eastern region has the escarpments and the Eastern Borderlands plateau and highlands (Bamenda Mountains and the Mambilla Plateau). The mountains, plateaux and highlands are made of igneous and metamorphic rocks. In general, the uplands and plains are denudation surfaces derived from the long-term denudation of crystalline rocks mainly of the Precambrian Basement Complex suite (granite, gneiss, quartzite, amphibolite and schist). In the central north, the plains are called the High Plains of Hausa land, and they, along with the Jos Plateau, form a major headwater zone from where rivers radiate forming a radial drainage pattern. The Eastern Borderlands constitute headwaters for some of the tributaries of River Benue, Lake Chad and River Cross. In western Nigeria, the uplands comprise the Yoruba Hills and Ranges and its extension, the Kukuruku Hills. The ranges and hills constitute a major drainage divide separating the rivers running southwards into the Gulf of Guinea from those running eastwards and northwards into the

River Niger. Most of these rivers run parallel to each other and the drainage pattern is trellised where it is structurally controlled or otherwise dendritic.

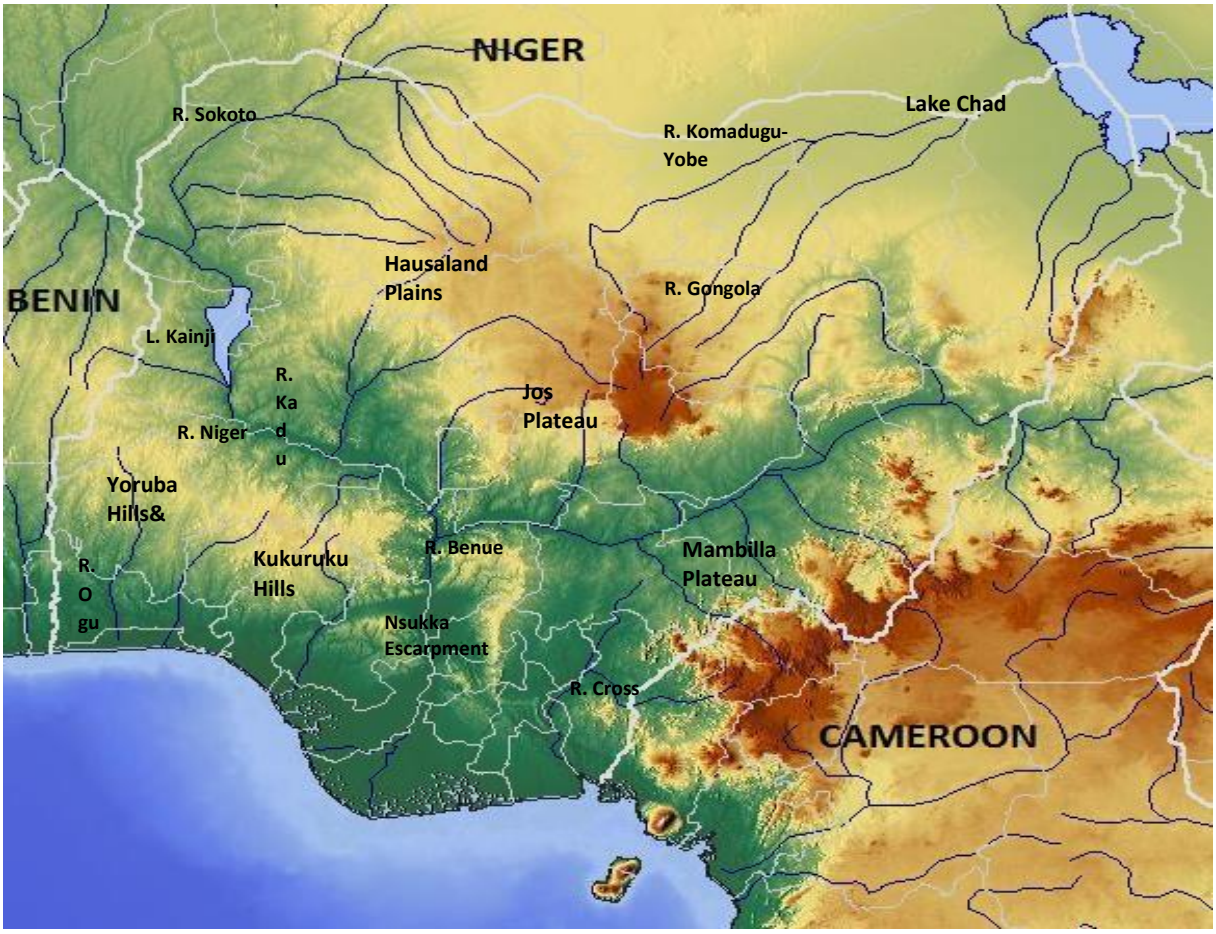



Fig. 1.1: Generalized relief map of Nigeria

Another category of plains consists of aggradations land surfaces and are found in areas bordering the denudation land surfaces. The Sokoto Plain (in the northwest), and the Kerri–Kerri and the Gombe Hills (to the east of the Jos Plateau) belong to this category. They are composed of Cretaceous to Tertiary age sedimentary rocks. The Kerri–Kerri merges to the north with the Quaternary plains of the Chad Basin. The drainage pattern on these plains is centripetal with a focus on the Lake Chad in the east, and the Sokoto valley in the west (Figure 1.1). Similar aggradation surfaces extend over the areas bordering the southern and eastern margins of the Yoruba/Kukuruku Hills and Ranges. These extend to the coast where they form

coastal plains associated with barrier islands, and fresh water, brackish water and marine wetlands. The plains also extend eastwards across the Niger valley into eastern Nigeria where they constitute the Anambra and the Cross River plains. In central eastern Nigeria, the plains are composed of resistant rocks that form the Awka–Orlu, and the Nsukka–Okigwe escarpments. These latter constitute drainage divides separating rivers draining into the Niger (e.g. River Anambra) and the River Imo from those draining into the River Kwa Ibo and River Cross.

The coastal zone consists of four contiguous physiographic types, each terminating landward at the southern boundary of the Coastal Plains. These are the Barrier Beach–Lagoon complex, Transgressive mud coast and associated wetlands and intertidal flats, Niger delta and its distributary system, characterized by barrier islands separated by tidal channels and backed by extensive mangrove swamps, Strand coast–estuary complex consisting of narrow sandy beaches backed by coastal plains and rather limited wetlands.

The climate at any location in Nigeria is directly related to the distance from the Atlantic coast (Figure 1.2), except where coastal upwelling on the one hand, and inland orographic effects on the other, provide counteracting influences. The climate type within 100 km of the coast is the Koppen's$A_f$ humid tropical type, with mean rainfall ranging from 1800mm at Lagos in the west, to amounts in excess of 4000 mm in the area proximate to the River Cross estuary (Eket, Akwa Ibom). Landward, at distances exceeding 200 km from the coast in western

Nigeria, and 250 km in the east, the Koppen's $A_{w1}$ wet and dry climate type prevails. The rainy season extends from April to October with mean annual rainfall in excess of 1200 mm**.** This is the zone referred to as the Guinea Savanna given its diagnostic floral composition. Between the Guinea Savanna and the Humid Tropical $A_f$ climate or rain Forest zone is an area described as Derived Savanna, an anthropogenic derivative from the Rain Forest but with characteristics similar to those of the Guinea Savanna (Figure 2). The northern boundary of the

Koppen'sA$_{w1}$ region follows a line extending from the northern end of the Lake Kainji to the northern foreland of the Jos plateau, after which it dips southwards towards the Mambilla plateau. Northward of this region, the prevailing climate is the Koppen's A$_{w2}$ Tropical Wet and Dry (Sudan type). The Koppen'sBshw (Sahel type) prevails in the extreme northeast of Nigeria. Mean annual rainfall in these two climatic zones varies from less than 400 mm in the distal northeast to approximately 1000 mm in the southwest, along the boundary with the Koppen's A$_{w1}$ zone. The length of the rainy season varies from three months in the northeast (July – September) to six months (in the south) (May –October). The dry season lasts variously from October to May, during which, cold and dry Harmattan winds prevail, particularly between November and February. The rainfall and number of rain–days both decrease rapidly northwards (Ogunkoya, 2017).

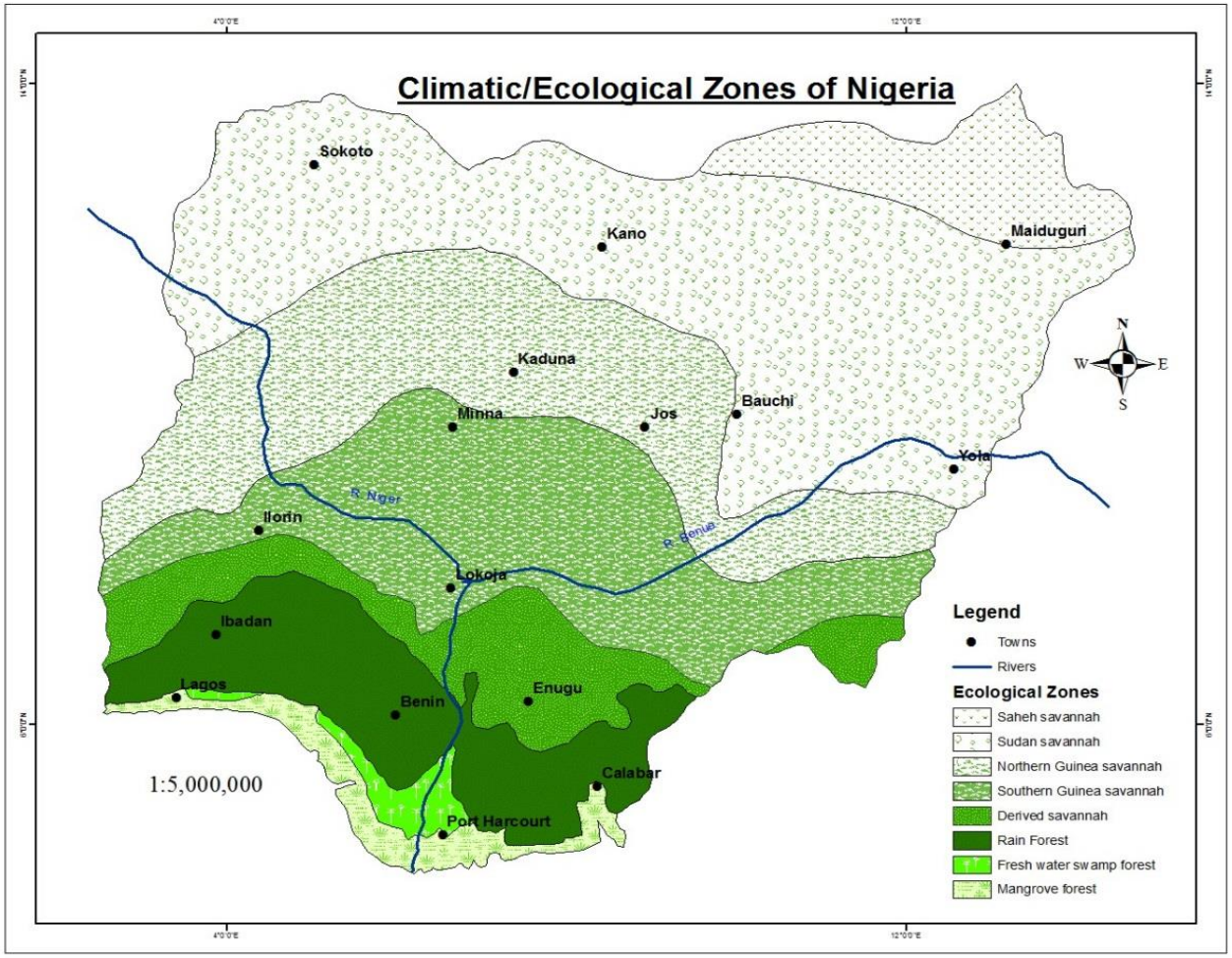



*Fig. 1.2: Climatic/Ecological Zones of Nigeria*

## 1.3 THE RIVER SYSTEMS OF NIGERIA

The large number of high order rivers and the well–drained nature of the country present a picture of inexhaustible water resources (Figure 1.3). However, the climate over Nigeria imposes a regime on many of the rivers such that there is a rainy season of high water and a dry season of little or no water within the average year.

The rivers in Nigeria can be grouped into five drainage systems:

- Niger (i.e. the Niger and its tributaries apart from the Benue)
- Benue (the Benue and its tributaries)
- Chad (Lake Chad and all its tributaries)
- Cross River/Imo/Qua-Iboe and all the short rivers draining the eastern littoral zone
- •Western littoral rivers (the rivers of western Nigeria that follow more or less regular courses in the N – S direction.

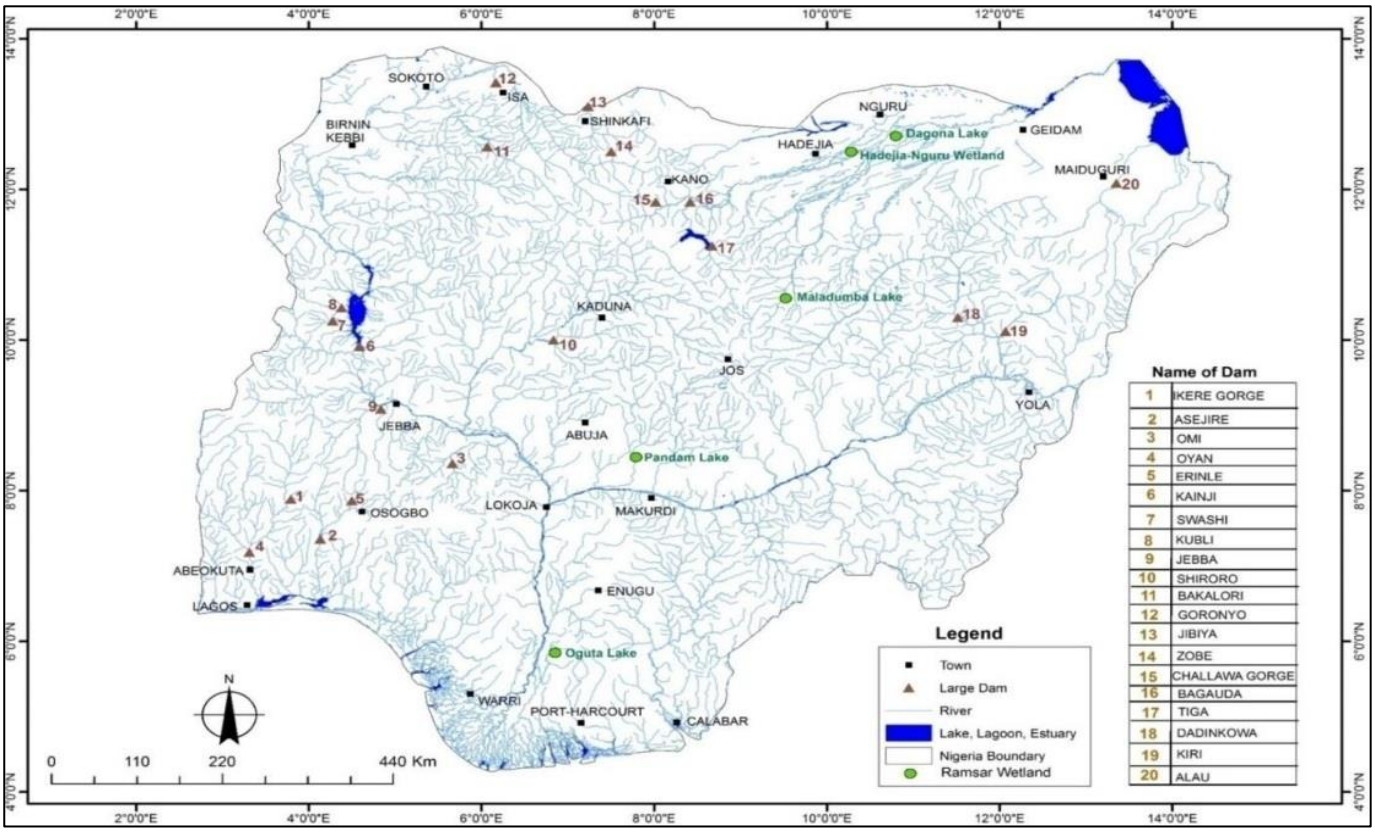



*Fig. 1.3: Map of Nigeria Showing Drainage System*

The division of these rivers into the five groups is not based on any peculiar characteristic but that of proximity and similarity in the direction of flow. Except for the Chad drainage system, which is an endorheic drainage system, all the other drainage systems ultimately drain into the Gulf of Guinea. The rivers flowing into Lake Chad from Nigeria (mainly River Komadugu–Yobe, River Ngadda and River Yedseram) provides 10% inflows into the lake. The other tributaries of the Lake Chad originate from Cameroon, Chad and Central African Republic (including Chari and Logone), which provides 80% of the inflow, while precipitation provides the remainder 10%.

The Nigeria's drainage system have been divided into eight Hydrological Areas or Basins based on the drainage patterns (Figure 1.4 and Table 1):

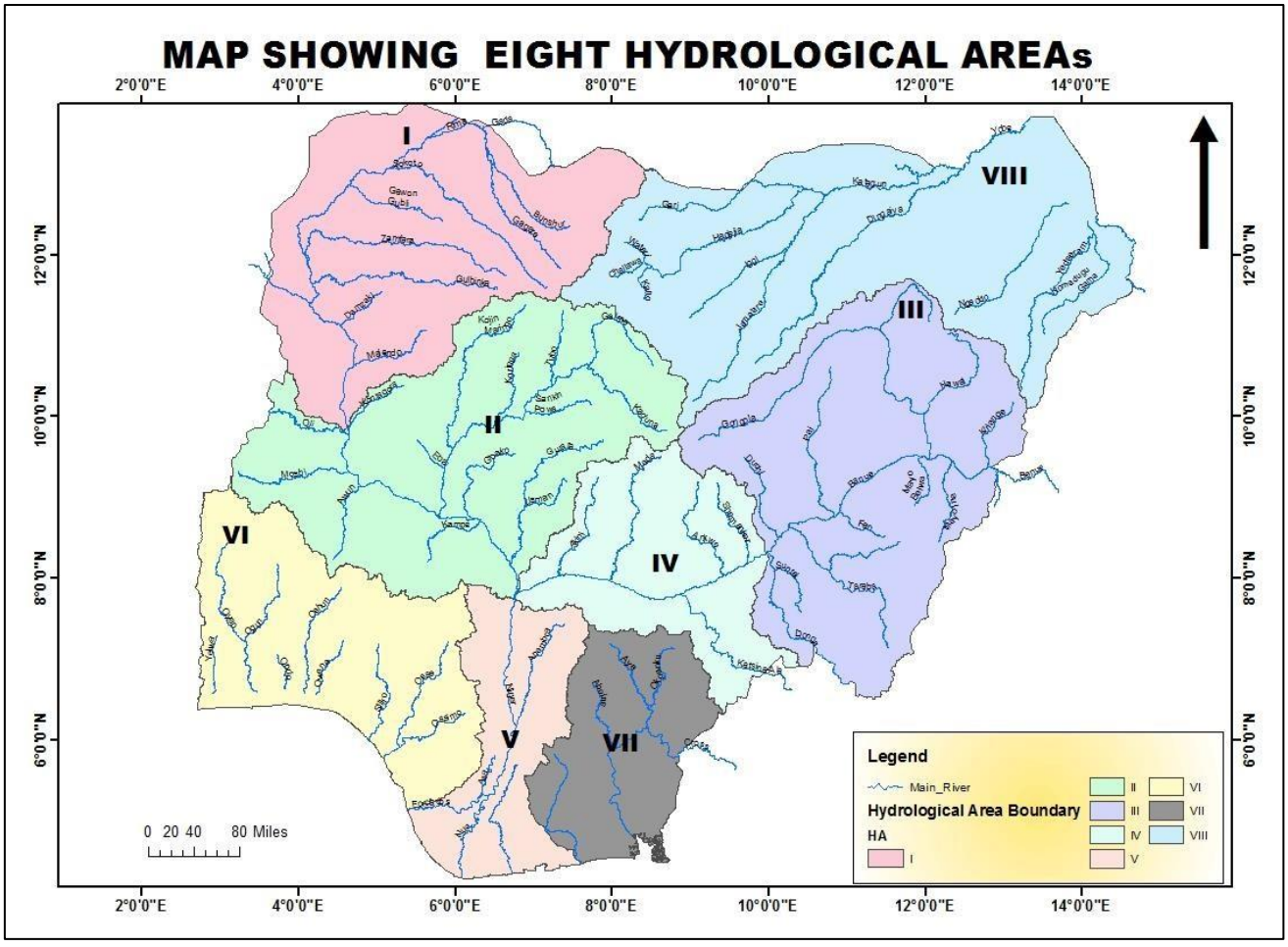



*Fig. 1.4: Hydrological Areas of Nigeria*

**Table 1: The Eight (8) Hydrological Areas – Principal drainage system**

| Hydrological Area | Drainage Area ($Km^2$) | Description |
|---|---|---|
| HA I: Niger North | 131,600 | Consists mainly of the Sokoto–Rima drainage basin and some relatively small drainage basins in the northwestern zone of the country. All the rivers drain directly or otherwise into River Niger. |
| HA II: Niger Central | 158,100 | Consists mainly of the Kontagora, Kaduna, Gbako, Gurara, Moshi, Oyi–Kampe and some smaller drainage basins discharging into the middle section of the River Niger (Kainji Dam – Lokoja). |
| HA III: Upper Benue | 158,900 | Mainly the Gongola, Donga and Taraba drainage basins though it includes numerous but small rivers draining directly into Benue. |
| HA IV: Lower Benue | 73,000 | Rivers Mada, Ankwe, Shemankar, Katsina Ala and many others that drain into the Benue from the north and south between the confluence with the Niger and some distance east of Makurdi. |
| HA V: Niger South | 53,900 | Consists of tributaries such as the Mimi, Orle, and the Anambra discharging into the main trunk of the Niger, and the Ase, Orashi and Sombreiro, which drained into Upper Niger Delta. |
| HA VI: Western Littoral | 100,500 | All the north–south flowing rivers in the southwestern zone of the country. |
| HA VII: Eastern Littoral | 59,800 | Consists of the rivers draining eastern Nigeria, including Cross River and River Qua-Iboe, which drained into the Gulf of Guinea. |
| HA VIII: Chad Basin | 188,000 | Consists of the rivers draining into the Lake Chad. The principal rivers are the Hadejia, Gana-Komadugu–Yobe, Ngadda and Yedseram. |

## 1.4 CAUSES OF FLOODING IN NIGERIA

The soil moisture regime of the lower lying plains during the peak of raining season, the prevailing extreme weather conditions presumed to be associated with climate change, dam operations particularly outside the nation's borders, and topography have promoted significant flooding in recent times. Floods have since become annual, ubiquitous raining season phenomena not only within floodplains in Nigeria, but also in her urban and semi-urban areas.

Large parts of Nigeria were subjected to massive flooding and long-term inundation (> 2months) between June and October 2012. These were the consequences of extreme rainfall events that marked the raining season of that year; river channel inadequacy and dam operations, particularly, that of the Lagdo dam on the River Benue in the neighbouring Republic of Cameroun. There was also urban flooding linked to inadequacies of drainage systems that had become too small to contain excess runoff, the use of river channels as waste repositories thus clogging the channels, poor compliance with or non-existence of land use zoning/building codes, poor waste management practices and removal of trees that create resistance and minimize flood impact.

Moreso, urbanization that was hitherto confined to higher elevations and levees encroached into lower areas including the flood plains. Typical dwellers in these regions are traditionally fishermen or people who depend on water for agriculture and other purposes. Hence, population growth and urbanization tend to begin from areas near water bodies and proceed outwards.

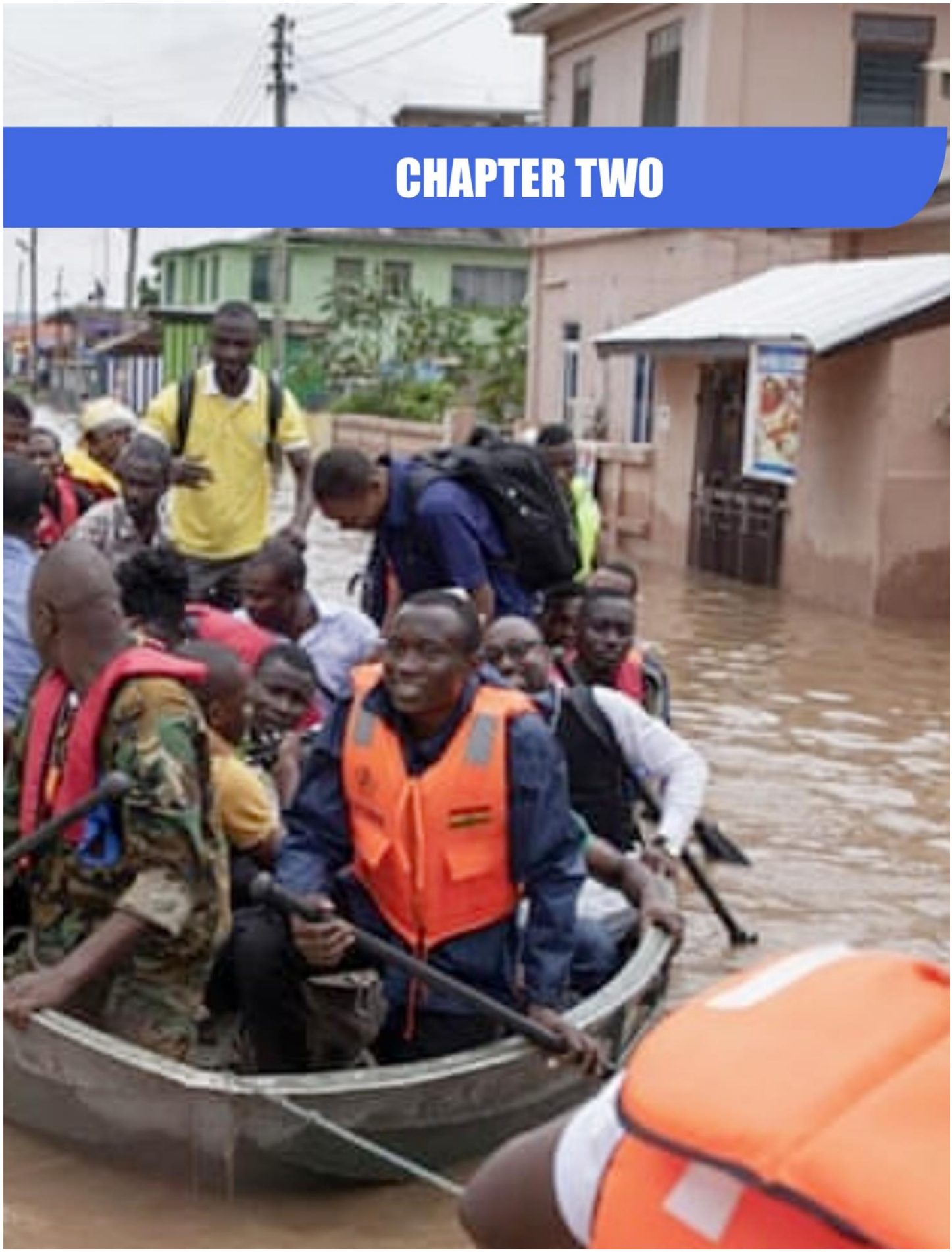
Coastal areas of Nigeria are not spared from flooding. A cause could be the continuing global warming and associated extreme events (IPCC, 2007). Rising temperatures cause glaciers to retreat and ice caps to melt promoting sea level rise by the added water from melting ice and the expansion of sea water as it warms. Also, mangroves that provided buffers to cushion flooding is fast degrading along the Nigeria coastline, thus exacerbating flood impact. The flooding is always more

severe during high tides when coastal drainage is obstructed. Figures 1.5 and 1.6 show some flood scenes in the country in 2019.

*Fig. 1.5: Property erected along river courses that were destroyed by flood in 2019.*


*Fig. 1.6: Flooding at EFAB Estate, Lokogoma, Abuja, 2019.*

# CHAPTER TWO



# CHAPTER TWO

## 2.0 EVALUATION OF THE 2019 ANNUAL FLOOD OUTLOOK (AFO)

### 2.1 INTRODUCTION

The prevalence of flooding within Nigeria has been generally attributed to climate change and poor urban planning. In order to avert and reduce the impact of flooding in Nigeria, Nigeria Hydrological Services Agency (NIHSA) has since 2013 consistently published yearly predictions of flood scenarios and extents which serve as a pointer to areas that are likely to be flooded and invariably provide useful guide to flood mitigation and control measures.

The 2019/2020 Hydrological Year began in June 2019 with resultant increase in water level and discharge across the river channels in the country. Water Level (WL) downstream the confluence of rivers Niger and Benue at Lokoja (Kogi State), steadily rose from a minimum of 4.89m corresponding to a discharge of 6,638$m^3$/s on the 1$^{st}$ July 2019 to a maximum of 10.99m corresponding to a discharge of 24,800$m^3$/s on 5$^{th}$ November 2019 (Fig.2.1).

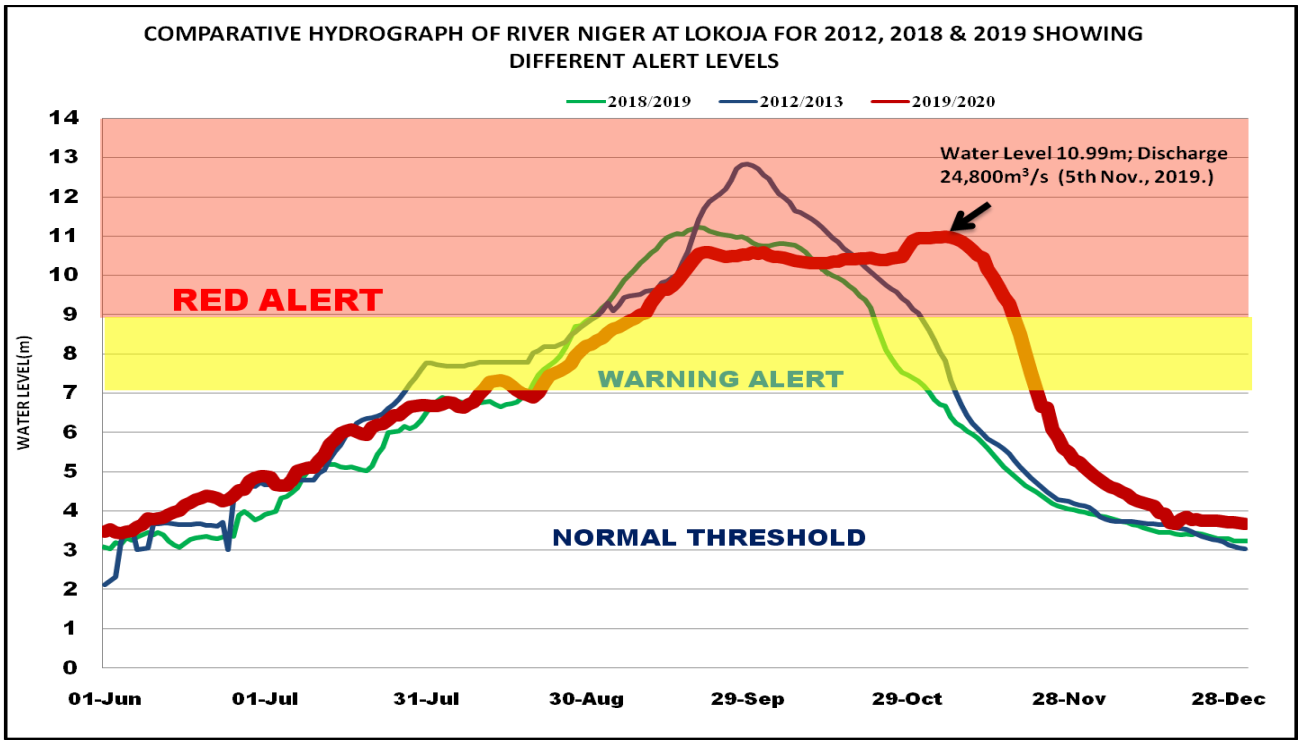



*Fig.2.1: Comparative Hydrographs of river Niger downstream the Confluence in Lokoja.*

The increase in water level due to persistent rainfall resulted to different degrees of flooding across the eight hydrological areas. Figure 2.2 shows flooding in Rann, Borno State due to increase in water level of transboundary river Kaalia in Cameroon. Eighty-eight (88) LGAs in thirty-two (32) states experienced flooding as at 30th August, 2019. By December, 2019, the number of reported flood incidents across the country rose to One hundred and eighty-four (184). Appendix I.

*Fig. 2.2: Flooding in Rann, Borno State, Nigeria. Credit: GISCOR*

So far, the Agency has successfully produced seven (7) editions of the AFO (2013-2019), recording a remarkable success as the number of displaced persons, property loss, number of deaths and casualties has reduced compared to that of 2012 (Table 2.1). The AFO has helped in mitigating the effects of flood within the country through its awareness campaigns on the effects of human activities on drainage systems, such as dumping of refuse, erecting of structures on floodplains and other indiscriminate actions that interfere with the free flow of water.

Table 2.1: Showing indicators for measuring the success of AFO

| S/No | Flood Scenario | 2012 | 2018 | 2019 |
|---|---|---|---|---|
| 1 | Number of Death | 363 | 204 | 126 |
| 2 | Displaced persons IDPs | 2.1 million | 210,206 | 48,114 |
| 3 | Property loss (In Naira, ₦) | 1Trillion | 246Billion | 176Million |
| 4 | Predicted (flooded LGAs) | - | 319 | 356 |
| 5 | Actual (flooded LGAs) | 489 | 172 | 184 |

*Source: NIHSA Field Assessment, Daily News Papers and NEMA flood - situation reports. The difference in the predicted and actual occurrence is as a result of the Agency's sensitization campaigns and compliance by the general public on appropriate mitigation measures.*

The Agency uses two (2) models, Geospatial Stream Flow Model (GeoSFM) and Soil and Water Assessment Tool (SWAT) to simulate flood level for forecast in the eight (8) Hydrological Areas (HAs) of the country in GIS (Arcmap) environment using Local Government Areas boundary to delineate flood extent. It should also be noted that the 2012 flood scenarios have been used as a reference point for flood assessment. The analysis of the model performance is in Table 2.2 and Figure 2.3. The analysis shows that the two (2) models used is effective and the Agency look forward to adopting more improved models.

**Table 2.2: Performance of NIHSA's Models from 2013 - 2019**

| S/No. | YEAR | PERFORMANCE | REMARK |
|---|---|---|---|
| 1. | 2013 | 70% | Maiden edition |
| 2. | 2014 | 63% | Decreasing trend |
| 3. | 2015 | 55% | Decreasing trend |
| 4. | 2016 | 53% | Decreasing trend |
| 5. | 2017 | 53% | Decreasing trend |
| 6. | 2018 | 53% | Decreasing trend |
| 7. | 2019 | 52% | Decreasing trend |

*The decrease in trends is as a result of the Agency's sensitization campaigns and compliance by the general public on appropriate mitigation measures*.

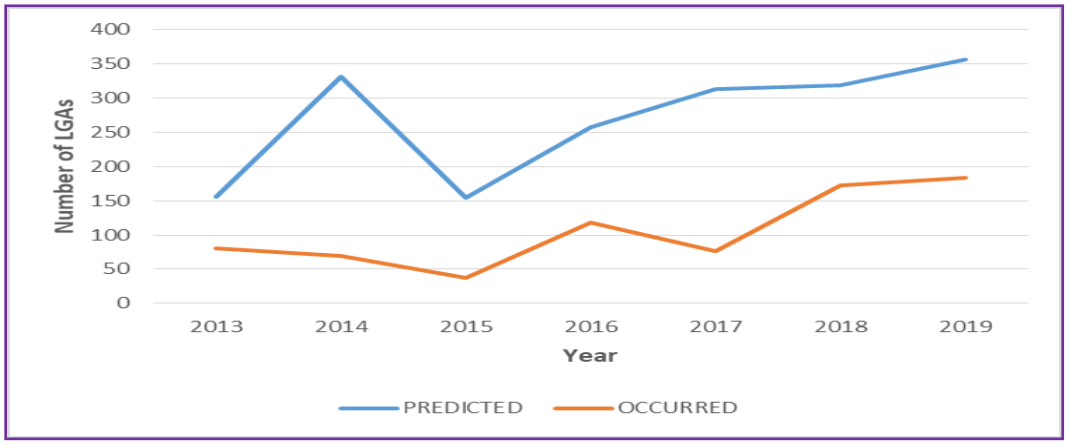



*Fig. 2.3: Graph Showing the Trend of NIHSA's model prediction and occurrence from 2013- 2019.*

## 2.2 Evaluation of the 2019 Flood Incidences and AFO

In 2019, flood incidences were recorded across the country. The central and south-eastern states were particularly affected. As at 7th October, 2019, the International Federation of the Red Cross and Red Crescent Societies (IFRC) reported 12 fatalities (11 in Niger and 1 in Cross River states), 4,485 people displaced (2,300 in Taraba, 1,129 in Niger, and 1,056 in Cross River states). In 2019, a total of 130,934 persons were affected by the flood; 48,114 were internally displaced, while 26,356 houses were affected (*NEMA 2019 floods summary*). Figure 2.4 shows 2019 flood incident in Igbodo community, Delta State.

*Fig. 2.4: Flood incident in Igbodo community, Delta (Credit: Gallant Reporters July, 28, 2019).*

The flood forecast for 2019 was classified into three (3) categories: Highly Probable, Probable and Less Probable Risk Areas. The predicted and actual flood risk areas for 2019 are shown in Figures 2.5 and 2.6 respectively while Tables 2.3 and 2.4 show the comparative analyses of flood events in 2018 and 2019.

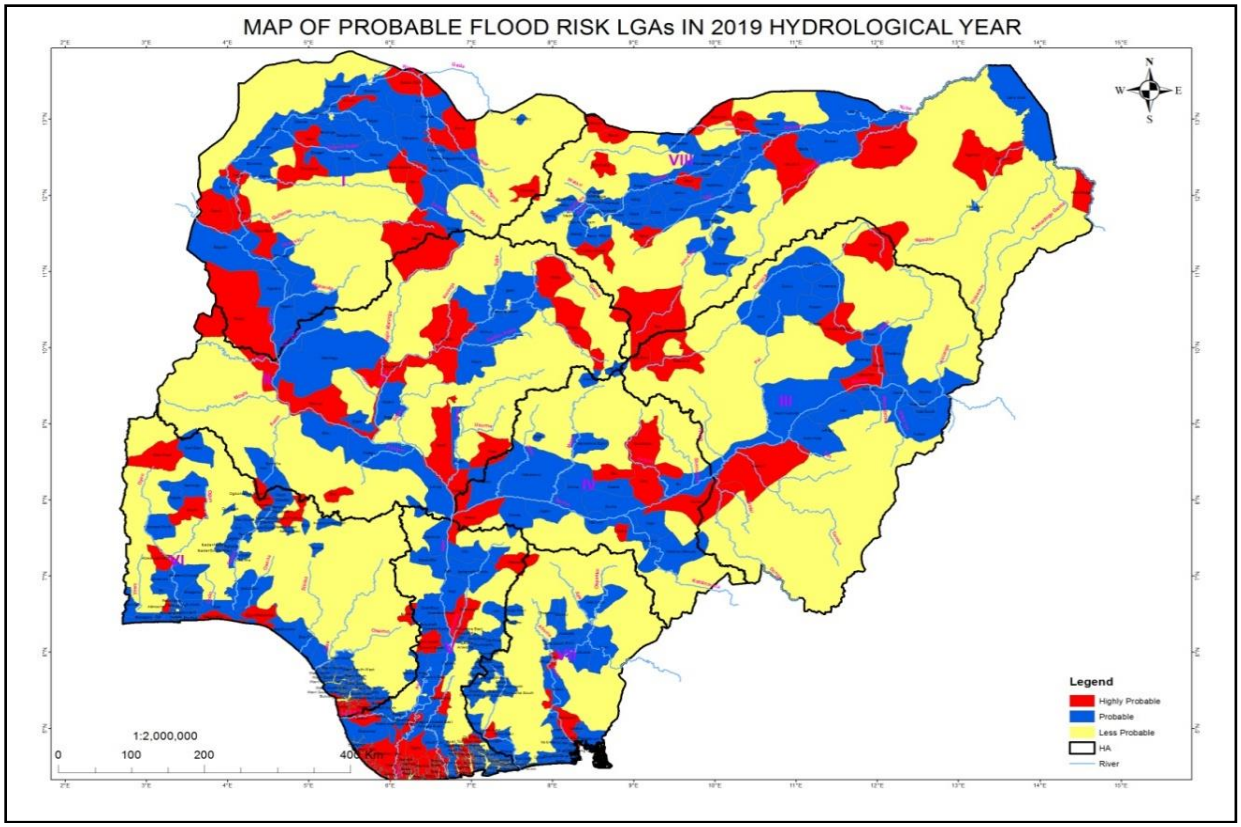



*Fig. 2.5: Map of Nigeria Showing Probable Flood Risk LGAs in 2019.*

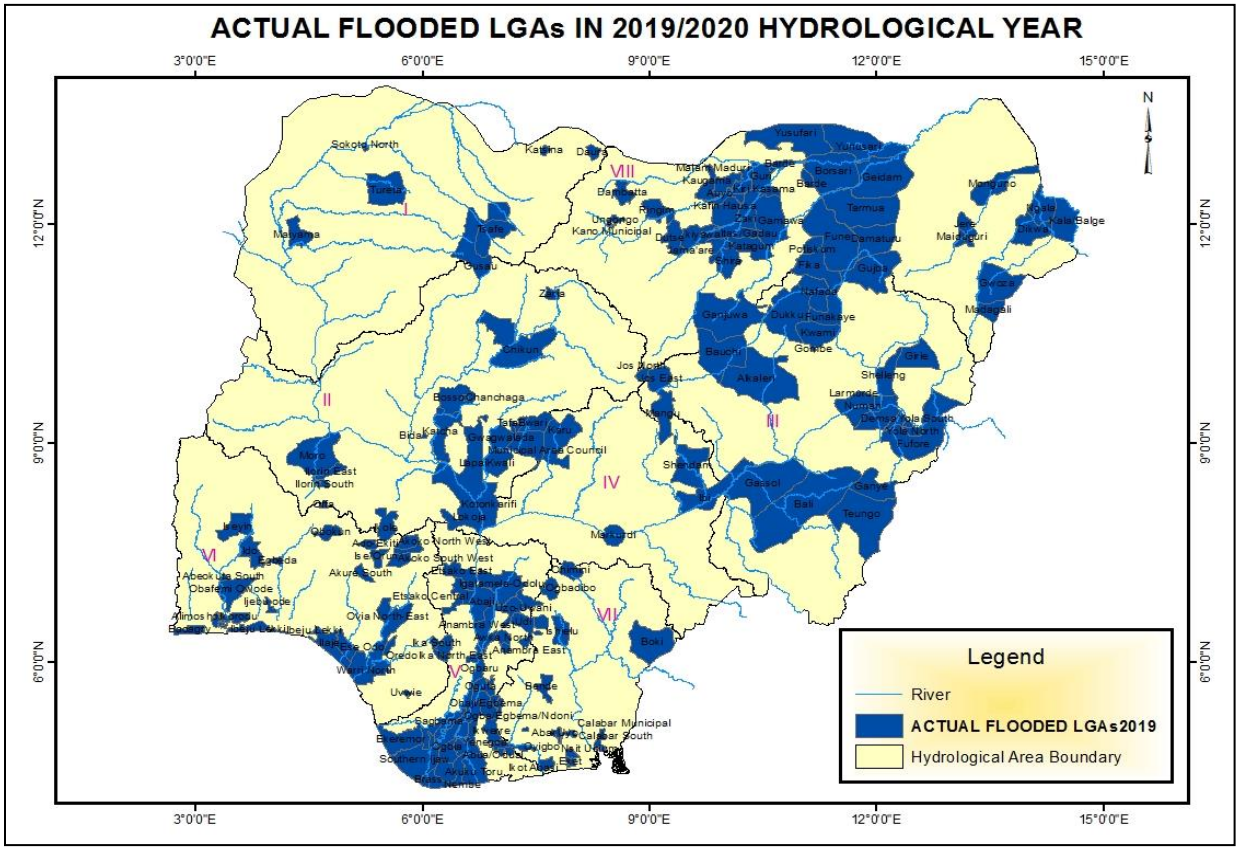



*Fig. 2.6: Map of Nigeria Showing Actual Flooded LGAs in 2019.*

Table 2.3: Comparative Analysis of 2018 Flood Occurrence

| Serial | Flood Scenarios | Number of Affected Local Government Areas |
|---|---|---|
| 1. | Predicted | 356 |
| 2. | Actual | 184 |
| 3. | Occurred Not Predicted | 78 |
| 4. | Predicted Not Occurred | 250 |
| 5. | Predicted Occurred | 106 |

Source: *NIHSA Field assessment and Daily News Papers.*

Table 2.4: Effect of 2019 floods in Nigeria

| S/No | Effect | 2018 | 2019 |
|---|---|---|---|
| 1. | Affected Population | 1,921,026 | 130,934 |
| 2. | Number of Deaths | 204 | 126 |
| 3. | Number of Internally Displaced Persons | 210,206 | 48,114 |
| 4. | Houses Destroyed | 82,376 | 29,356 |
| 5 | Hectares of Agricultural Land Destroyed | 156,672 | - |
| 6. | Number of Roads Damaged | 321 | - |

*Source: NIHSA Field Assessment NEMA 2019 Flood-summary.*

From Table 2.3, a total of 356 LGAs in 36 states including FCT were predicted in 2019, while 184 flood occurrences were recorded (*see Appendix 1*). Furthermore, flood occurred in 78 LGAs which were not predicted. The reason for this could be attributed to anthropogenic activities. The models only captured the locations along major river channels. Also, structural management measures put in place by state governments may have been responsible for reduction in flooding incidents in

some of the predicted areas. Figures 2.7 -2.9 show mitigation measures that are being put in place by some state governments to contain flooding.

*Fig. 2.7: Drainage clearing by Delta State Government (Credit: Leadership Newspaper, 12 June 2019).*

*Fig. 2.8: Drainage/Dredging inspection by Lagos State Government (Credit: TheNEWS, 23 February, 2020).*

*Fig. 2.9: Drainage/Dredging inspection by Lagos State Government (Credit: TheNEWS, 23 February, 2020).*

Figure 2.10 shows the comparative hydrographs of the river Niger downstream the confluence in Lokoja, Kogi State. It is imperative to note that accuracy of flood forecast and its adoption by the public who were sensitized on the high flood risk LGAs has led to a reduction in the devastating effect of flood on the communities that have heeded the warning and carried out remediation actions that were contained in the previous editions of AFO.

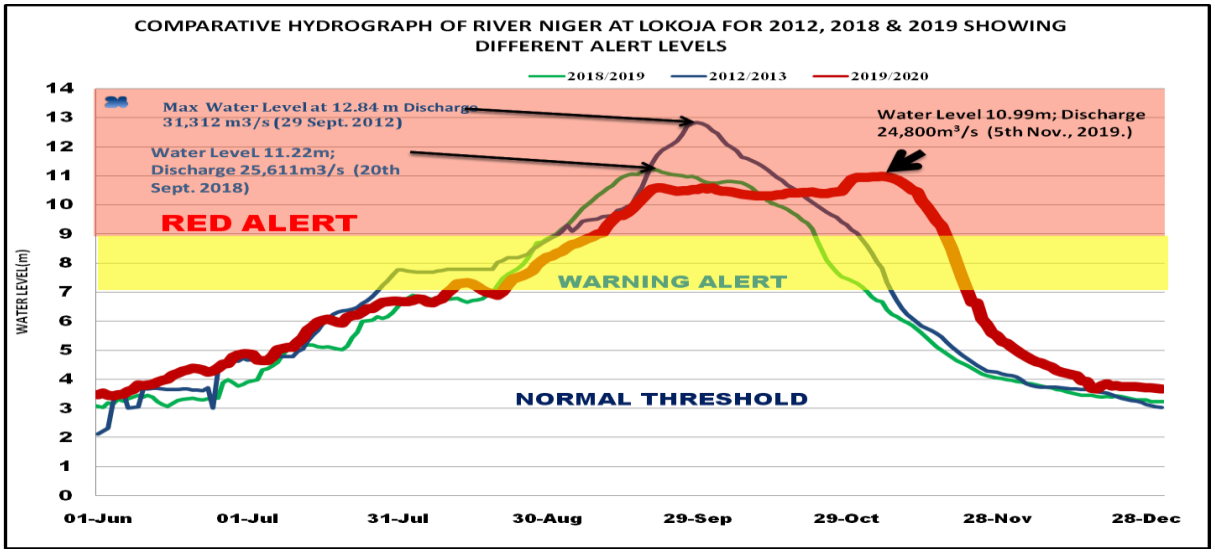



*Fig. 2.10: Graph Showing the Comparative Hydrographs for the stage and discharges at Lokoja, Kogi State.*

# CHAPTER THREE

# CHAPTER THREE

## 2020 ANNUAL FLOOD OUTLOOK

### 3.1 Preamble

The Geospatial Stream Flow Model (GeoSFM) and the Soil and Water Assessment Tool (SWAT) have been effective in the previous editions of AFO and hence were retained for 2020 AFO. Nonetheless, NIHSA is currently exploring other models for a more robust analysis.

The GeoSFM is a semi-distributed, physical based, catchment–scale, hydrologic modeling system developed by the United States Geological Survey Centre for Earth Resources Observation and Science (USGS/EROS). The model provides a tool for monitoring wide area hydrologic events. It is used to identify and map the status of stream flow and soil water condition.

The SWAT is a river-basin based model developed by the Texas Water Resources Institute, Texas A & M University System. The model is used to predict runoff and sediment yield in large complex basins. It is a physically based, semi–distributed and continuous simulation model with Geographic Information System (GIS) interface.

To predict the Annual Flood Outlook for 2020, the two models were successfully applied to each of the eight (8) Hydrological Areas of Nigeria in the form of Hydrographs converted to areal flood extent based on the affected LGAs across the drainage network of the country.

For the 2020 Annual Flood Outlook, calibration of the GeoSFM model at each Hydrological Area (HA) was based on the discharge record at the various stations within the respective HAs. Flows were simulated from the period 1981 – 2018 at

$0.05^0$ resolution in line with the 2020 Seasonal Rainfall Prediction (SRP) from NiMet based on the Climate Hazards Group InfraRed Precipitation with Stations (CHIRPS) dataset, Digital Elevation Model (DEM) and soil characteristics. The probable flood zones were determined based on the statistical analysis of the simulated flows and DEM using GIS package. The impact of trans-boundary inflow to HA I and HA III were assessed based on the $50^{th}$ and $90^{th}$ percentile as the extreme inflow scenarios.

These models were selected based on their wide application in various parts of the world from arid to semi-arid regions giving satisfactory results. Besides having simplified application, they utilize relevant data and are capable of simulating flood flows much more reliably and they also utilize geologic and catchment factors in their operations.

## 3.2 DATA USED AND SOURCES

i). Daily flow records (stage and discharge) from stations at Afikpo, Ikom, Okitipupa, Siluko, Katsina-Ala, Komadugu Gana, Abeokuta, Shiroro, Sokoto, Baro, Umaisha, Wuya, Ebba, Donga, Ebonyi, Hadejia, Gassol, Kurawa, Zungeru, Malabu, Otuocha, Onitsha, Makurdi, Geidam, Kainji, Kende, Dadinkowa, Ologbo, Ogun, Chokocho, Calabar, Tiga, and Lokoja on the Niger and Benue Rivers system and other hydrological stations in the eight (8) Hydrological Areas of the country (Figure 3.1).

ii). Data from groundwater and weather stations that provide hydrogeological and meteorological data to complement other data inputs (Figure 3.2).

iii). Daily, monthly and yearly rainfall records.

iv). The gridded satellite daily rainfall data available: the Climate Hazards Group Infra–Red Precipitation with Stations (CHIRPS) data archive available from 1981 to 2017 at $0.05^o$ resolution.

v). The daily potential evapotranspiration (PET) based on the data produced by the Famine Early Warning Systems Network (FEWSNET).

vi). NiMet Seasonal Rainfall Prediction (SRP).

vii). The soil characteristics, topography (Shuttle Radar Topography Mission (SRTM) data with a vertical accuracy specification of +/- 5 metres, and available in resolutions of 3 arc–second (90m) data around Nigeria from the USGS website), land use and land cover data.

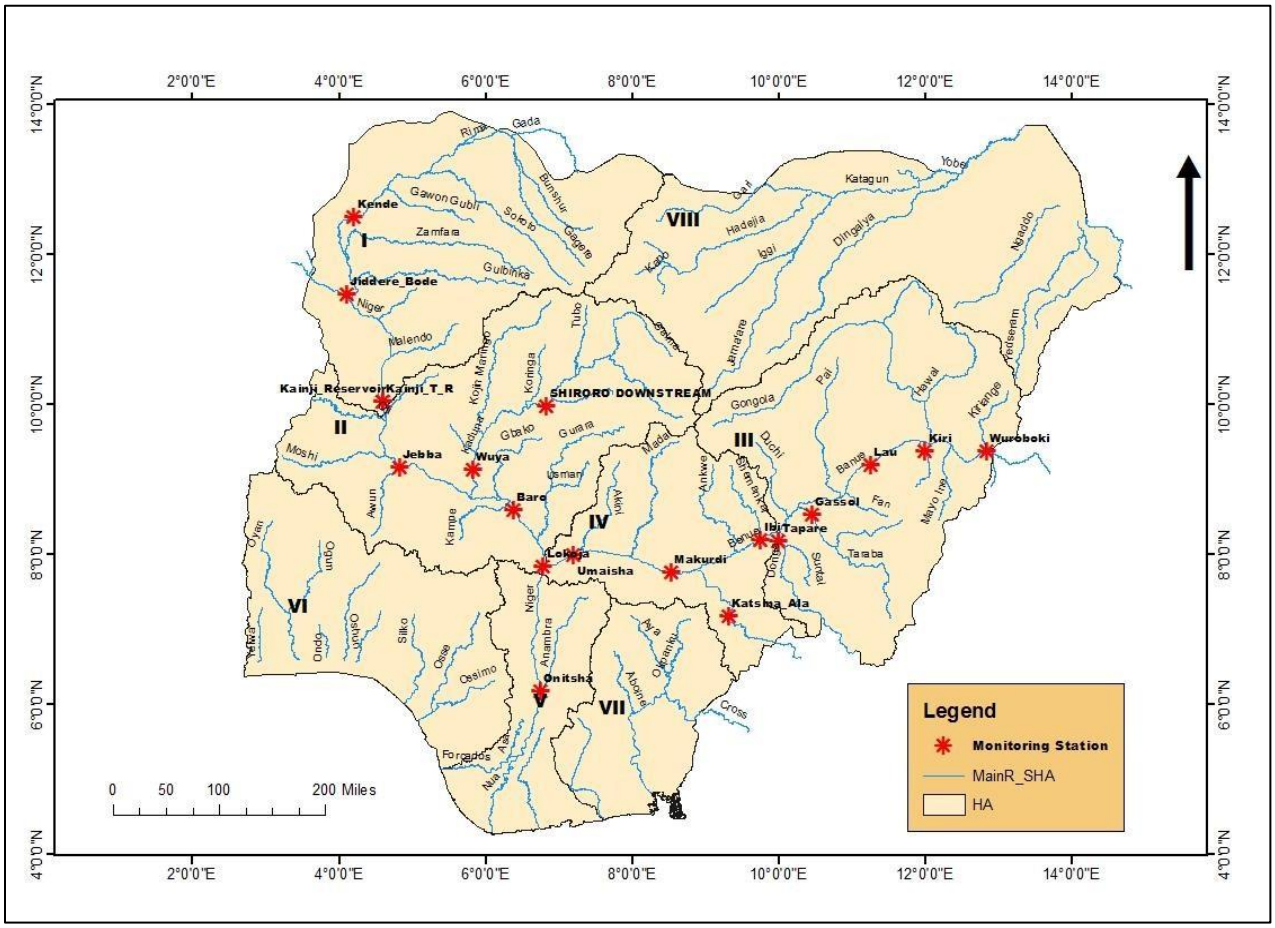



*Fig. 3.1: Map Showing the Location of Data Collection Platforms (DCPs) along the two major rivers in Nigeria.*

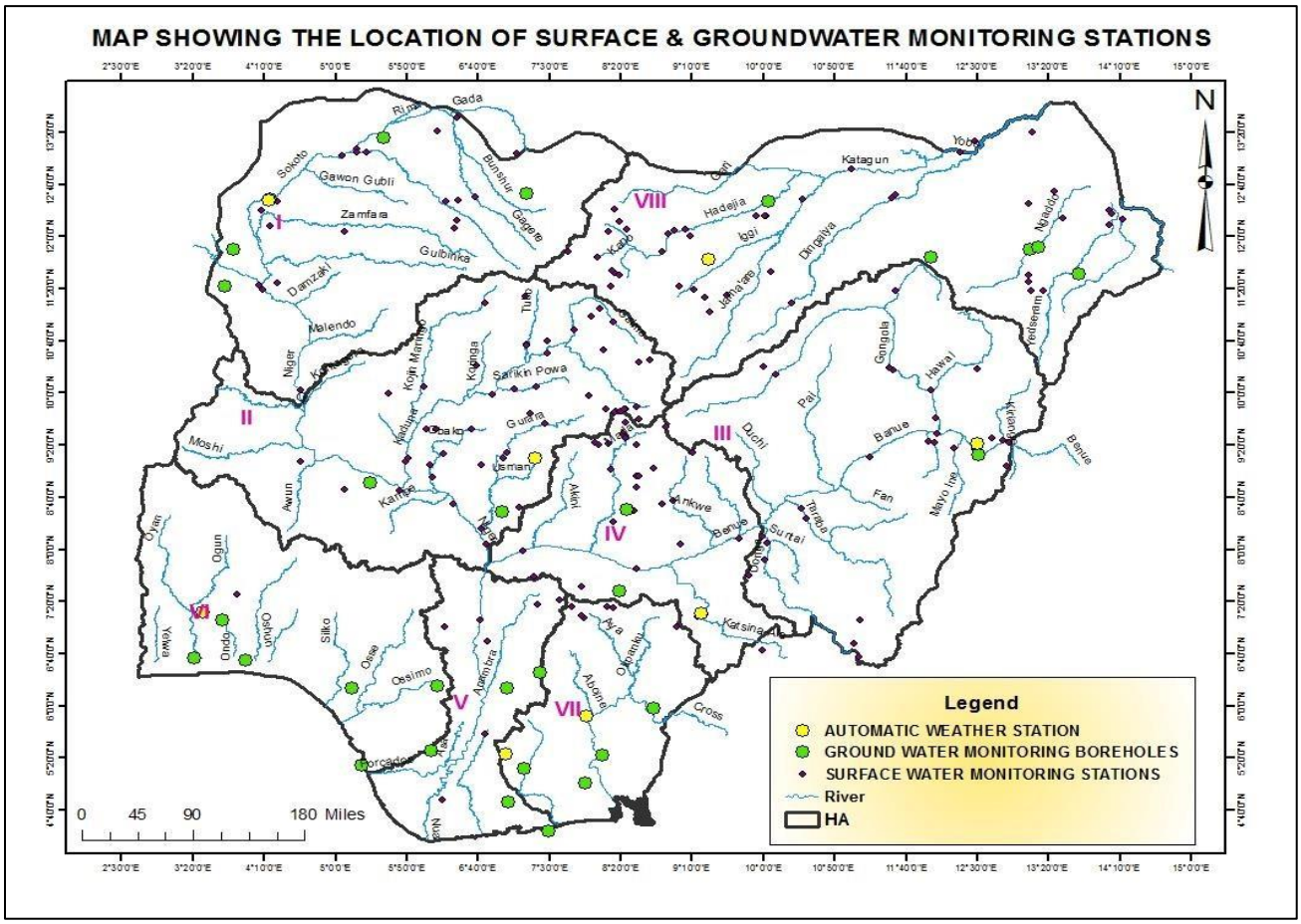



*Figure 3.2 showing network of NIHSA* groundwater and weather stations.

## 3.3 Highlights of 2020 Annual Flood Outlook

The eight Hydrological Areas and their well–defined hydrological and hydrogeological features which have been articulated in the flood prediction are discussed below.

### 3.3.1 Hydrological Area I (Niger North)

Hydrological Area I (Figure 3.3) comprises Kebbi, Zamfara, Sokoto, and parts of Niger and Katsina States and is drained mainly by the Rivers Niger, Sokoto and Rima.

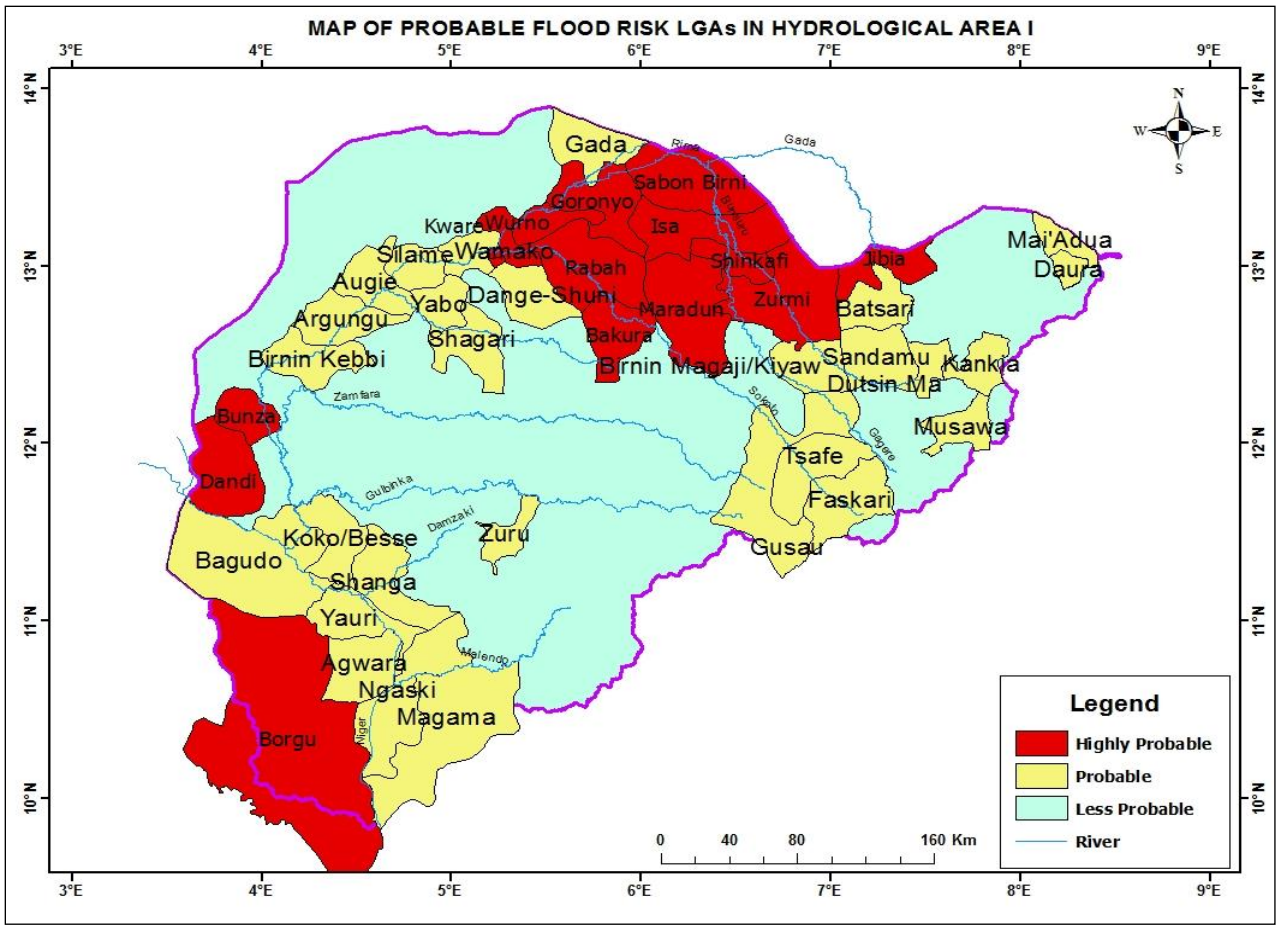



*Fig. 3.3: Probable Flood Risk LGAs in HA I.*

It has two distinct geological features, mainly the Precambrian Crystalline Basement which covers 30% of the area and Sedimentary terrain which covers 70%.

The Highly Probable and Probable flood risk areas in Hydrological Area I are shown in Tables 3.1 and 3.2 as well as Figure 3.3.

**Table 3.1: Highly Probable Flood Risk LGAs in HA I**

| S/N | State | LGAs |
|---|---|---|
| 1 | Katsina | Jibiya |
| 2 | Kebbi | Dandi, Bunza |
| 3 | Niger | Borgu |
| 4 | Sokoto | Goronyo, Sokoto North, Sabon Birni, Rabah, Isa, Sokoto South, Dange-Shuni, Kware, Wurno |
| 5 | Zamfara | Bakura, Maradun, Shinkafi, Zurmi |

**Table 3.2: Probable Flood Risk LGAs in HA I**

| S/N | State | LGAs |
|---|---|---|
| 1 | Katsina | Kankia, Faskari, Mai'Adua, Musawa, Sandamu, Batsari, Dutsin Ma, Daura |
| 2 | Kebbi | Argungu, Koko/Besse, Augie, Shanga, Bagudo, Ngaski, Birnin Kebbi, Zuru, Yauri |
| 3 | Niger | Magama, Agwara |
| 4 | Sokoto | Gada, Silame, Shagari, Yabo, Dange-Shuni, Wamako |
| 5 | Zamfara | Tsafe, Birnin Magaji/Kiyawa, Gusau |

### 3.3.2 Hydrological Area II (Niger Central)

Hydrological Area II (Figure 3.4) covers Niger, Kwara, Kaduna and part of Kogi States and the FCT. The geology of the Hydrological area II comprises of about 20% Sedimentary rocks and 80% Basement complex rocks. The main rivers in the area are: Niger, Kaduna, Gurara, Usuma, Kampe and Awun.

The Highly Probable and Probable flood risk areas in Hydrological Area II are shown in Tables 3.3 and 3.4 as well as Figure 3.4.

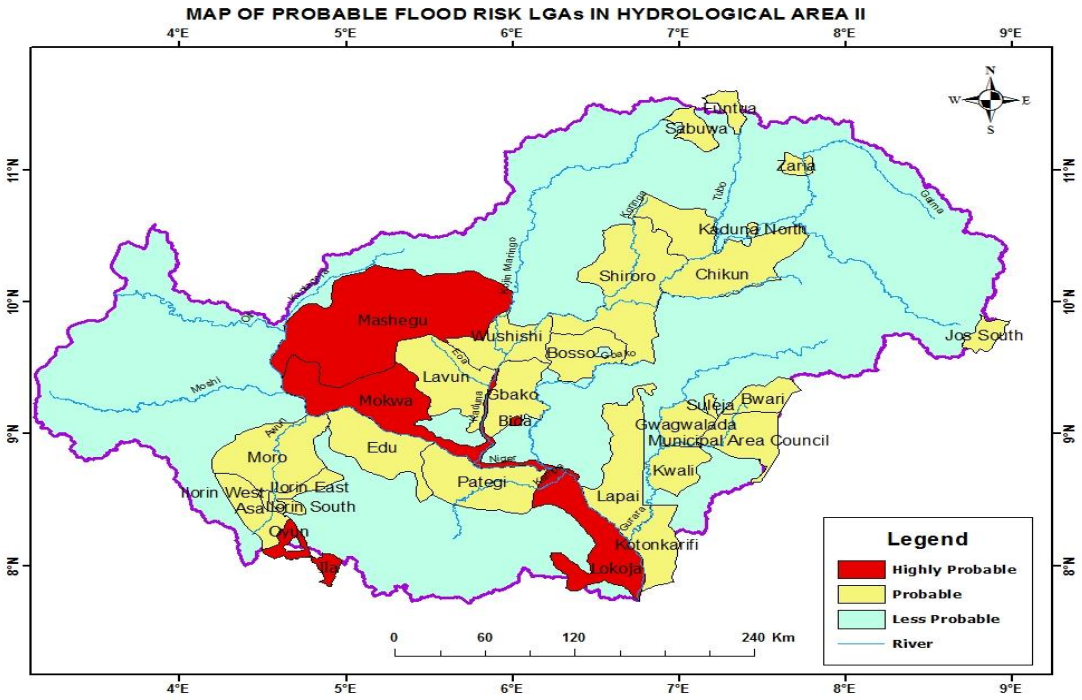



*Fig. 3.4: Probable Flood Risk LGAs in HA II*

**Table 3.3: Highly Probable Flood Risk LGAs in HA II**

| S/N | State | LGAs |
|---|---|---|
| 1 | Kogi | Lokoja |
| 2 | Kwara | Oyun |
| 3 | Niger | Bida, Mokwa, Mashegu |

**Table 3.4: Probable Flood Risk LGAs in HA II**

| S/N | State | LGAs |
|---|---|---|
| 1 | FCT | Gwagwalada, Kwali, Municipal Area Council, Bwari |
| 2 | Kaduna | Zaria, Kaduna North, Chikun |
| 3 | Katsina | Sabuwa, Funtua |
| 4 | Kogi | Kotonkarife |
| 5 | Kwara | Ilorin West, Pategi, Edu, Asa, Moro,Ilorin East, Ilorin South |
| 6 | Niger | Suleja, Gbako, Shiroro, Bosso, Wushishi, Lavun, Lapai |

### 3.3.3 Hydrological Area III (Upper Benue)

Hydrological Area III (Figure 3.5) comprises Adamawa, Taraba, Gombe, Bauchi and part of Plateau and Borno States.

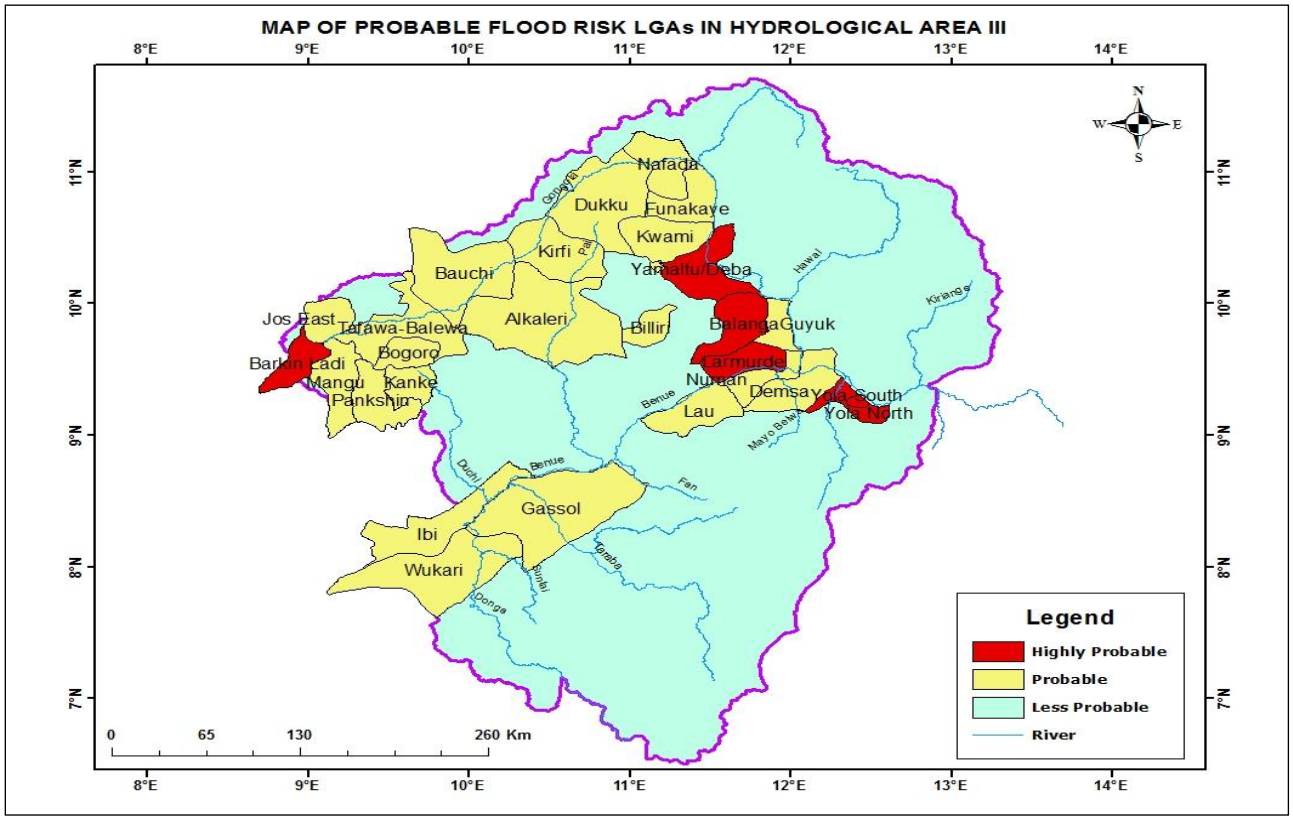



*Fig. 3.5: Probable Flood Risk LGAs in HA III.*

It is made up of about 70% Sedimentary and 30% basement. The major rivers are Benue, Gongola, Taraba, Donga, Faro, and Mayo-Kebbi.

The Highly Probable and Probable flood risk areas in Hydrological Area III are shown in Tables 3.5 and 3.6 as well as Figure 3.5.

**Table 3.5: Highly Probable Flood Risk LGAs in HA III**

| S/N | State | LGAs |
|---|---|---|
| 1 | Adamawa | Yola North, Yola South, Lamurde |
| 2 | Gombe | Balanga, Yamaltu/Deba |
| 3 | Plateau | Barkin Ladi |

**Table 3.6: Probable Flood Risk LGAs in HA III**

| S/N | State | LGAs |
|---|---|---|
| 1 | Adamawa | Numan, Guyuk, Demsa |
| 2 | Gombe | Balanga, Dukku, Funakaye, Gombe, Kwami, Nafada. |
| 3 | Plateau | Pankshin, Jos East, Kanke, Mangu |
| 4 | Taraba | Gassol, Ibi, Lau, Wukari |
| 5 | Bauchi | Alkaleri, Bauchi, Tafawa Balewa, Kirfi, Bogora |

### 3.3.4: Hydrological Area IV (Lower Benue)

Hydrological Area IV (Figure 3.6) covers Plateau, Nasarawa, Benue and part of Kogi States.

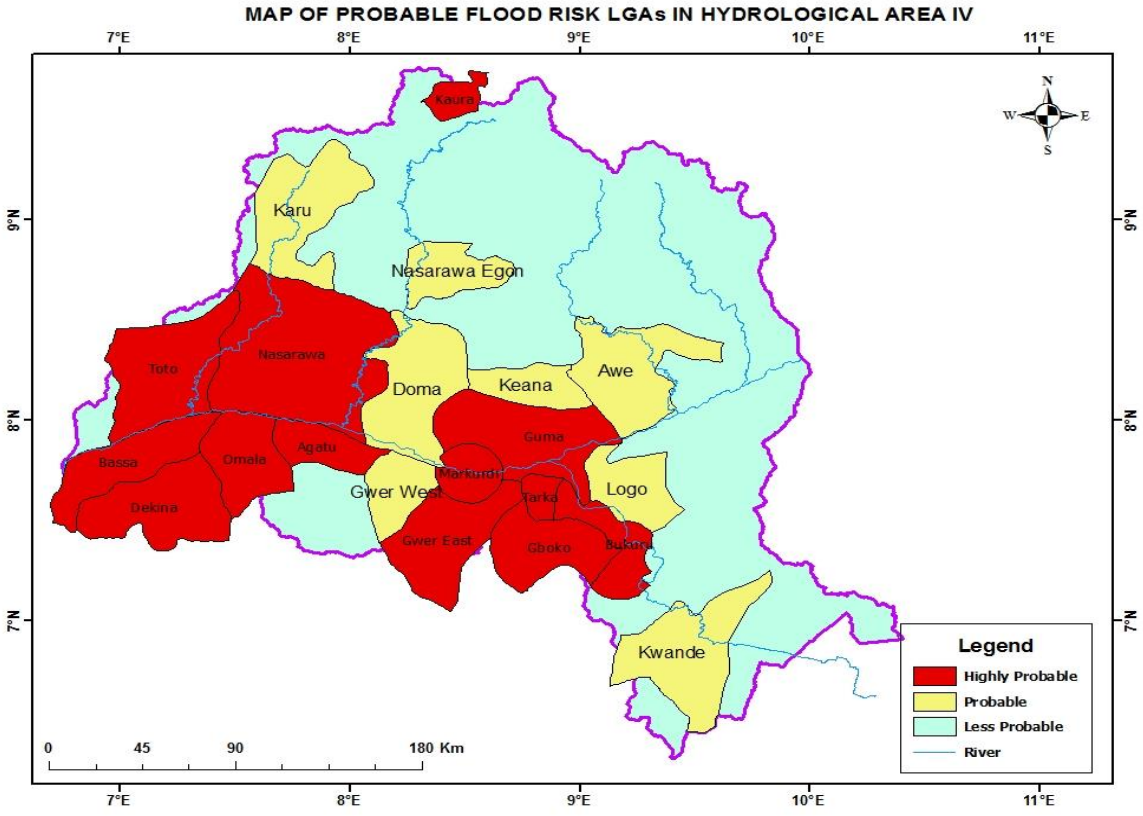



*Fig. 3.6: Probable Flood Risk LGAs in HA IV.*

The area is covered by 50% Sedimentary and 50% Basement and is drained mainly by Rivers Benue, Katsina–Ala, Dep and Mada.

The Highly Probable and Probable flood risk areas in Hydrological Area IV are shown in Tables 3.7 and 3.8 as well as Figure 3.6.

**Table 3.7: Highly Probable Flood Risk LGAs in HA IV**

| S/N | State | LGAs |
|---|---|---|
| 1 | Benue | Buruku, Agatu, Gboko, Gwer East, Makurdi, Tarka, Guma |
| 2 | Kaduna | Kaura |
| 3 | Kogi | Bassa, Dekina, Omala |
| 4 | Nasarawa | Nasarawa, Toto |

**Table 3.8: Probable Flood Risk LGAs in HA IV**

| S/N | State | LGAs |
|---|---|---|
| 1 | Benue | Gwer West, Logo, Kwande |
| 2 | Nasarawa | Nasarawa Egon, Keana, Doma, Karu, Awe |

### 3.3.5 Hydrological Area V (Niger South)

Hydrological Area V (Figure 3.7) includes: Bayelsa, Delta, Edo, Anambra and parts of Kogi, Imo, Enugu and Rivers States.

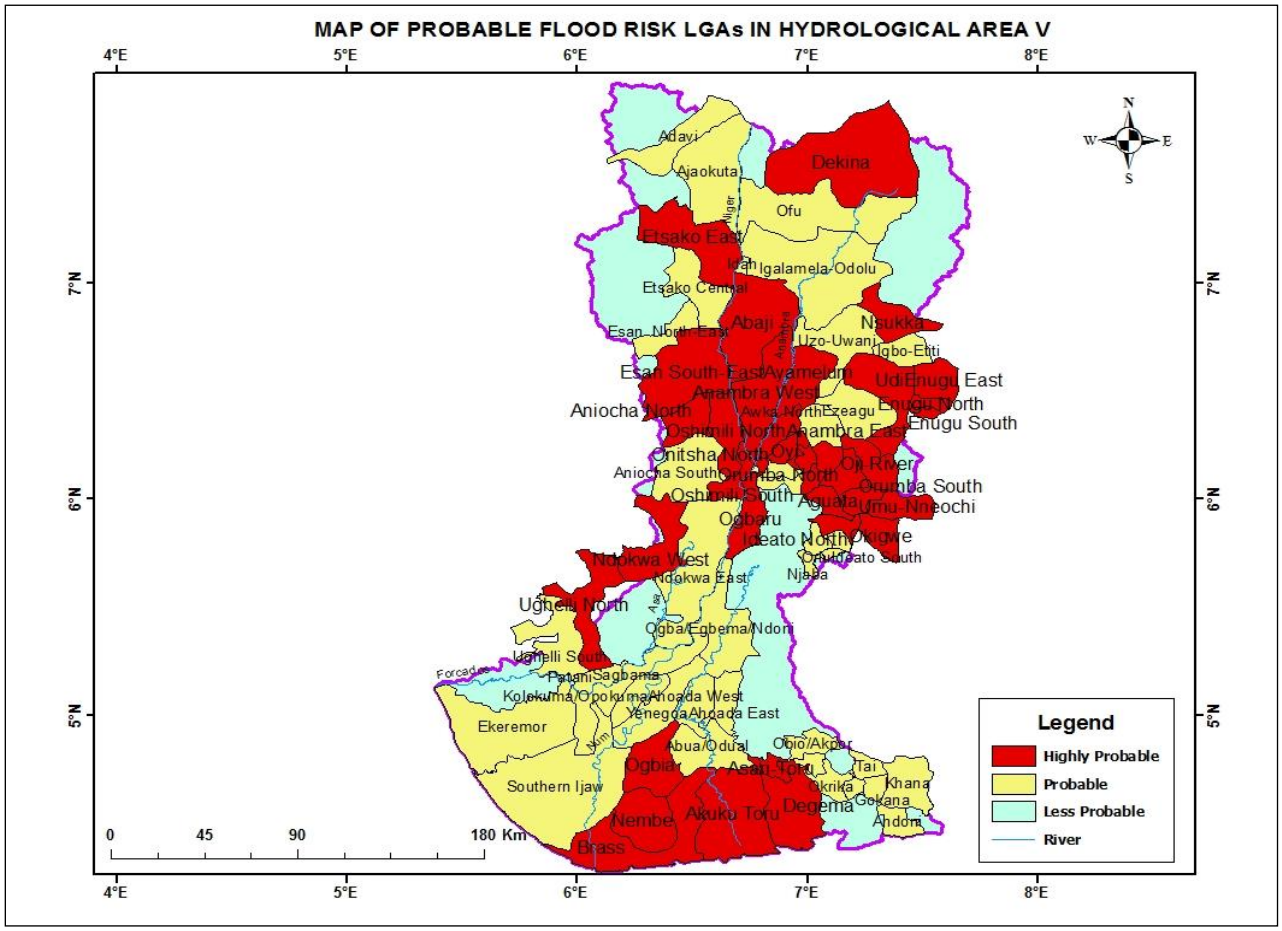



*Fig. 3.7: Probable Flood Risk LGAs in HA V*

The geology is 90% Sedimentary and 10% Basement. The major Rivers are: Niger, Anambra, Ase, Orashi, Nun and Forcados.

The Highly Probable and Probable flood risk areas in Hydrological Area V are shown in Tables 3.9 and 3.10 as well as Figure 3.7.

**Table 3.9: Highly Probable Flood Risk LGAs in HA V**

| S/N | State | LGAs |
|---|---|---|
| 1 | Anambra | Ogbaru, Anaocha, Oyi, Anambra East, Onitsha North, Orumba South, Njikoka, Orumba North, Ayamelum, Aguata, Awka South, Anambra West, Dunukofia |
| 2 | Bayelsa | Brass, Ogbia, Nembe |
| 3 | Delta | Ndokwa West, Aniocha North, Oshimili South, Ughelli North, Oshimili North |
| 4 | Edo | Etsako East, Esan South-East. |
| 5 | Enugu | Enugu East, Udi, Nsukka, Enugu North, Enugu South, Oji-River. |
| 6 | Imo | Ideato North, Okigwe. |
| 7 | Kogi | Dekina, Ibaji |
| 8 | Rivers | Degema, Akuku Toru, Asari-Toru |

**Table 3.10: Probable Flood Risk LGAs in HA V**

| S/N | State | LGAs |
|---|---|---|
| 1 | Anambra | Idemili North,Idemili South,Onitsha South, Awka North |
| 2 | Bayelsa | Southern Ijaw, Ekeremor, Kolokuma/Opokuma, Yenegoa, Sagbama |
| 3 | Delta | Aniocha South, Patani, Ndokwa East, Ughelli South, |
| 4 | Edo | Etsako Central, Esan North-East |
| 5 | Enugu | Igbo-Etiti, Ezeagu, Uzo-Uwani |
| 6 | Imo | Ideato South, Njaba, Nkwerre, Orlu |
| 7 | Kogi | Idah, Igalamela-Odolu, Ajaokuta, Ofu, Adavi |
| 8 | Rivers | Ahoada East, Ogba/Egbema/Ndoni, Andoni, Ogu Bolo, Ahoada West, Abua/Odual, Port-Harcourt, Obio/Akpor, Gokana, Tai, Khana, Okrika |

### 3.3.6 Hydrological Area VI (Western Littoral)

Hydrological Area VI (Figure 3.8) comprises the following States: Lagos, Ogun, Oyo, Osun, Ondo, Edo and parts of Delta and Ekiti States.

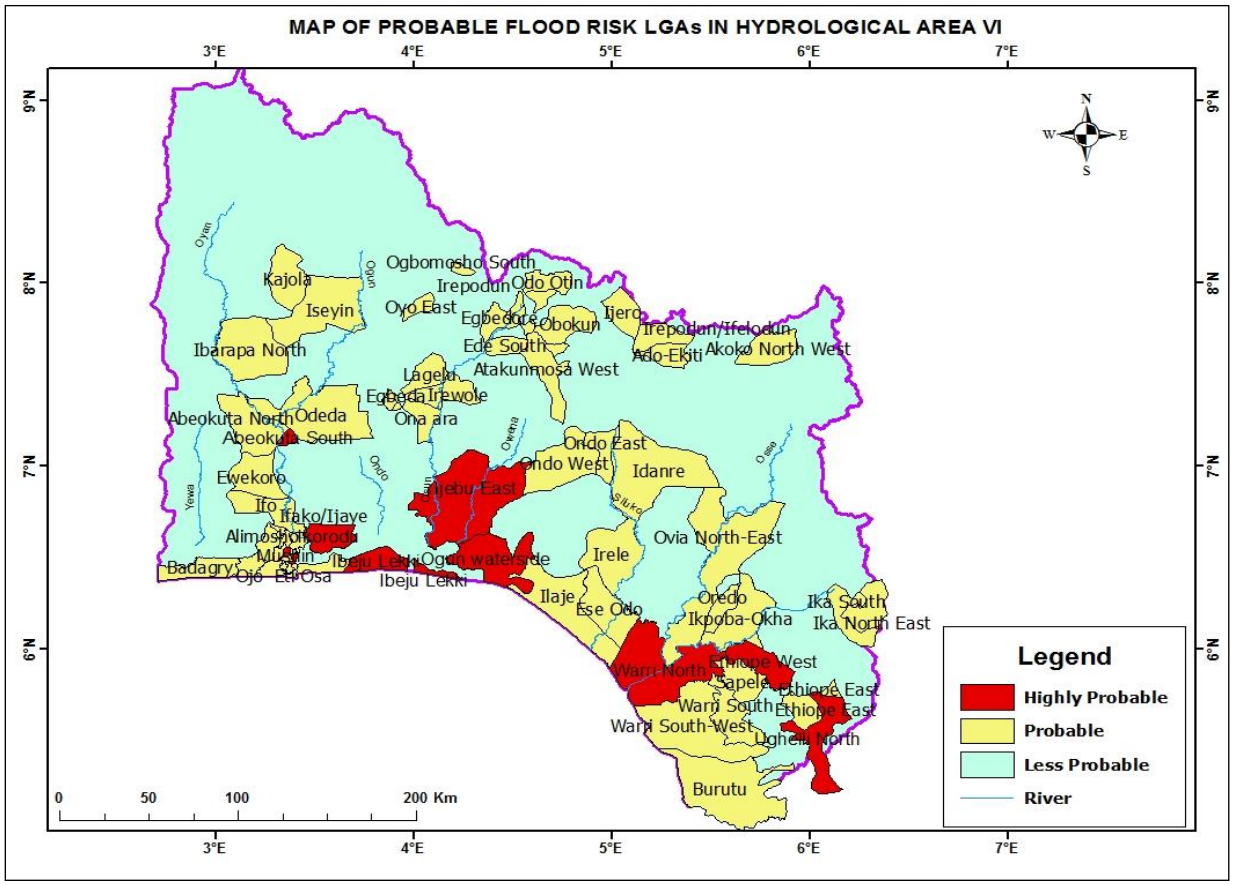



*Fig. 3.8: Probable Flood Risk LGAs in HA VI.*

The Area is 60% Basement and 40% Sedimentary and is drained by Rivers: Yewa, Ogun, Osun, Shasha, Omi, Owena, Osse,and Ossiomo

The Highly Probable and Probable flood risk areas in Hydrological Area VI are shown in Tables 3.11 and 3.12 as well as Figure 3.8.

**Table 3.11: Highly Probable Flood Risk LGAs in HA VI**

| S/N | State | LGAs |
|---|---|---|
| 1 | Delta | Ughelli North, Ethiope West, Warri North |
| 2 | Lagos | Lagos Mainland, Mushin, Ibeju Lekki, Ikorodu |
| 3 | Ogun | Abeokuta South, Ogun waterside, Ijebu East |
| 4 | Osun | Ila |

**Table 3.12: Probable Flood Risk LGAs in HA VI**

| S/N | State | LGAs |
|---|---|---|
| 1 | Delta | Sapele, Warri South-West, Warri South, Ethiope East, Burutu, Ika North East, Ika South |
| 2 | Edo | Ikpoba-Okha, Oredo, Ovia North-East |
| 3 | Ekiti | Ijero, Irepodun/Ifelodun, Ado-Ekiti |
| 3 | Lagos | Lagos Island, Alimosho, Amuwo Odofin, Ikeja, Kosofe, Eti Osa, Apapa, Ojo, Oshodi/Isolo, Agege, Ifako/Ijaye, Badagry, Surulere, Ajeromi/Ifelodun |
| 4 | Ogun | Ewekoro, Abeokuta North, Odeda, Ifo |
| 5 | Ondo | Irele, Ondo West, Ilaje, Akoko North West, Idanre, Ondo East, Ese Odo |
| 6 | Osun | Ayedire, Ede North, Ede South, Egbedore, Ifelodun, Ilesha East, Ilesha West, Irepodun, Isokan, Iwo, Odo Otin, Ola–Oluwa, Olorunda, Orolu, Osogbo. |
| 7 | Oyo | Ona ara, Lagelu, Oyo East, Kajola, Egbeda, Ogbomosho South, Iseyin, Ibarapa North, Ibadan South West, Ibadan North West, Ibadan South East |

### 3.3.7 Hydrological Area VII (Eastern Littoral)

The Hydrological Area VII (Figure 3.9) comprises Abia, Anambra, Imo, Enugu, Ebonyi, Cross–River, Akwa–Ibom and Rivers States.

The area is covered by 90% Sedimentary and 10% Basement and drained by Imo, Qua–Iboe, Calabar, Ivo, Asu, Cross River and Ebonyi Rivers.

The Highly Probable and Probable flood risk areas in Hydrological Area VII are shown in Tables 3.13 and 3.14 as well as Figure 3.9.

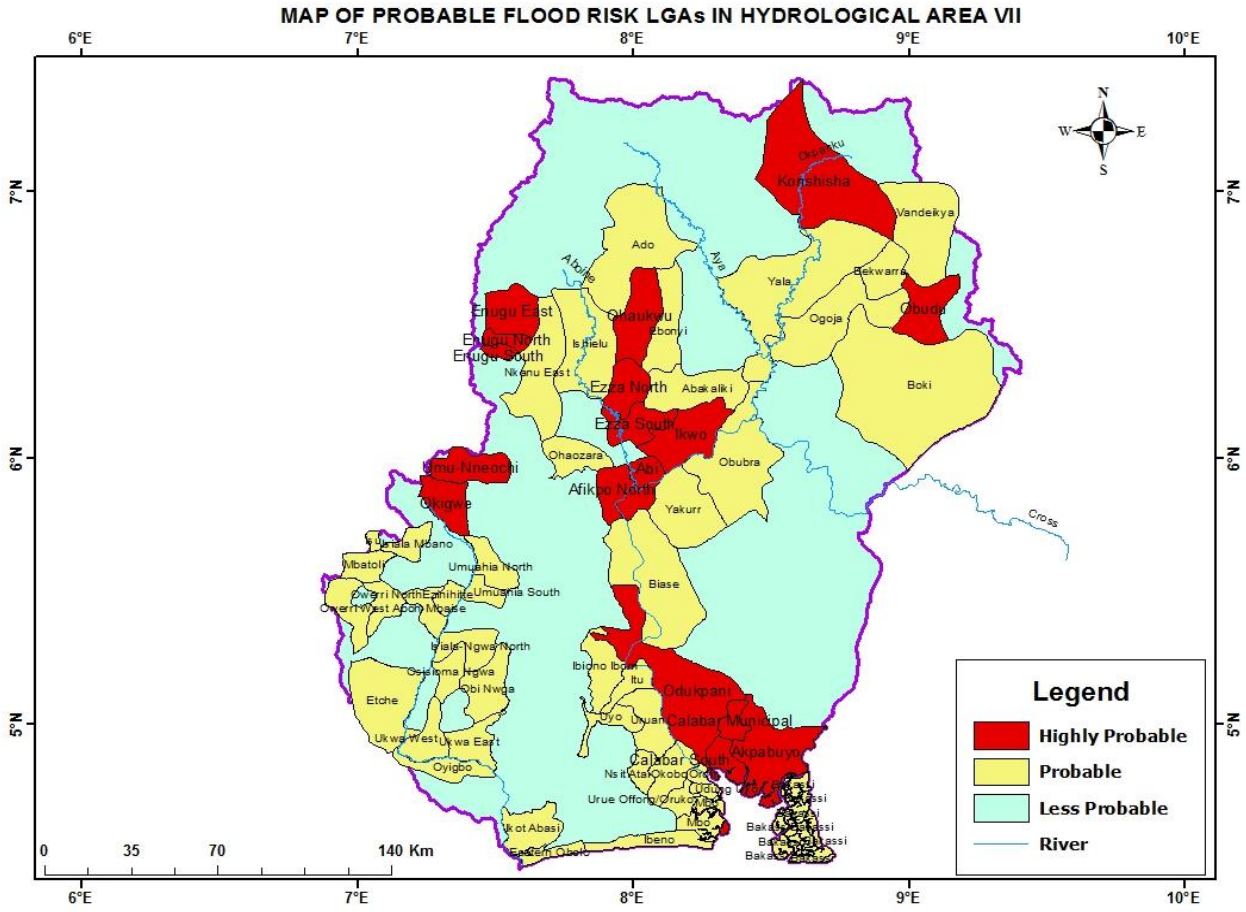



*Fig. 3.9: Probable Flood Risk LGAs in HA VII.*

**Table 3.13: Highly Probable Flood Risk LGAs in HA VII**

| S/N | State | LGAs |
|---|---|---|
| 1 | Abia | Umunneochi |
| 2 | Benue | Konshisha |
| 3 | Cross River | Calabar South, Calabar Municipal, Akpabuyo, Abi, Obudu, Odukpani |
| 4 | Ebonyi | Afikpo North, Ezza South, Ezza North, Ikwo, Ohaukwu, |
| 5 | Enugu | Enugu East, Enugu North, Enugu South |
| 6 | Imo | Okigwe |

**Table 3.14: Probable Flood Risk LGAs in HA VII**

| S/N | State | LGAs |
|---|---|---|
| 1 | Abia | Osisioma Ngwa, Obi Ngwa, Umuahia South, Umuahia North, Ukwa East, Ukwa West, Isiala-Ngwa North |
| 2 | Akwa - Ibom | Nsit Atai, Okobo, Mbo, Udung Uko, Oron, Eastern Obolo, Itu, Ikot Abasi, Ibiono Ibom, Uruan, Uyo, Ibeno, Urue Offong/Oruko |
| 3 | Benue | Ado, Vandeikya |
| 4 | Cross River | Yakurr, Obubra, Yala, Bakassi, Boki, Ogoja, Bekwarra, Biase |
| 5 | Ebonyi | Ebonyi, Ishielu, Ohaozara, Abakaliki |
| 6 | Enugu | Nkanu East |
| 7 | Imo | Owerri West, Owerri North, Mbatoli, Ezinihitte, Isu, Isiala Mbano, Aboh-Mbaise |
| 8 | Rivers | Oyigbo, Etche |

### 3.3.8 Hydrological Area VIII (Chad Basin)

The Hydrological Area VIII (Figure 3.10) comprises Kano, Jigawa, Yobe, Borno States and parts of Bauchi, Plateau and Adamawa States.

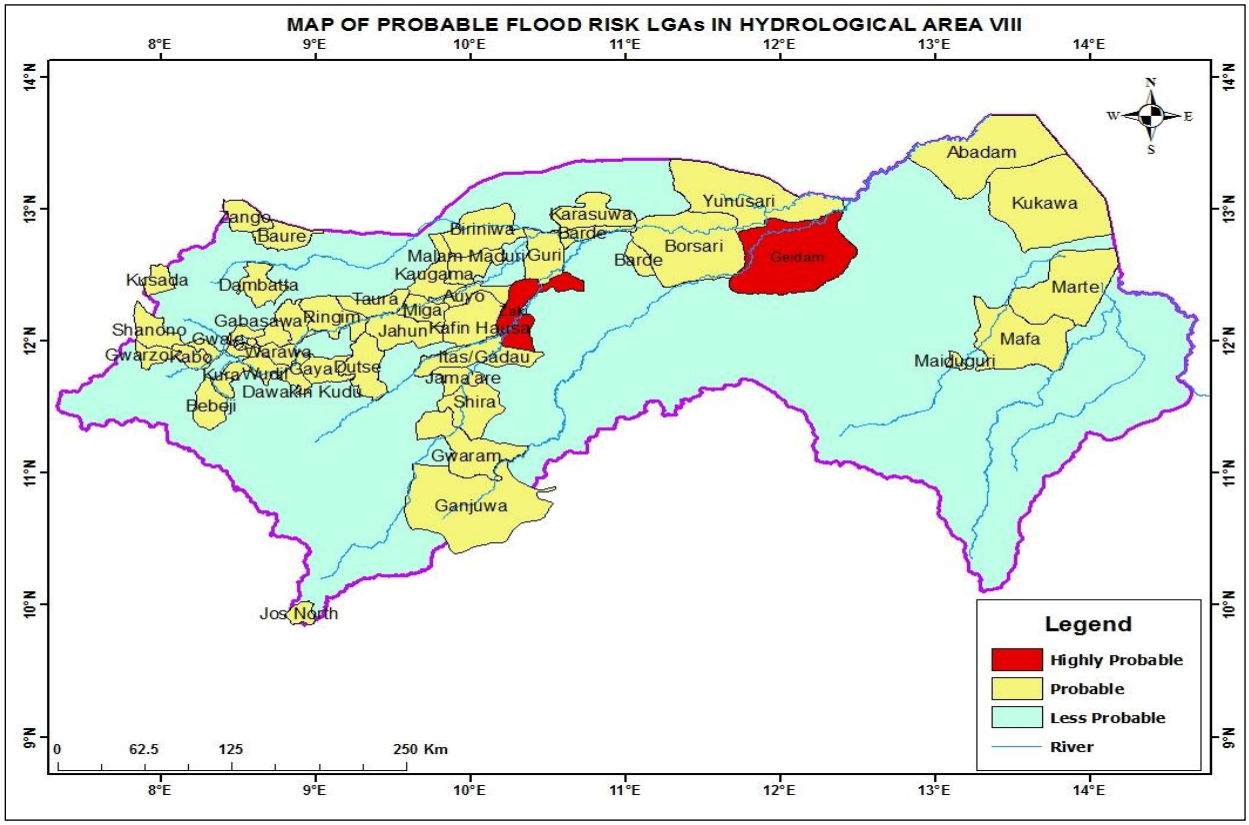



*Fig. 3.10: Probable Flood Risk LGAs in HA VIII.*

The geology is made up of 80% Sedimentary and 20% Basement rocks. Major rivers in the area are: Hadejia, Jama'are, Komadugu–Yobe, Yedseram, Ngadda and Dingaiya.

The Highly Probable and Probable flood risk areas in Hydrological Area VIII are shown in Tables 3.15 and 3.16 as well as Figure 3.10.

**Table 3.15: Highly Probable Flood Risk LGAs in HA VIII**

| S/N | State | LGAs |
|---|---|---|
| 1 | Bauchi | Zaki |
| 2 | Yobe | Geidam |

**Table 3.16: Probable Flood Risk LGAs in HA VIII**

| S/N | State | LGAs |
|---|---|---|
| 1 | Bauchi | Jama'are, Itas/Gadau, Shira, Ganjuwa |
| 2 | Borno | Marte, Maiduguri, Abadam, Mafa, Kukawa |
| 3 | Jigawa | Kaugama, Taura, Guri, Gwaram, Dutse, Auyo, Miga, Malam Maduri, Ringim, Biriniwa, Jahun, Kafin Hausa |
| 4 | Kano | Tarauni, Garum Mallam, Rimin Gado, Gaya, Gezawa, Gwale, Shanono, Gabasawa, Gwarzo, Ungongo, Warawa, Dawakin Kudu, Dambatta, Bebeji, Kabo, Wudil, Kura, Nassarawa, Kano Municipal, Kumbotso |
| 5 | Katsina | Kusada, Zango, Baure |
| 6 | Plateau | Jos North |
| 7 | Yobe | Barde, Borsari, Karasuwa, Yunusari |

## 3.4 MAP OF FLOOD RISK LOCAL GOVERNMENT AREAS IN 2020

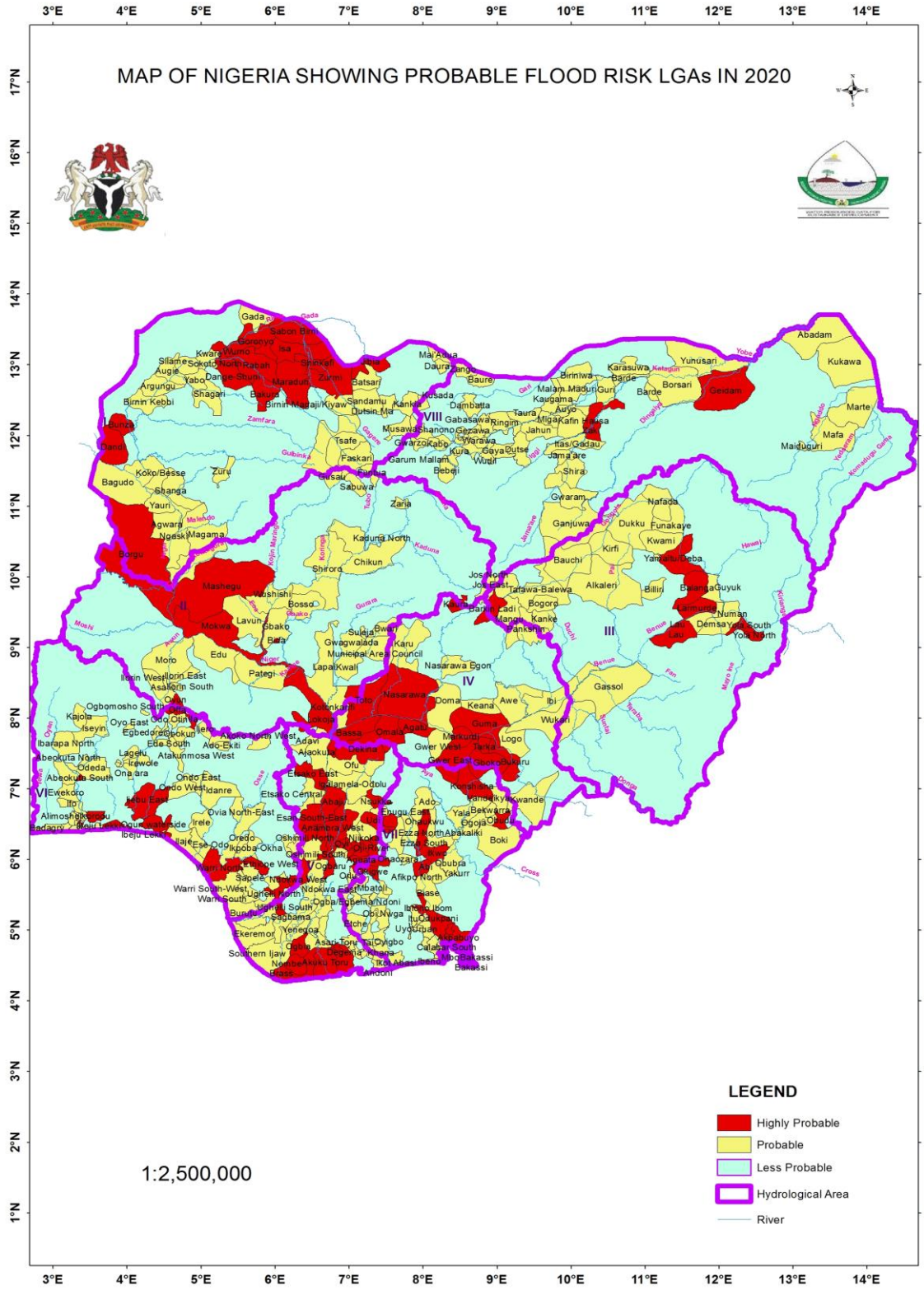



*Fig. 3.11: Map of Flood Risk LGAs in 2020.*

The expected areas of river flooding in 2020 are located in the following drainage basins: Benue, Niger, Anambra–Imo, Niger Delta, Sokoto–Rima, Komadougu–Yobe, Ogun–Osun, Cross River and other sub–basins of the country. The predicted probable flood areal coverage in 2020 is expected to be lower than that of 2019 (Figure 3.11).

## 3.5 Flood Vulnerability

River channels across the nation were subjected to buffering analysis and areas within a radius of 1km, 2km, and 3km were categorized as high, medium and low zones of flood vulnerability respectively (Figure 3.12). Summary of vulnerable communities in each of the Hydrological Area is in Tables 3.51 – 3.58.

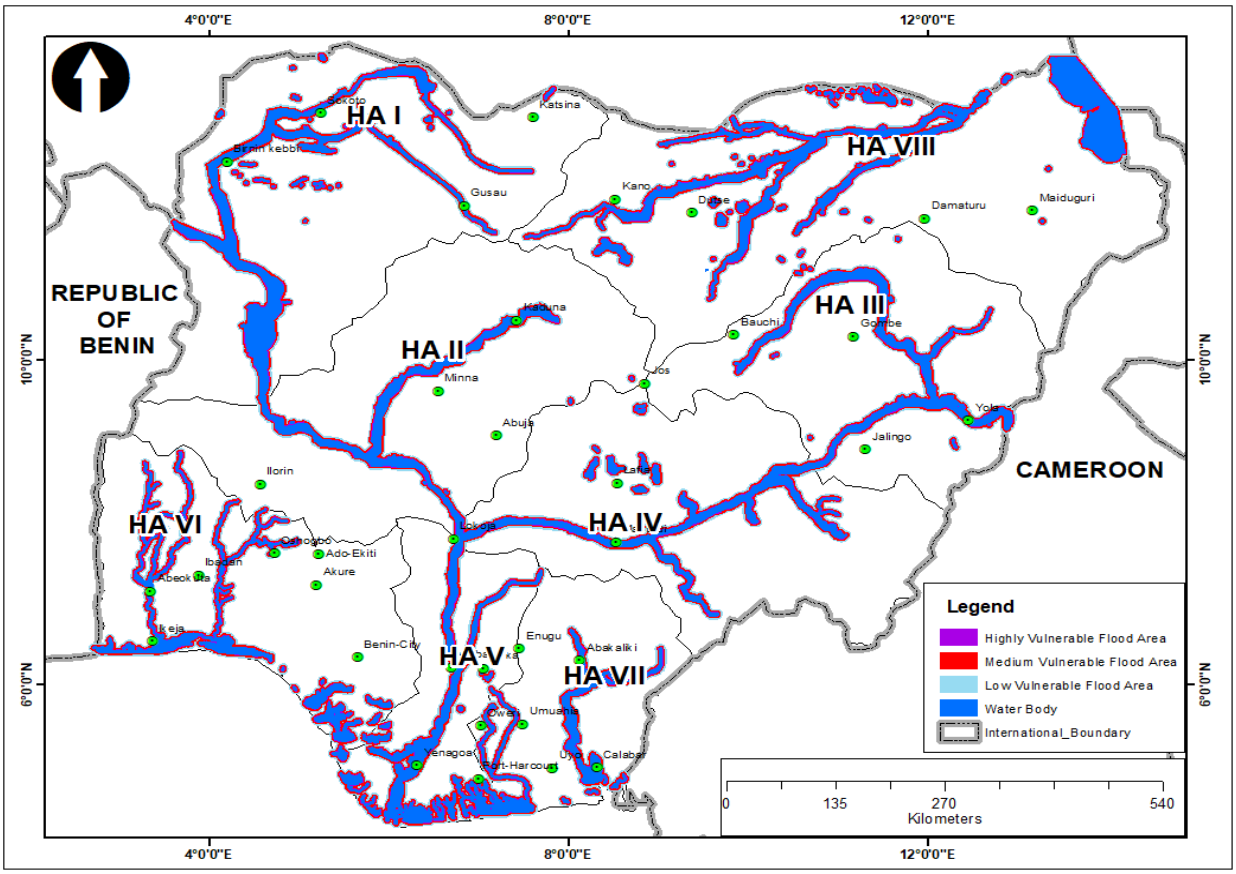



*Fig. 3.12: 2020 Flood Zone Vulnerability Map.*

**Table 3.51: Vulnerable Communities/Villages in HA I**

| | | | No. of Vulnerable Communities | | | |
|---|---|---|---|---|---|---|
| **S/N** | State | No. of LGA | High | Medium | Low | Total |
| **1** | Katsina | 8 | 15 | 26 | 15 | 56 |
| **2** | Kebbi | 12 | 258 | 169 | 121 | 548 |
| **3** | Niger | 5 | 61 | 21 | 25 | 107 |
| **4** | Sokoto | 14 | 143 | 82 | 79 | 304 |
| **5** | Zamfara | 4 | 37 | 44 | 39 | 120 |
| | Total | 43 | 514 | 342 | 279 | 1135 |

**Table 3.52: Vulnerable Communities/Villages in HA II**

| | | | No. of Vulnerable Communities | | | |
|---|---|---|---|---|---|---|
| S/N | State | No. of LGA | High | Medium | Low | Total |
| 1 | Kaduna | 3 | 62 | 32 | 19 | 113 |
| 2 | Kogi | 2 | 28 | 11 | 8 | 47 |
| 3 | Kwara | 5 | 19 | 13 | 17 | 49 |
| 4 | Niger | 9 | 111 | 57 | 36 | 204 |
| 5 | Plateau | 1 | 0 | 4 | 5 | 9 |
| 6 | Oyo | 1 | 0 | 8 | 7 | 15 |
| 7 | Osun | 1 | 0 | 0 | 1 | 1 |
| | Total | 22 | 220 | 125 | 93 | 438 |

**Table 3.53: Vulnerable Communities/Villages in HA III**

| | | | No. of Vulnerable Communities | | | |
|---|---|---|---|---|---|---|
| *S/N* | State | No. of LGA | High | Medium | Low | Total |
| *1* | Adamawa | 6 | 116 | 81 | 65 | 262 |
| *2* | Bauchi | 5 | 40 | 33 | 16 | 89 |
| *3* | Borno | 5 | 96 | 44 | 36 | 176 |
| *4* | Gombe | 6 | 50 | 37 | 36 | 123 |
| *5* | Taraba | 3 | 28 | 12 | 11 | 51 |
| *6* | Yobe | 1 | 3 | 1 | 1 | 5 |
| | Total | 26 | 333 | 208 | 165 | 706 |

**Table 3.54: Vulnerable Communities/Villages in HA IV**

| | | | No. of Vulnerable Communities | | | |
|---|---|---|---|---|---|---|
| S/N | State | No. of LGA | High | Medium | Low | Total |
| 1 | Benue | 9 | 64 | 60 | 45 | 169 |
| 2 | Kogi | 4 | 15 | 11 | 12 | 38 |
| 3 | Kaduna | 1 | 0 | 0 | 1 | 1 |
| 4 | Nassarawa | 8 | 34 | 28 | 31 | 93 |
| 5 | Plateau | 2 | 5 | 8 | 4 | 17 |
| 6 | Taraba | 3 | 72 | 33 | 29 | 134 |
| | Total | 27 | 190 | 140 | 122 | 452 |

**Table 3.55: Vulnerable Communities/Villages in HA V**

| | | | **No. of Vulnerable Communities** | | | |
|---|---|---|---|---|---|---|
| **S/N** | State | No. of LGA | High | Medium | Low | Total |
| **1** | Anambra | 14 | 31 | 16 | 27 | 74 |
| **2** | Bayelsa | 8 | 125 | 42 | 39 | 206 |
| **3** | Delta | 9 | 58 | 41 | 24 | 123 |
| **4** | Edo | 2 | 7 | 3 | 4 | 14 |
| **5** | Kogi | 10 | 42 | 17 | 15 | 74 |
| **6** | Rivers | 10 | 95 | 48 | 39 | 182 |
| | Total | 53 | 358 | 167 | 148 | 673 |

**Table 3.56: Vulnerable Communities/Villages in HA VI**

| | | | **No. of Vulnerable Communities** | | | |
|---|---|---|---|---|---|---|
| **S/N** | State | No. of LGA | High | Medium | Low | Total |
| **1** | Detla | 8 | 72 | 37 | 43 | 152 |
| **2** | Edo | 1 | 7 | 4 | 2 | 13 |
| **3** | Ekiti | 1 | 0 | 1 | 0 | 1 |
| **4** | Kwara | 2 | 8 | 5 | 4 | 17 |
| **5** | Ogun | 3 | 126 | 123 | 114 | 363 |
| **6** | Ondo | 2 | 12 | 10 | 9 | 31 |
| **7** | Osun | 17 | 63 | 74 | 70 | 207 |
| **8** | Oyo | 14 | 215 | 229 | 238 | 682 |
| **9** | Lagos | 20 | 186 | 74 | 39 | 299 |
| | Total | 68 | 689 | 557 | 519 | 1765 |

**Table 3.57: Vulnerable Communities/Villages in HA VII**

| | | | No. of Vulnerable Communities | | | |
|---|---|---|---|---|---|---|
| S/N | State | No. of LGA | High | Medium | Low | Total |
| 1 | Abia | 6 | 3 | 17 | 23 | 43 |
| 2 | Akwa-Ibom | 12 | 33 | 32 | 54 | 119 |
| 3 | Cross River | 11 | 132 | 69 | 53 | 254 |
| 4 | Ebonyi | 7 | 43 | 39 | 26 | 108 |
| 5 | Imo | 16 | 18 | 15 | 6 | 39 |
| 6 | Kogi | 1 | 1 | 0 | 4 | 5 |
| 7 | Rivers | 9 | 37 | 32 | 32 | 101 |
| | Total | 62 | 267 | 204 | 198 | 669 |

**Table 3.58: Vulnerable Communities/Villages in HA VIII**

| | | | No. of Vulnerable Communities | | | |
|---|---|---|---|---|---|---|
| **S/N** | State | No. of LGA | High | Medium | Low | Total |
| **1** | Bauchi | 4 | 73 | 49 | 41 | 163 |
| **2** | Borno | 4 | 7 | 7 | 11 | 25 |
| **3** | Jigawa | 13 | 76 | 53 | 70 | 199 |
| **4** | Kano | 17 | 63 | 54 | 48 | 165 |
| **5** | Katsina | 1 | 2 | 8 | 4 | 14 |
| **6** | Yobe | 7 | 78 | 53 | 39 | 170 |
| | Total | 46 | 299 | 224 | 213 | 736 |

## 3.6 Highly Probable Flood Risk Basins

The expected high flood risk basins are: Sokoto–Rima, Niger, Adamawa, Benue, Anambra–Imo, Niger–Delta, lower fringes of Ogun–Osun part of Cross River, and Komadougu–Yobe. A total of one hundred and two (102) LGAs are predicted Highly Probable for 2020/2021 Hydrological Year, Appendix 2.

## 3.7 Probable Flood Risk Areas

The level of floods in this category is expected to be at moderate in term of impact and effect on the people. Two hundred and seventy five (275) LGAs are predicted to fall within this category, detail list in Appendix 3.

## 3.8 Coastal Flooding

Some coastal States: Rivers, Cross River, Delta, Lagos, Ondo and Bayelsa are expected to experience coastal flooding due to rise in sea level and tidal surge which would impact on fishing, habitation and coastal transportation.

## 3.9 Flash and Urban Flooding

Flash and Urban Flood is also expected to occur in some locations such as:

Birnin–Kebbi, Sokoto; Lokoja, Kaduna, Suleja; Gombe, Yola, Makurdi, Abuja, Lafia; Asaba, Port Harcourt, Yenagoa, Lagos, Ibadan, Abeokuta, Benin City, Oshogbo, Ado-Ekiti, Abakaliki, Awka, Nsukka, Calabar, Owerri, Maiduguri, Kano, and major cities with poor drainage systems.

## 3.10 Simulated Hydrographs at selected stations

The simulated hydrographs of gauging stations at Tiga, Kainji, Ologbo, Kende, Geidam, Ikom, Lokoja, Malabu, Okitipupa, Onitsha, Siluko, Zungeru, Abeokuta, Dadin Kowa, Hadejia, KafinGana, Katsina-Ala, Makurdi, Shiroro, Afikpo, Ebba, Gassol, Baro, Kurawa, Umaishia, Otuocha, Wuya, Donga, Chokocho, and Ogun, are shown in Figures 3.13 – 3.46 for both SWAT and GeoSFM models.

The peak flood flow for the year 2020 is expected to be significantly lower than that of year 2012 (reference flood events at all stations).

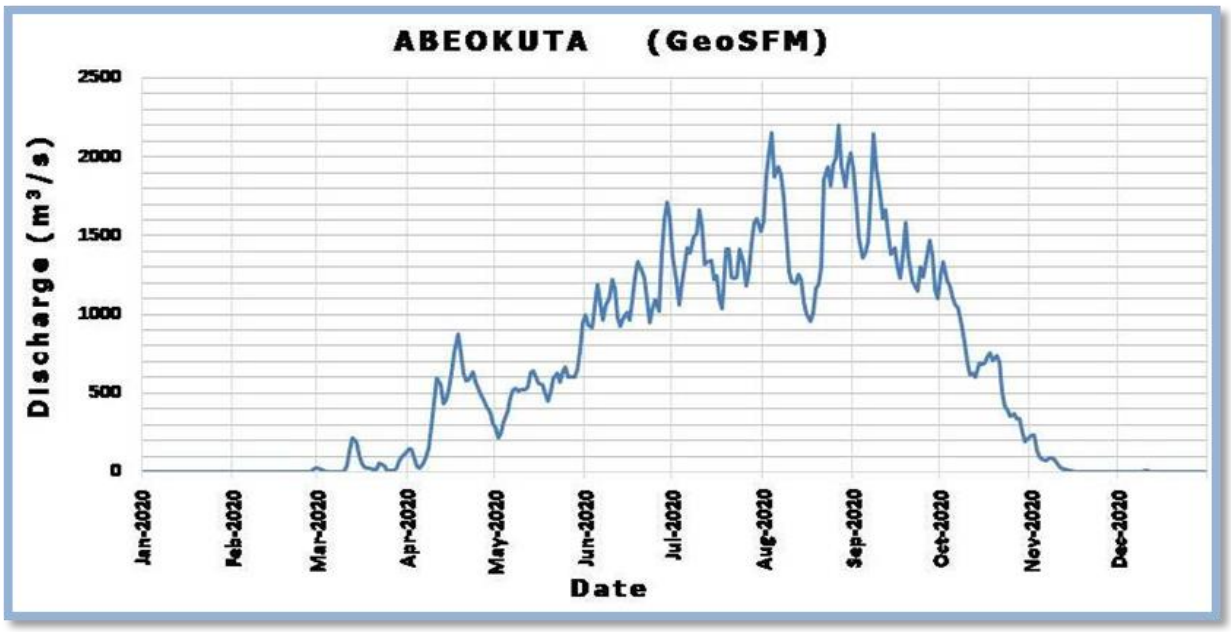



*Fig. 3.13: Simulated Flows at Abeokuta, River Ogun.*

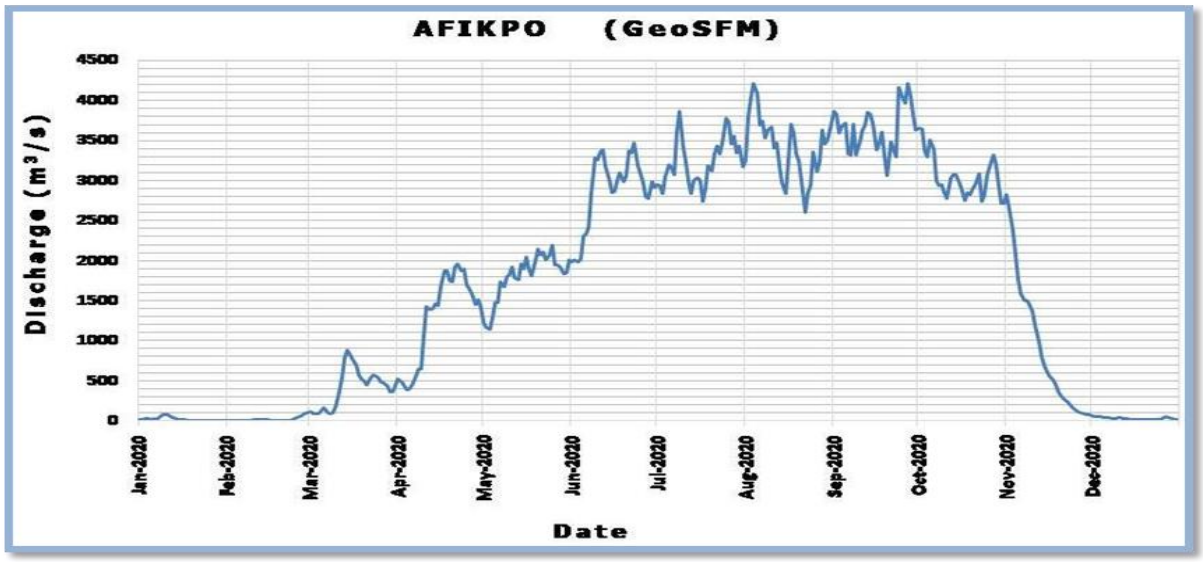



*Fig.3.14: Simulated Flows at Afikpo, Cross-River.*

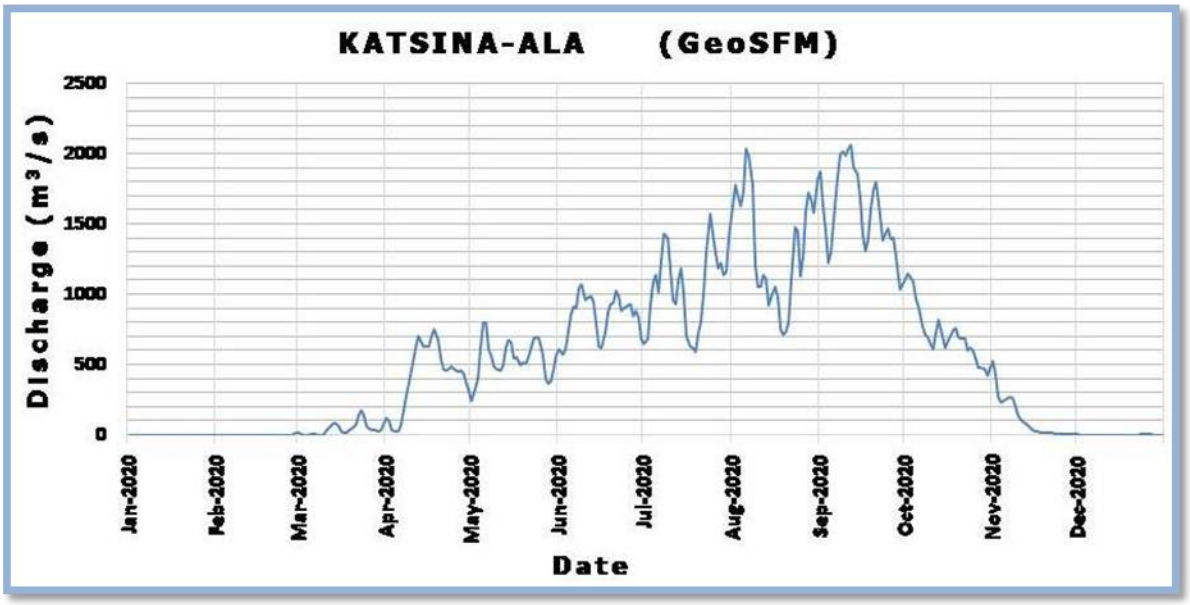



*Fig. 3.15: Simulated Flows at Katsina-Ala, River Katsina-Ala*

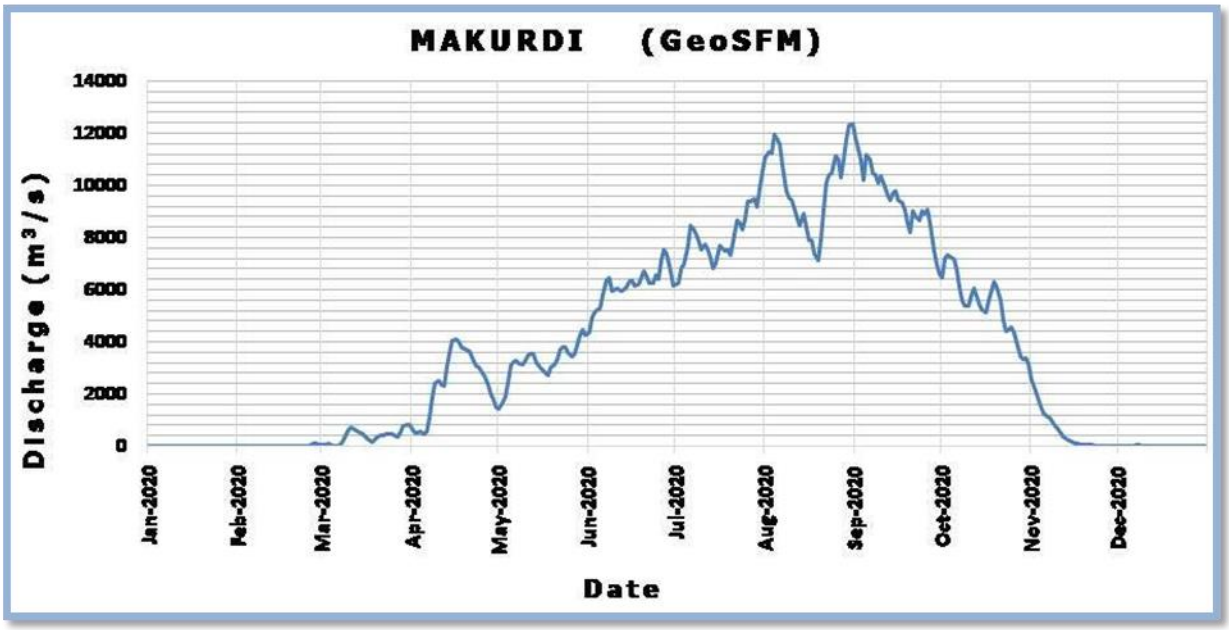



*Fig. 3.16: Simulated Flows at Makurdi, River Benue*


*Fig. 3.17: Simulated Flows at Shiroro, River Kaduna*

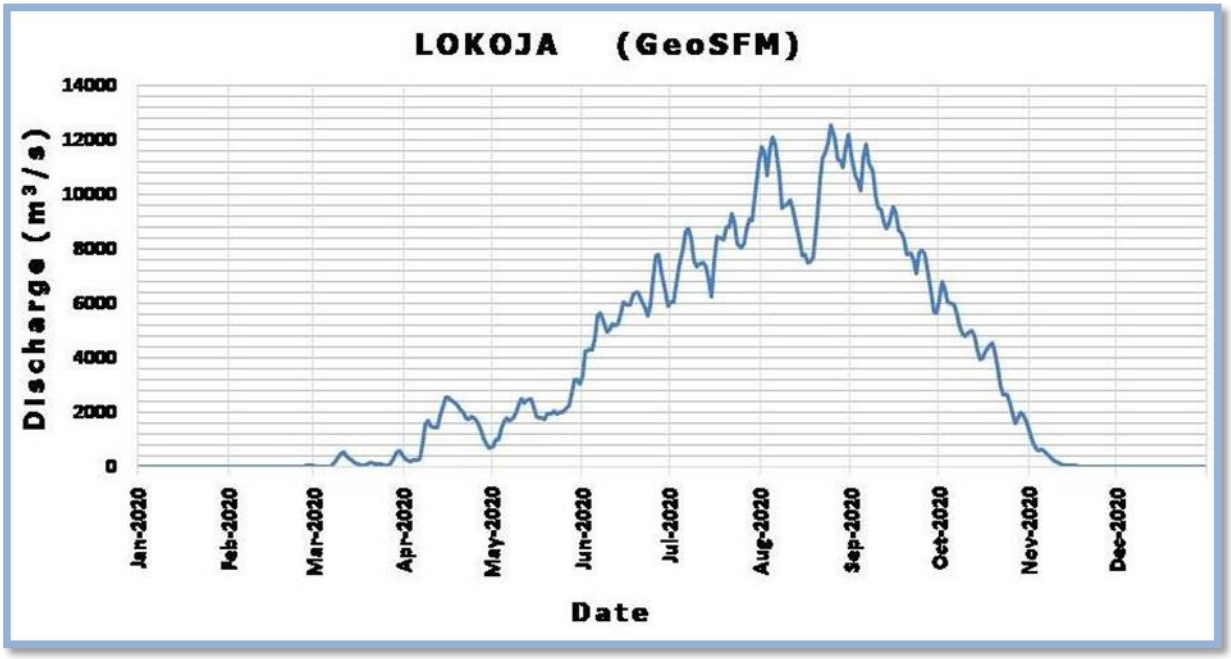



*Fig. 3.18: Simulated Flows at Lokoja, River Niger*


*Fig. 3.19: Simulated Flows at Onitsha, River Niger*

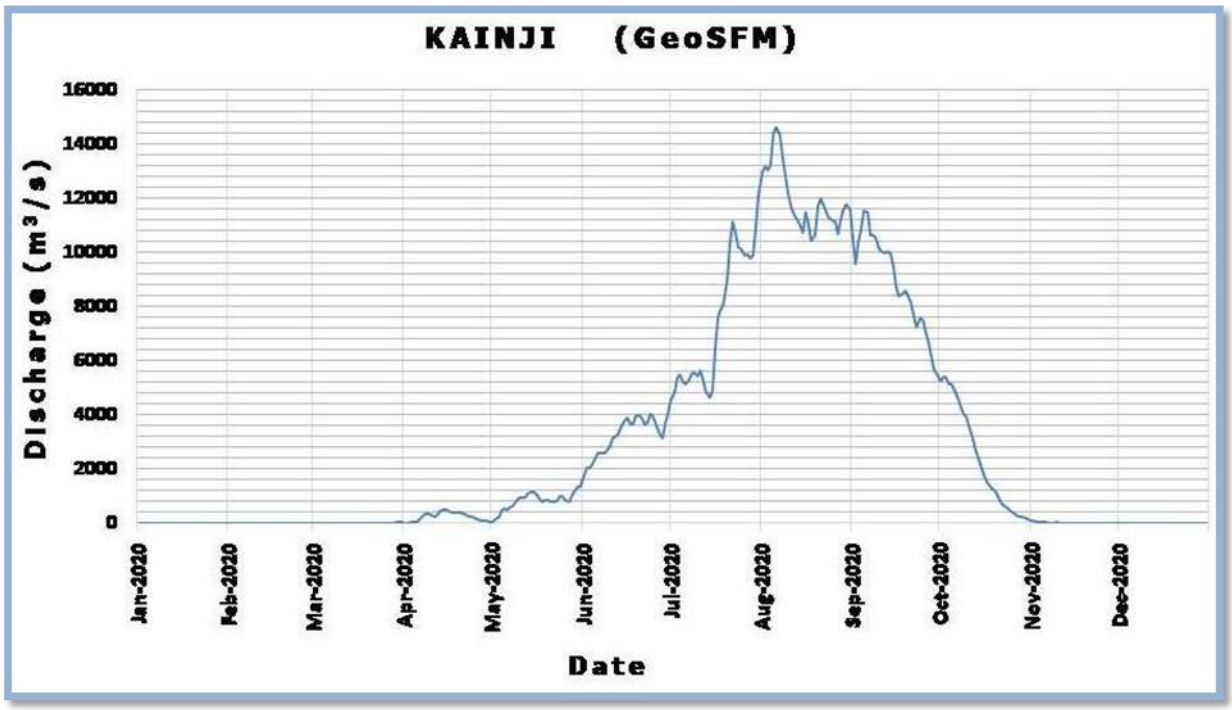



*Fig. 3.20: Simulated Flows at Kainji, Niger-River*

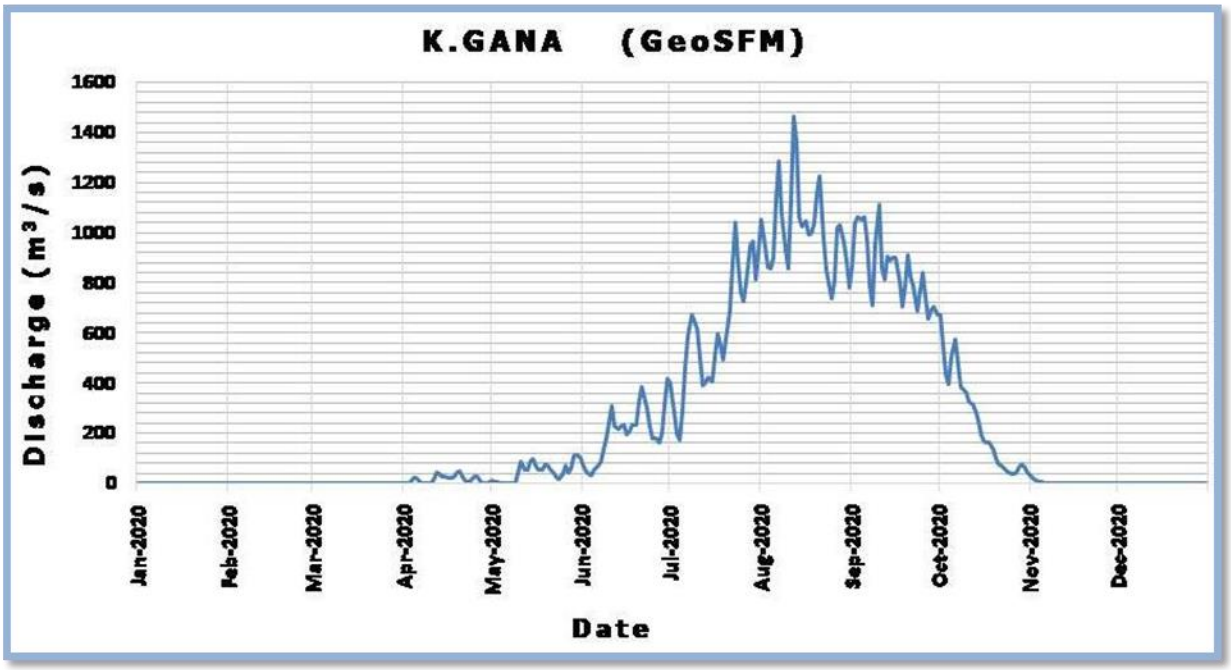



*Fig. 3.21: Simulated Flows at Kafin Gana, River KomaduguYobe*

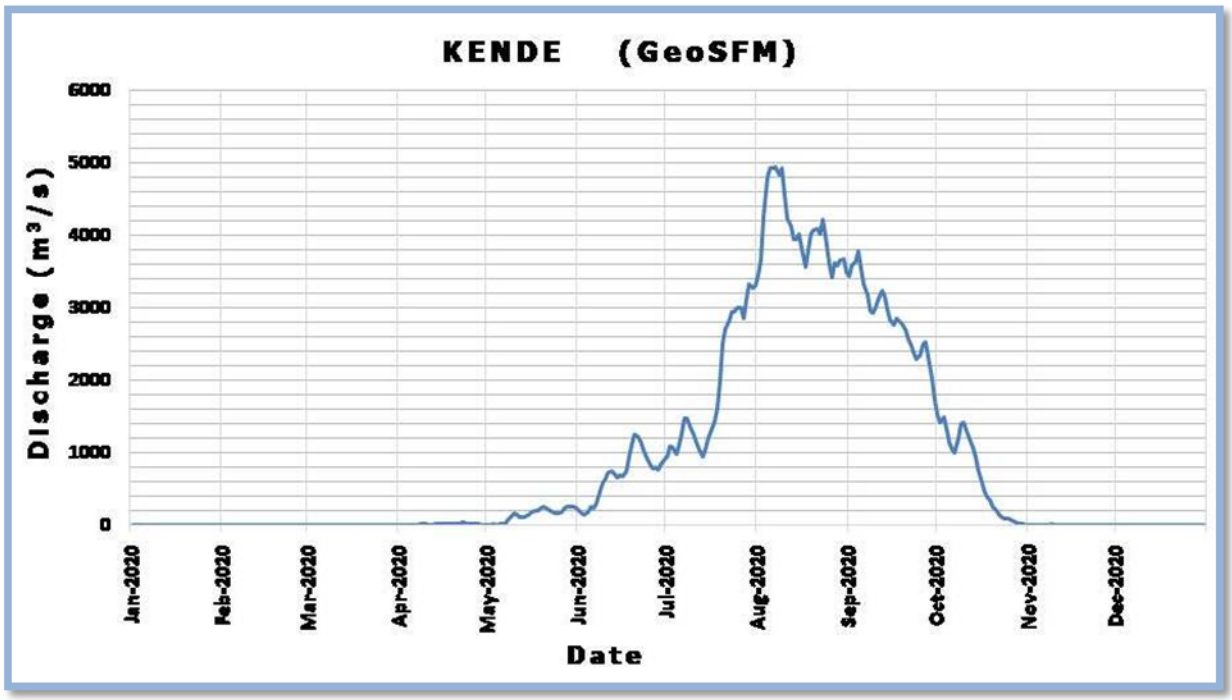



*Fig. 3.22: Simulated Flows at Kende, River Rima*

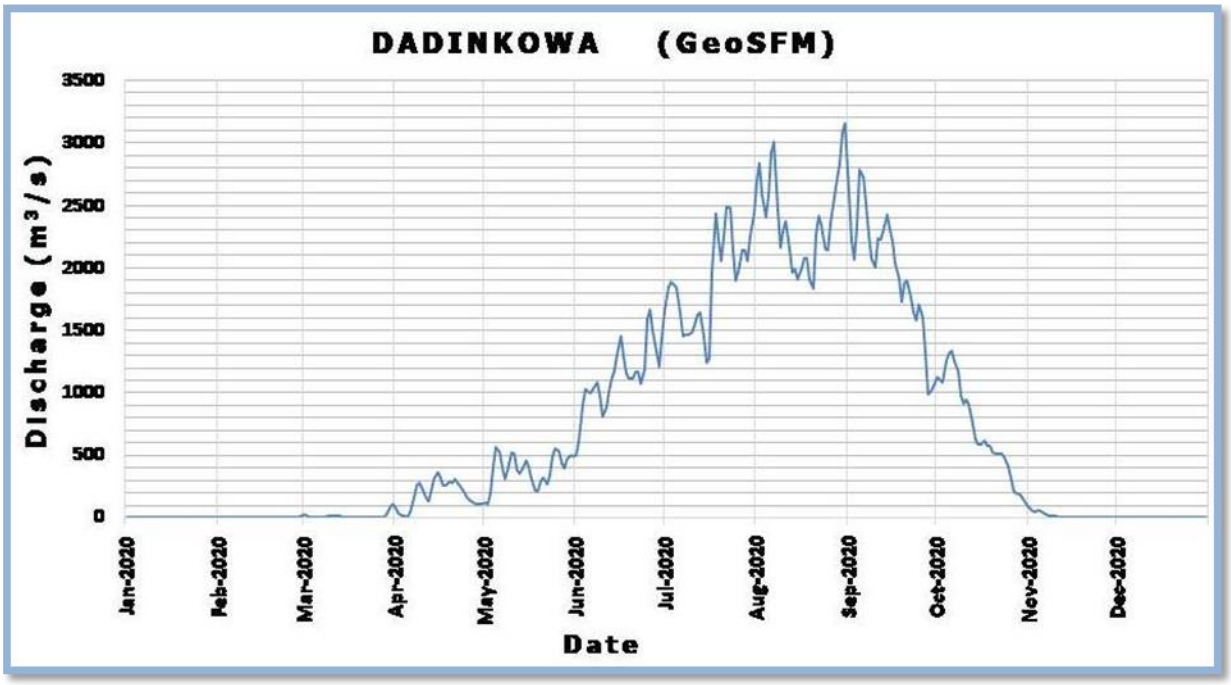



*Fig. 3.23: Simulated Flows at Dadinkowa, River Gongola*

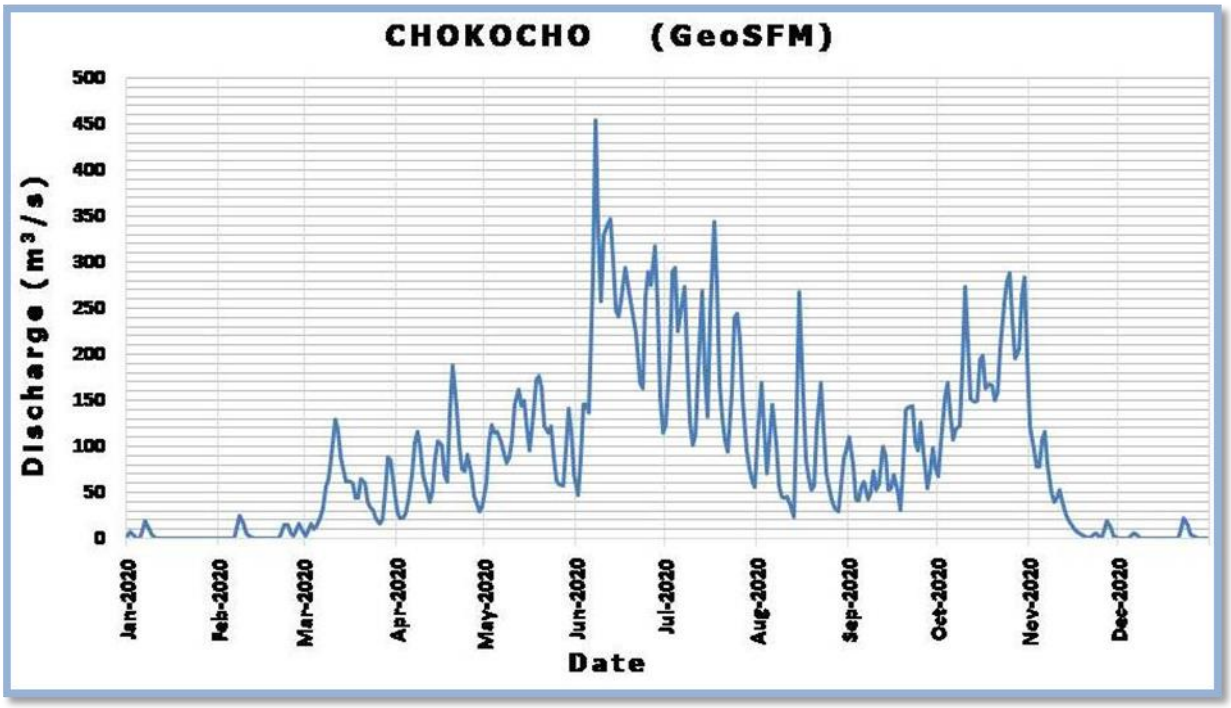



*Fig. 3.24: Simulated Flows at Chokocho, River Otamiri*


*Fig. 3.25: Simulated Flows at Tiga, Kano River*

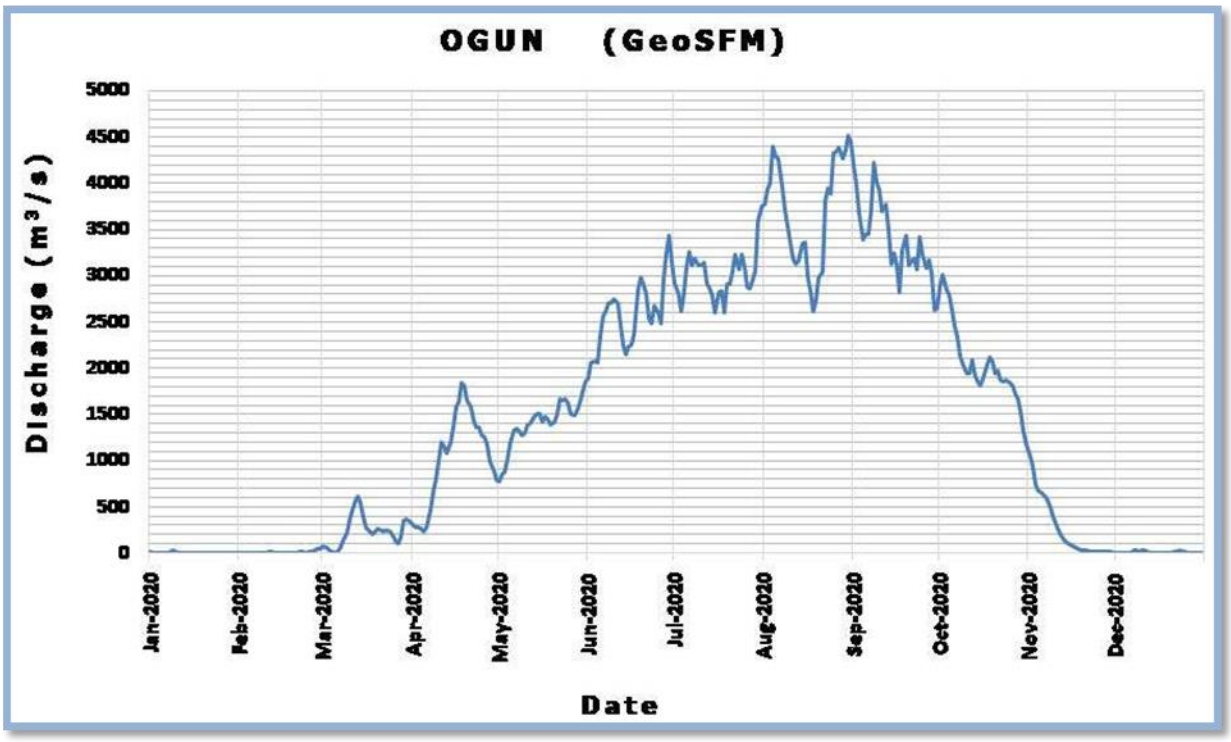



*Fig. 3.26: Simulated Flows at Ogun, River Ogun*

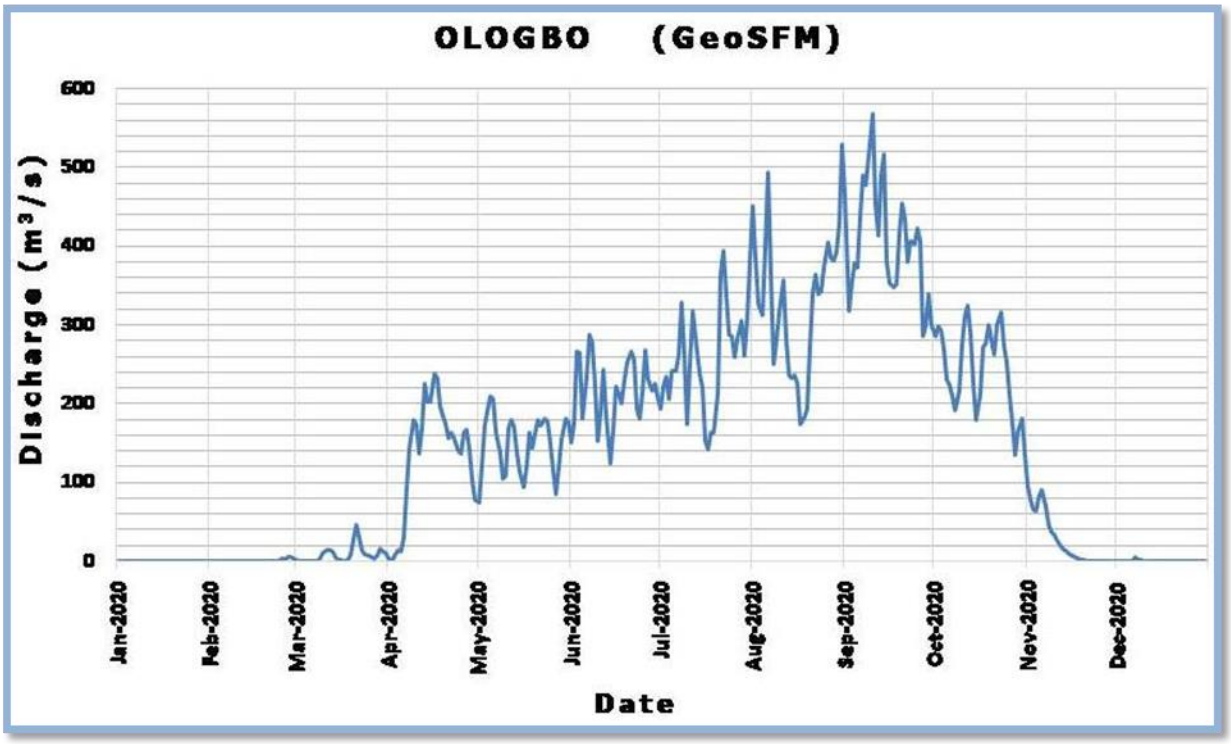



*Fig. 3.27: Simulated Flows at Ologbo, River Ossiomo*

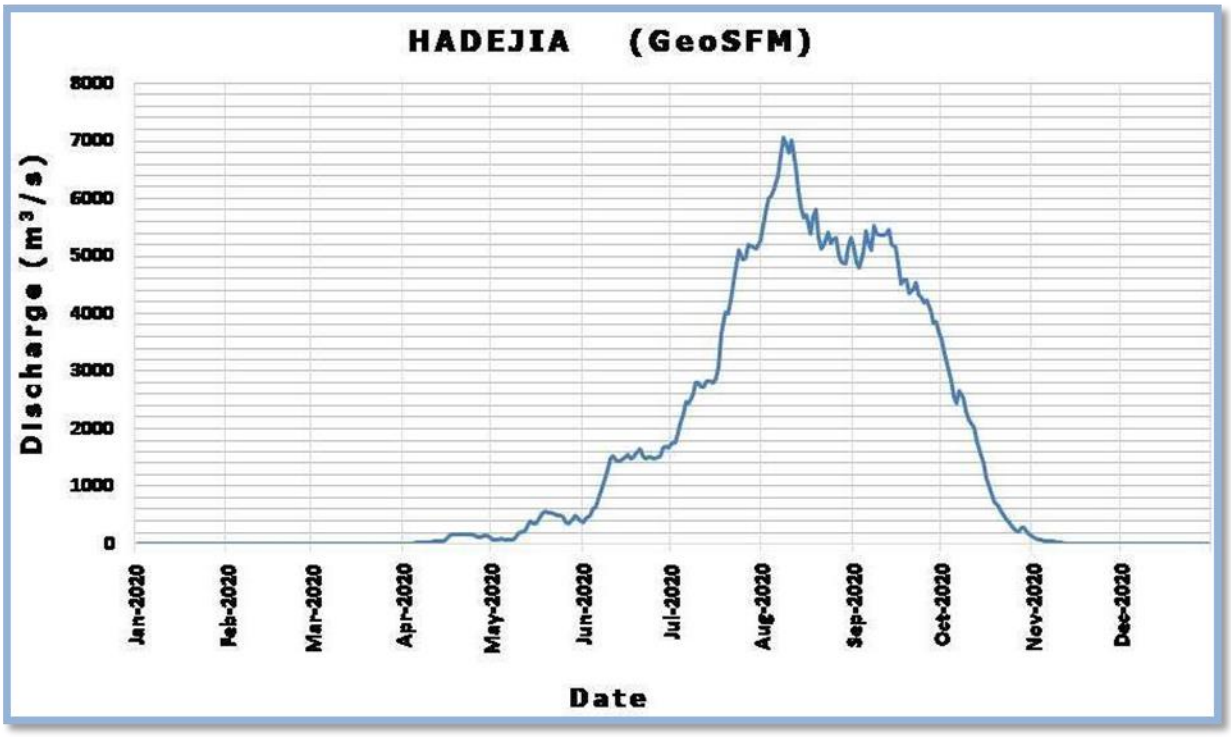



*Fig. 3.28: Simulated Flows at Hadejia*

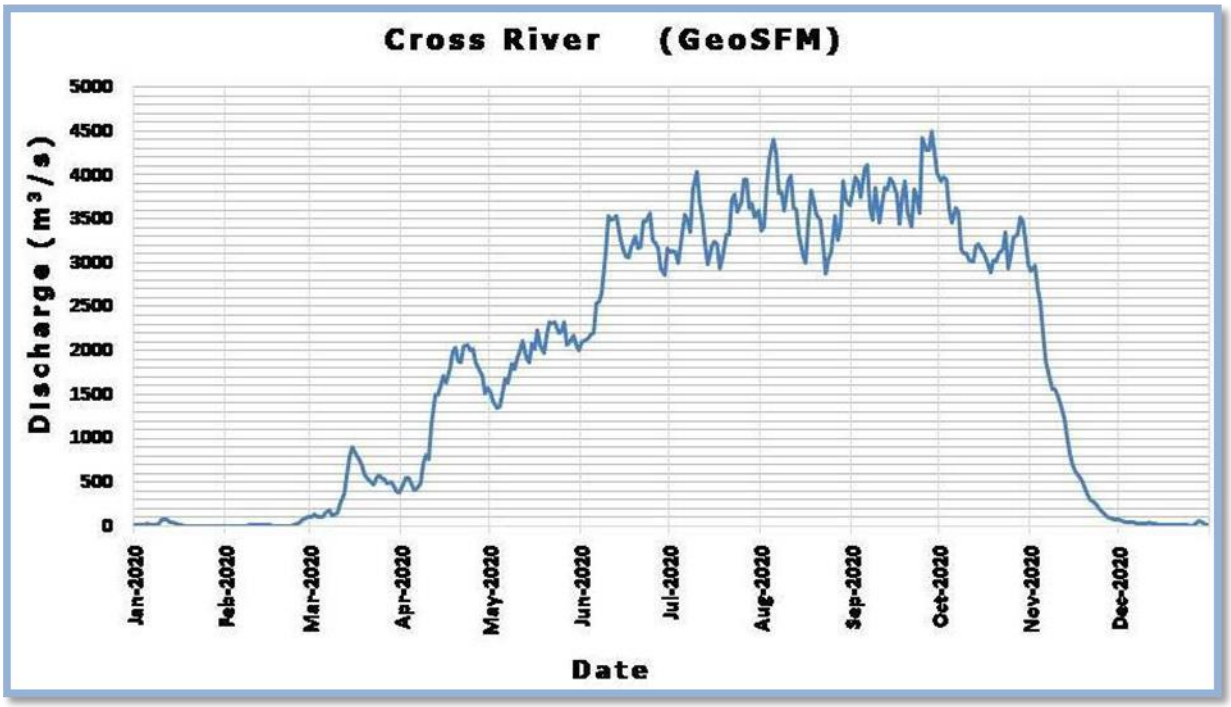



*Fig. 3.29: Simulated Flows at Cross Rvier at Ikom*


*Fig. 3.30: Simulated Flows at Baro, River Niger*

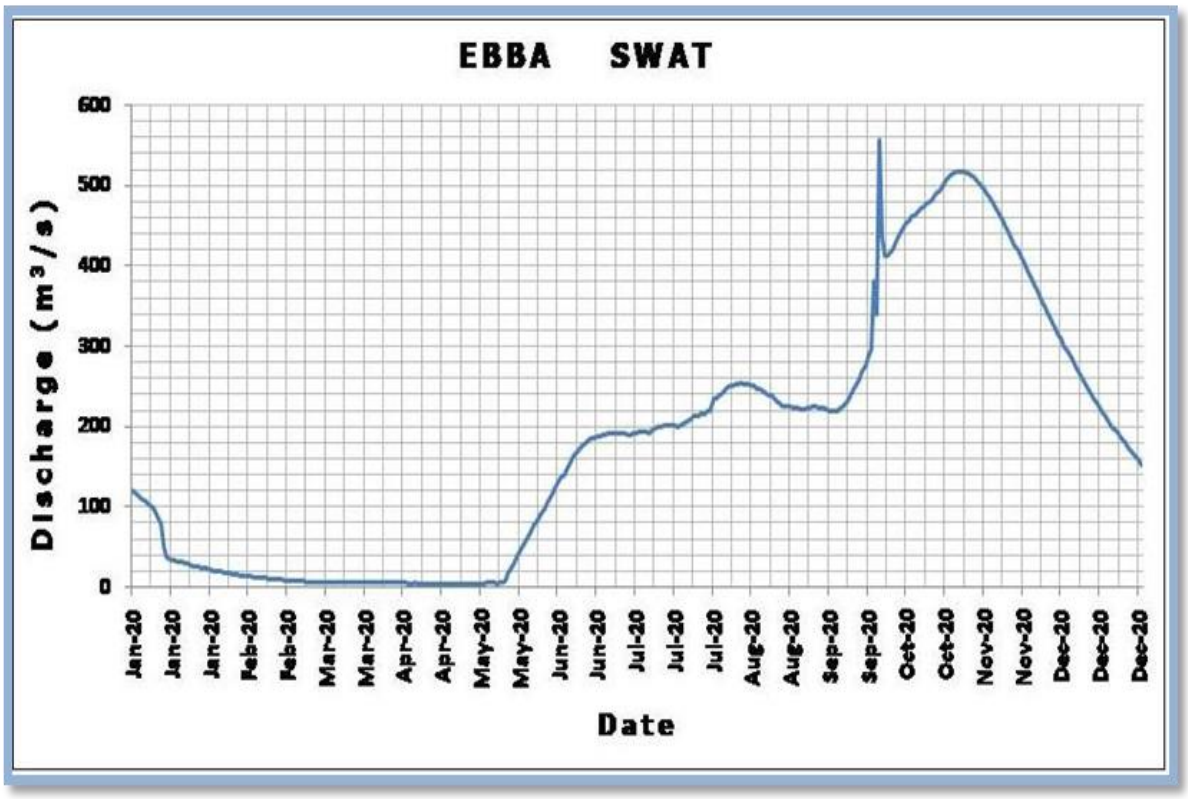



*Fig. 3.31: Simulated Flows at Ebba, River Gbako*

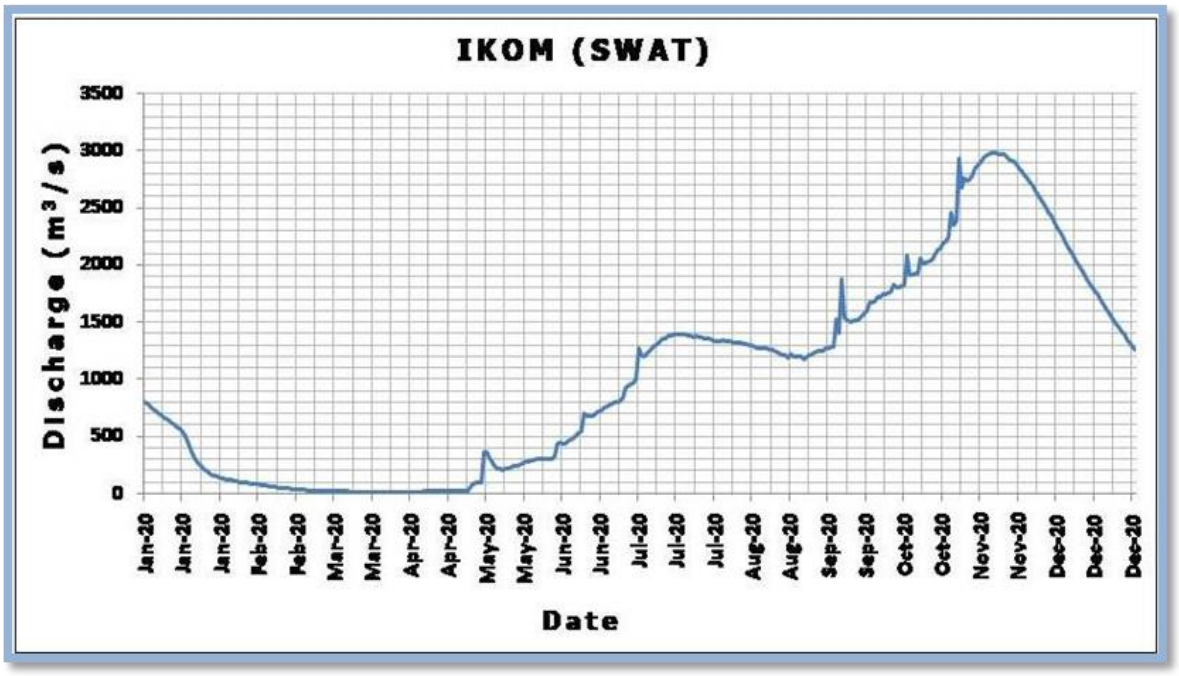



*Fig. 3.32: Simulated Flows at Ikom, Cross River*

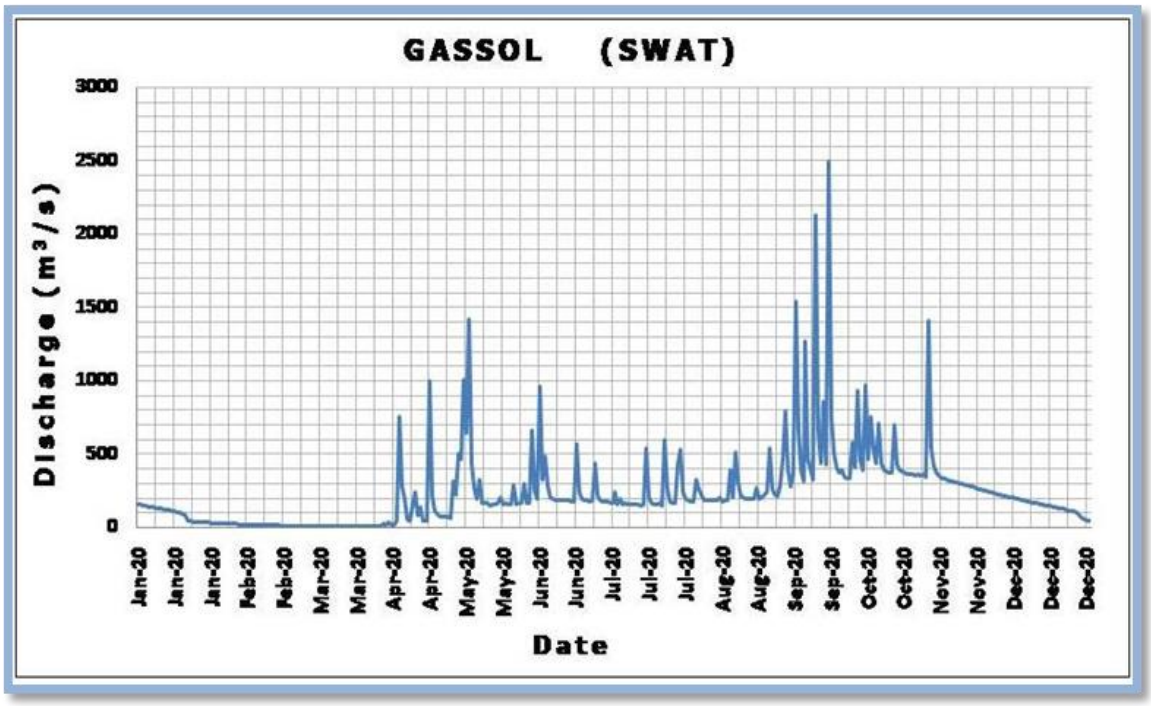



*Fig. 3.33: Simulated Flows at Gassol, River Taraba*

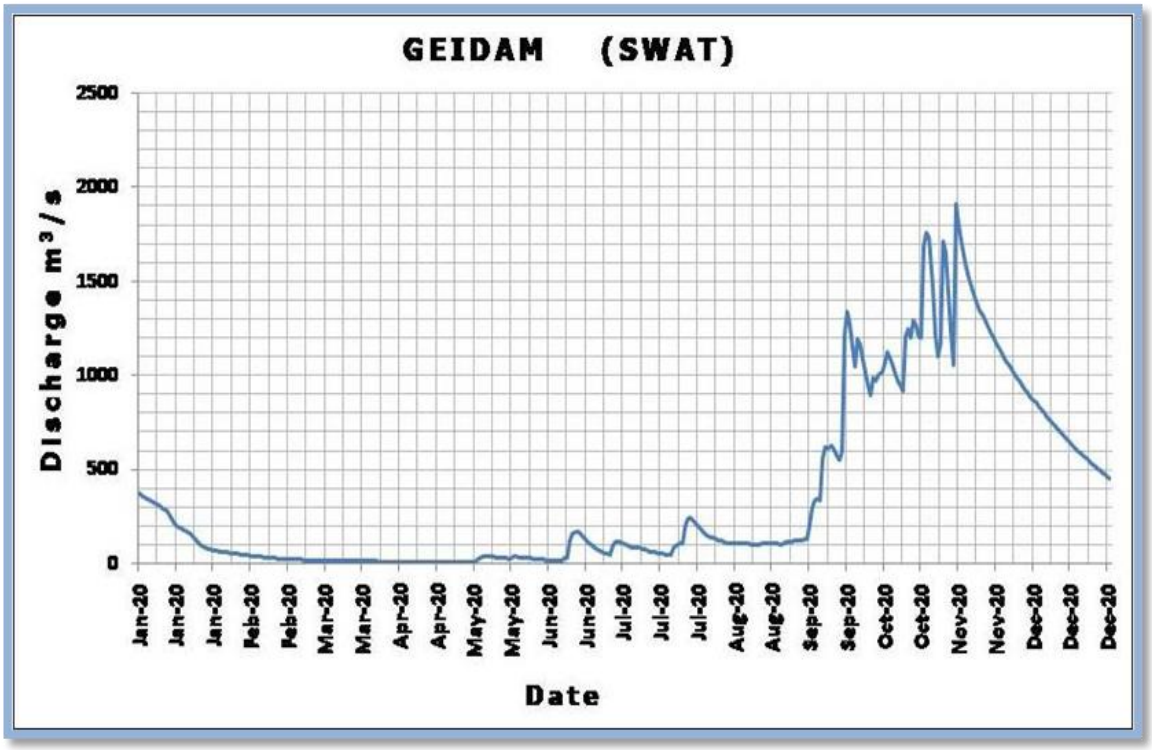



*Fig. 3.34: Simulated Flows at Geidam, River Hadejia*

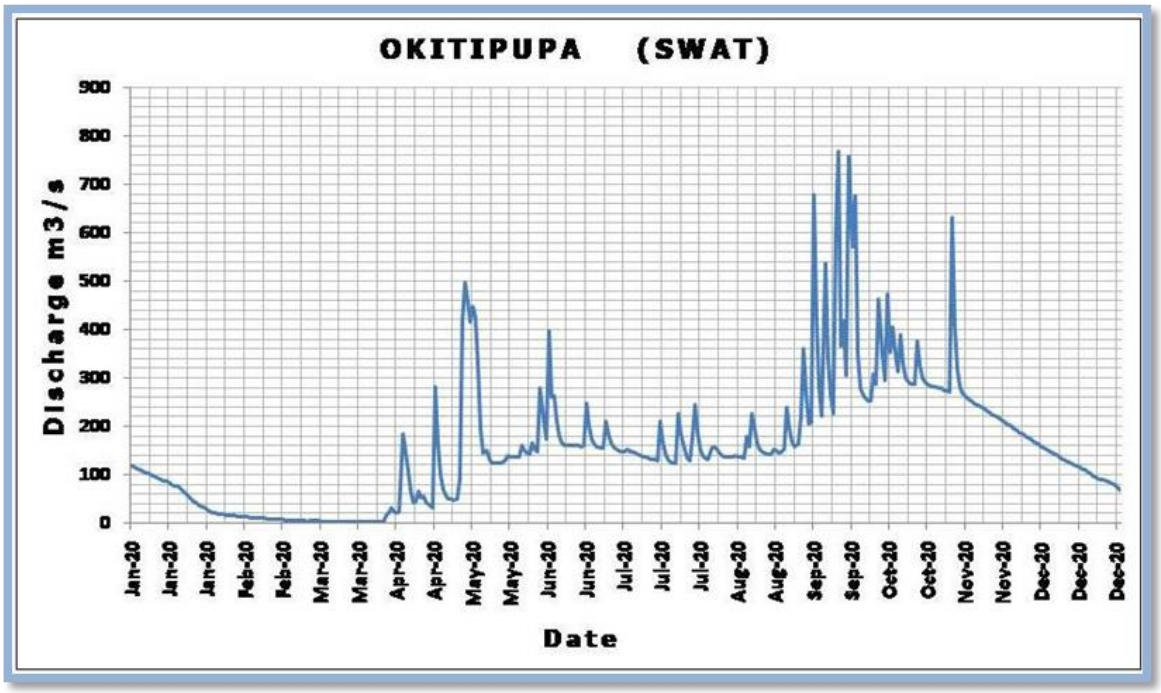



*Fig. 3.35: Simulated Flows at Okitipupa, River Omi Nla*

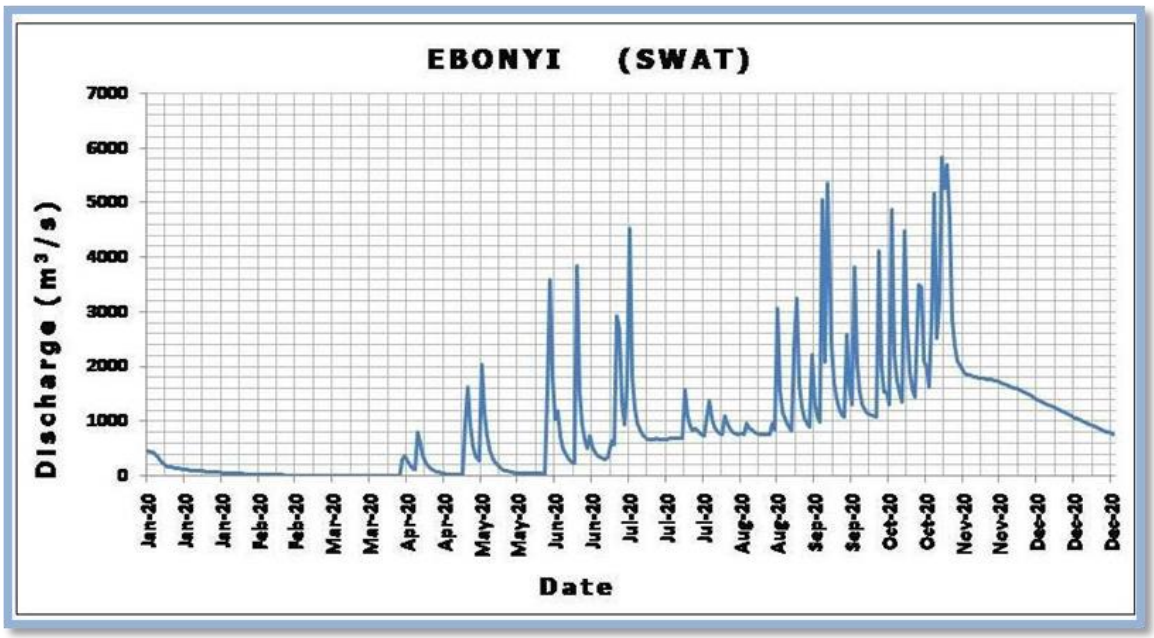



*Fig. 3.36: Simulated Flows at Ebonyi*

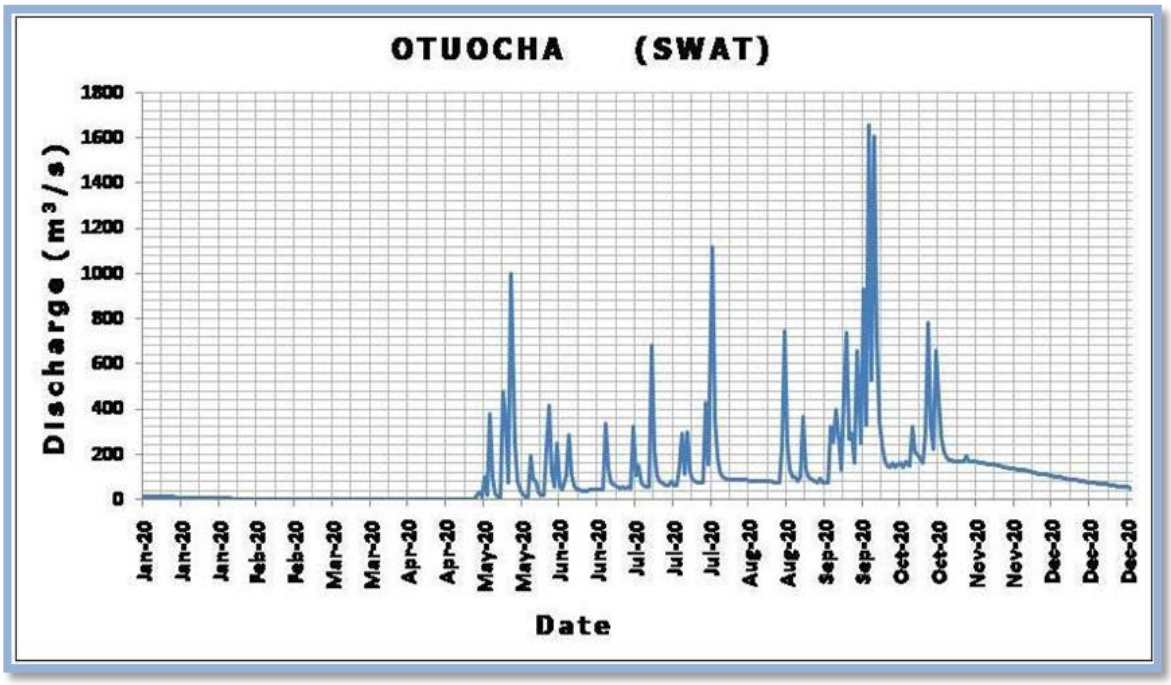



*Fig. 3.37: Simulated Flows at Otuocha, River Niger*

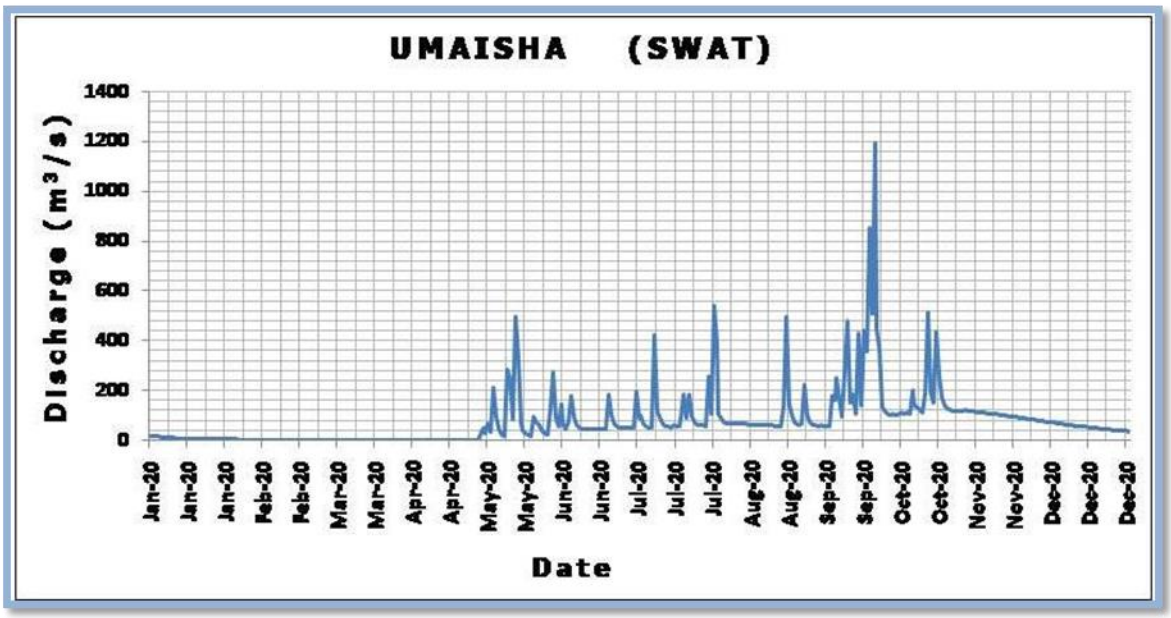



*Fig. 3.38: Simulated Flows at Umaisha, River Niger*

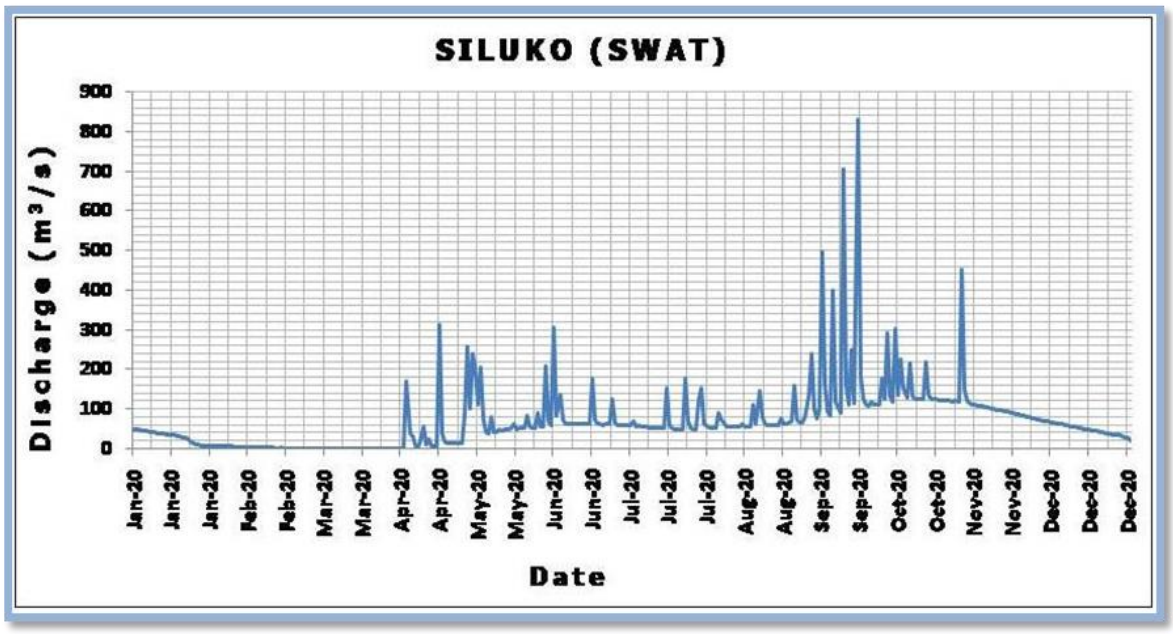



*Fig. 3.39: Simulated Flows at Siluko, River Owena*


*Fig. 3.40: Simulated Flows at Shiroro, River Kaduna*

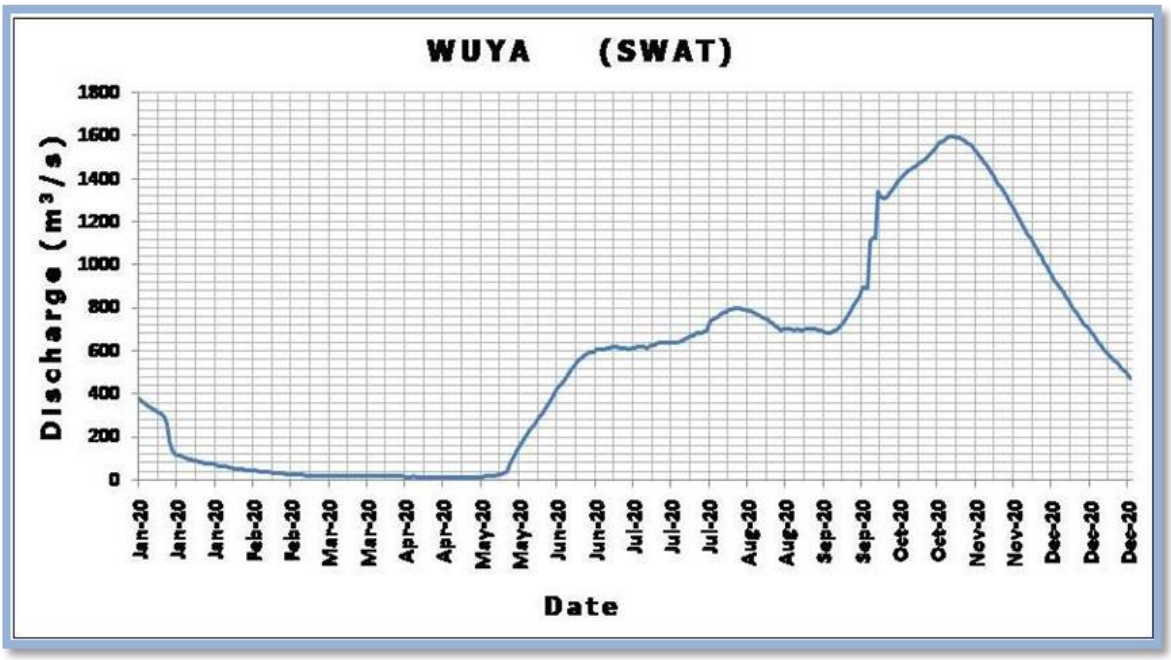



*Fig. 3.41: Simulated Flows at Wuya, River Kaduna*

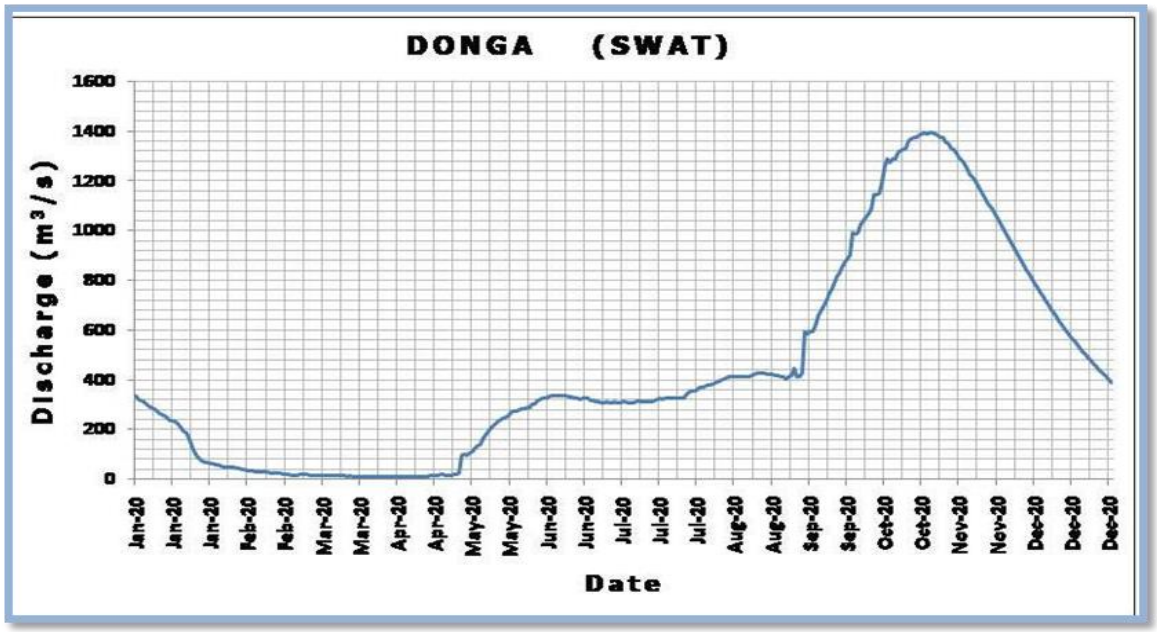



*Fig. 3.42: Simulated Flows at Donga.*

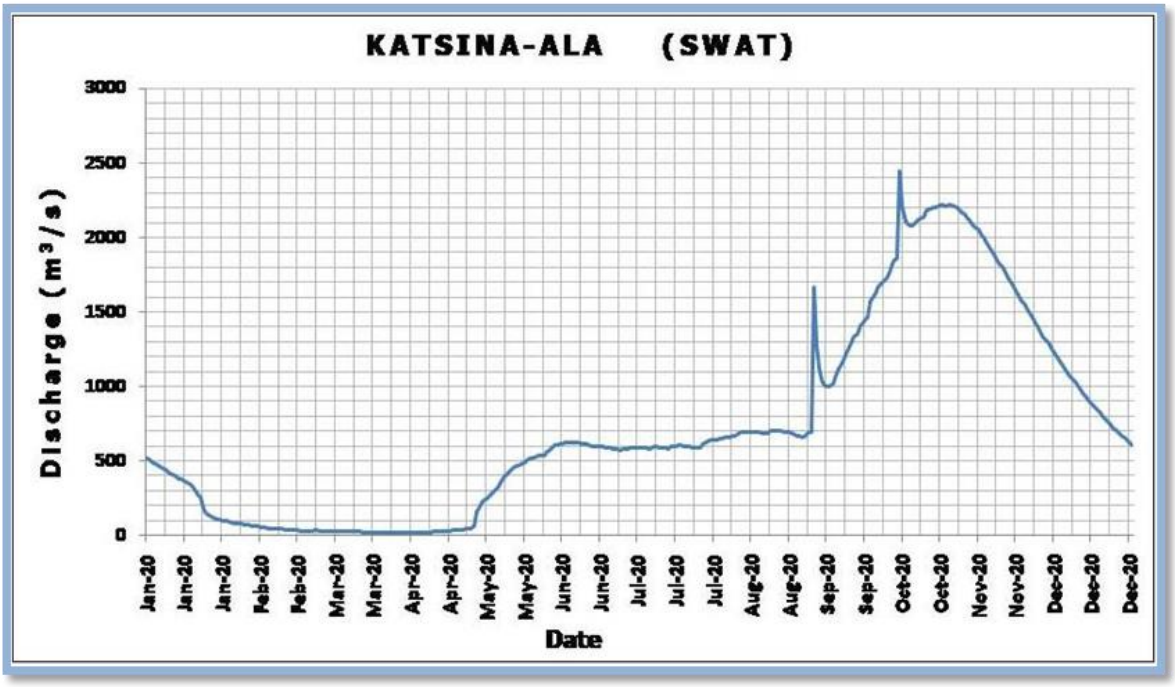



*Fig. 3.43: Simulated Flows at Katsina–Ala, River Katsina–Ala*

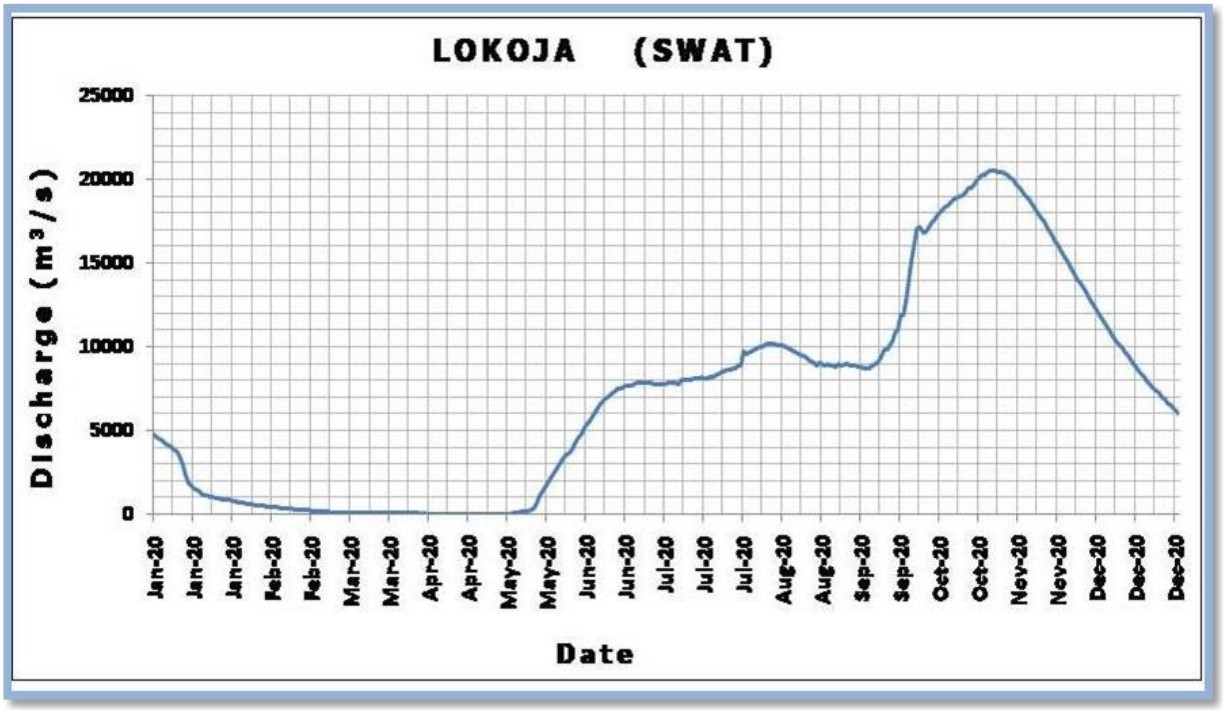



*Fig. 3.44: Simulated Flows at Lokoja, River Niger*

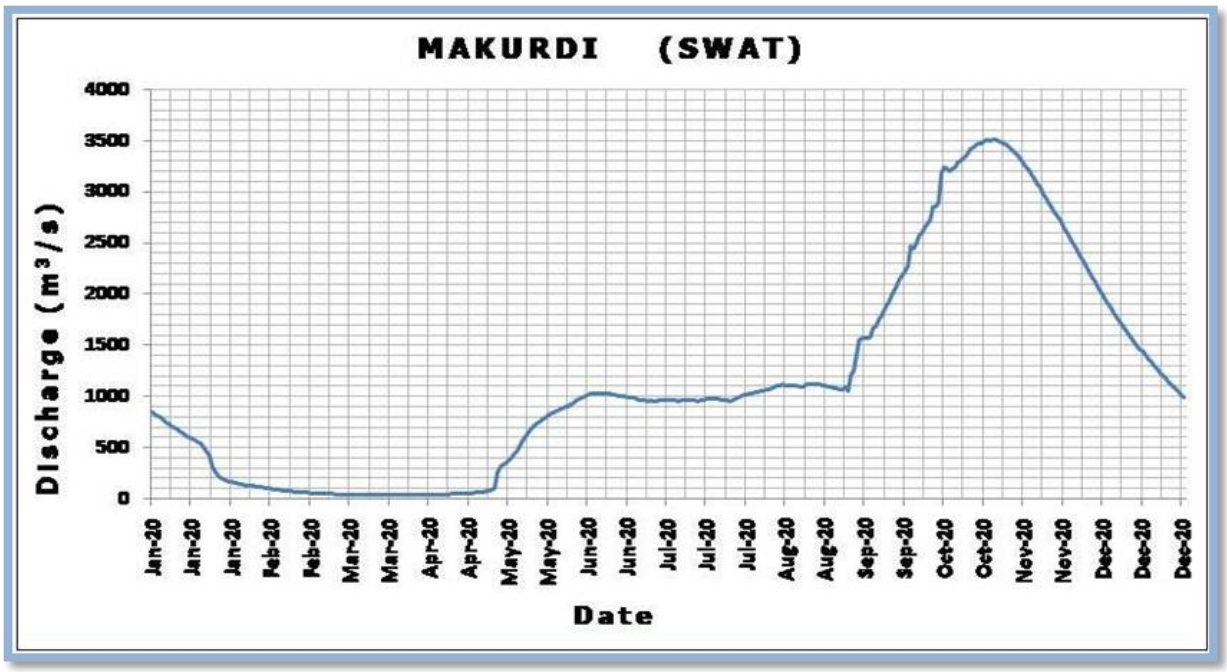



*Fig. 3.45: Simulated Flows at Makurdi, River Benue*

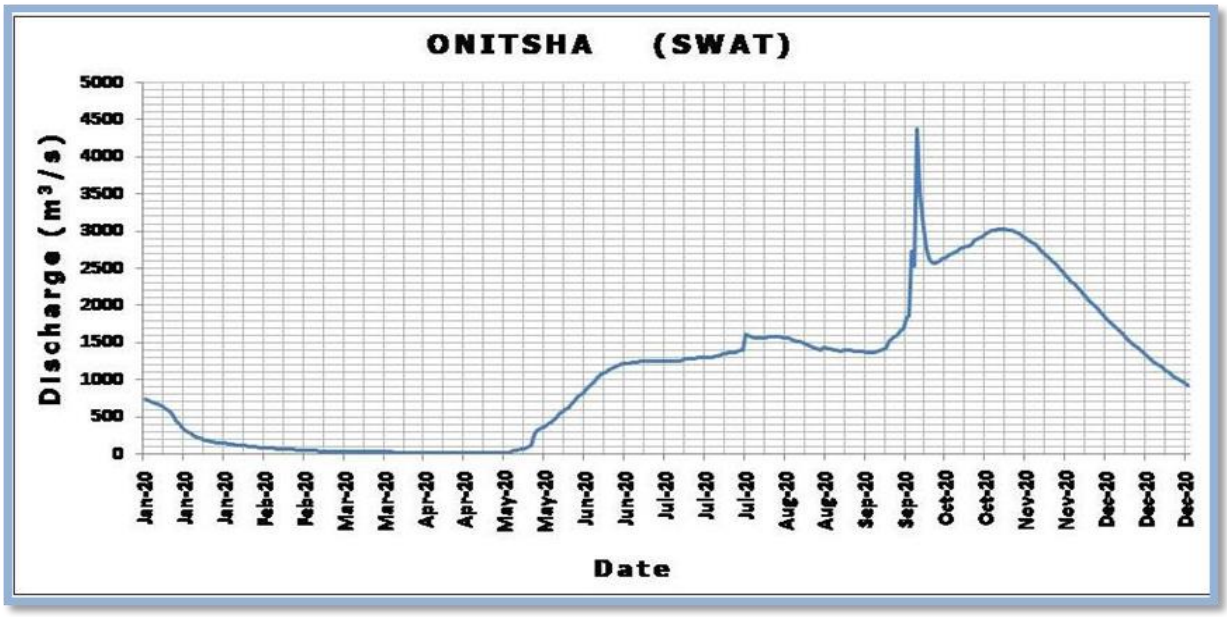
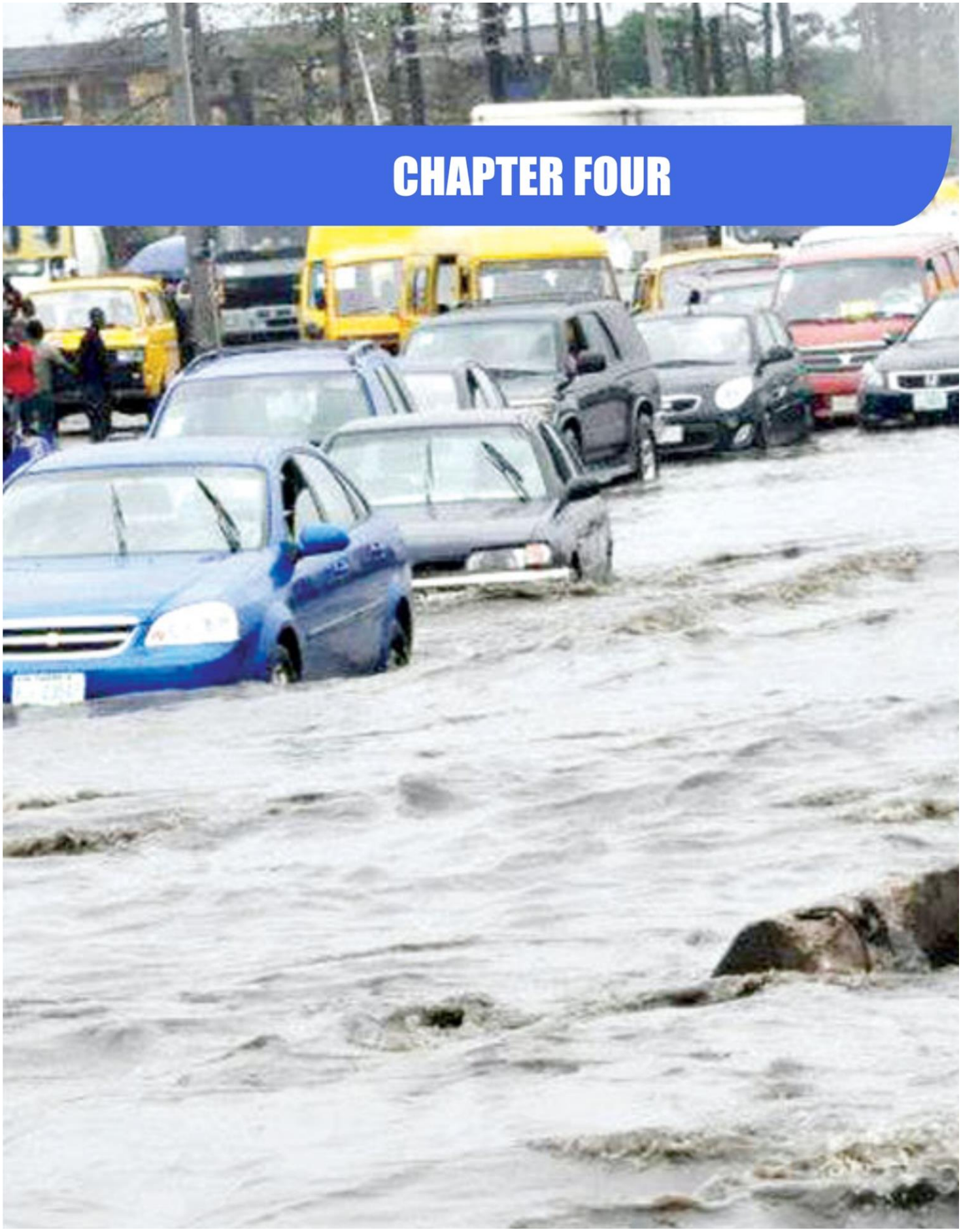



*Fig. 3.46: Simulated Flows at Onitsha, River Niger*

From the hydrographs as seen in figures '3.12 – 3.45", a steady rise in discharge rate and water level is expected from May, June to July and a Peak flow between September and October along the nation's major river channels.

# CHAPTER FOUR



# CHAPTER FOUR

## 4.0 CONCLUSION AND RECOMMENDATIONS

Flooding is multidimensional in causes and effects; it is a global phenomenon that has increased in frequency over years. Impending climate change and anthropogenic activities exacerbate flooding.

In predicting flood occurrence and mitigation of flood hazards, understanding the hydro-meteorological and catchment processes is essential. Imaginative and innovation management approaches should be encouraged and applied in the planning and management of flood. The most sustainable approach in dealing with flooding is to put in place measures to manage the hazards and eventually adapt and learn to live with floods.

Hydrologic modeling and simulation are indispensable tools in water resources management and should continue to be adopted and applied in flood forecasting and risk management. Beginning from the maiden edition of the publication of the AFO, two modeling tools have been appreciatively effective (SWAT and GeoSFM).

The concept of AFO should feature prominently in planning and development processes of critical sectors of the economy namely: Agriculture, Aviation, Water Resources, Power, Health, Environment and Education amongst others.

The synergy between Nigeria Hydrological Services Agency, stakeholders and other collaborative agencies involved in flood management and disaster issues should be encouraged. The effective management of flood risk should be a collective responsibility of all stakeholders from individual, federal, state and local levels.

Furthermore, there should be in place programmes to enhance resilience (insurance; compensation, economic empowerment, education and awareness) flood forecasting and early warning systems, floodplain mapping and catchment management plans, innovative building and construction schemes, enactment and enforcement of planning laws.

Governments at various levels should also put in place measures for better town planning and effective land use zoning, effective flood disaster management in the changing environment, improved biodiversity and ecosystem management for the enhancement of rapid and sustainable development in the country.

The states should create retention basins for harvesting flood waters downstream of major rivers where there is scarcity of groundwater thereby using this flood waters for possible groundwater recharge and other uses. By so doing, the fresh flood waters will not be lost to the sea to become saline water.

From the prediction, all the states including FCT are expected to experience different levels of flooding. Out of the 774 local government areas of the country, one hundred and two (102) are predicted to be highly probable to flood occurrence in 2020 while two hundred and seventy-five (275) local government areas are probable areas of flood and three hundred and ninety-seven (397) are predicted to be less probable to flood occurrence. This AFO contains useful information on the areas that are likely to be flooded and the severity of the expected flooding in 2020. Finally, it is advised that the predictions of flood for the year 2020 be adhered to and all recommendations heeded.

# GLOSSARY

**5.1 Annual rainfall amount** – This is the total amount of rainfall observed and recorded in the year under reference.

**5.2 Anthropogenic** - It describes changes in nature made by people. If your town has rerouted water from the river for drinking water, that is an anthropogenic activity.

**5.3 Basin** - It is an area of land that is lower at the centre than at the edges, especially one from which water runs down into a river. It is also large, bowl shaped depression in the surface of the land or ocean floor.

**5.4 Catchment** - A structure, such as a basin or reservoir, used for collecting or draining water.

**5.5 Climate change** – It is a non-random change in climate that is measured over several decades or longer, which may be due to natural or human-induced causes.

**5.6 Coastal inundation** – A type of flooding which occurs when water is driven onto land from an adjacent body of water such as the sea or ocean.

**5.7 Discharge** - It is the volume rate of water flow per unit time, including any suspended solids (e.g. sediment), solute, and/or biological material (e.g. diatoms), which is transported by the water.

**5.8 Flash flood** - It is a rapid flooding of geomorphic low-lying areas: washes, rivers, dry lake sand basins. It may be caused by heavy rain associated with a severe thunderstorm, hurricane, tropical storm, or melt water from ice or snow flowing over ice sheets or snowfields.

**5.9 Flood** - A flood is an event where the river channel becomes inadequate to contain the flow, leading to overtopping of banks and the inundation of parts of the

environment. The term has been extended to situations where, due to high impermeability and relative low-lying nature of an area, overland flow stagnates in, and inundates such zones. Flooding associated with high-magnitude storm events, overtopping of river banks, high surface impermeability, low elevation areas, and unrestrained/sustained inundation of communities.

**5.10 Floodplains** -. A floodplain is the strip of very low relative relief alluvial plain that borders a river channel and is usually bounded on the channel side by levees – discontinuous, wedge-shaped ridges around active and abandoned channels, and on the landward side by bluffs and uplands. It is subject to periodic inundation particularly during seasonal floods, and comprises river channels, oxbow lakes, levees, and terraces (Bridge 2003).

**5.11 Global warming** – An overall increase in the world temperatures, which may be caused by additional heat being trapped by greenhouse gases mostly as a result of human activities.

**5.12 Hydrology**- Hydrology is the study of the occurrence, circulation and distribution of fresh water (i.e. water with total solute load less than 1000 mg $L^{-1}$) on the surface of the earth. It also investigates the physical and chemical properties of the water and its interactions with man and his environment. A practitioner of hydrology is a hydrologist, working within the fields of earth or environmental science, physical geography, geology or civil and environmental engineering.

**5.13 Inundation** - It is the covering of the land by water as a result of flood or construction of a dam across a river.

**5.14 Meteorology** - It is the interdisciplinary scientific study of the atmosphere. Meteorological phenomena are observable weather events which illuminate, and are explained by the science of meteorology. Those events are bound by the variables that exist in Earth's atmosphere; temperature, air pressure, water vapor,

and the gradients and interactions of each variable, and how they change in time. Different spatial scales are studied to determine how systems on local, regional, and global levels impact weather and climatology.

**5.15 Morphology** - It is a scientific study of form and structure, usually without regard to function.

**5.16 Permeability** – It is a process whereby water percolates into the ground through the interconnected pores and spaces in a rock.

**5.17 Precipitation** - as any product of the condensation of atmospheric water vapour that falls to the earth under gravity. The main forms of precipitation include drizzle, rain, sleet, snow and hail. Precipitation occurs when a local portion of the atmosphere becomes saturated with water vapour, so that the water condenses and precipitates.

**5.18 Surface Runoff** – **Surface runoff** (also known as **overland flow**) is the flow of water that occurs when excess storm water, melt water, or other sources flows over the earth's surface. This might occur because soil is saturated to full capacity. It can also occur because rain arrives more quickly than soil can absorb it.

**5.19 Telemetric** - It is a technology that involves the automatic measurement and transmission of data from remote sources.

**5.20 Topography** - This is a detailed map of the surface features of land. It includes the mountains, hills, creeks, and other physical features on the earth's surface.

**5.21 Transboundary Aquifer Systems (TAS)** - It can also be referred to as Internationally Shared Aquifer Systems. This is a situation where water bearing rock formations (aquifers) underlie two or more countries

# ACRONYMS

- **ACMAD** : African Centre for Meteorological Application for Development
- **AFO**: Annual Flood Outlook
- **AGRHYMET** : Agro–meteorology and Operational Hydrology and their Applications
- **AMESD** : African Monitoring of Environment for Sustainable Development
- **ArcGIS** : Arc Geographic Information System
- **CHIRPS** : Climate Hazards Group Infra-Red Precipitation with Stations
- **DAR** : Deviation of Length of Rainy Season
- **DCP** : Data Collection Platform
- **DEM** : Digital Elevation Model
- **FEWSNET** : Famine Early Warning System Network
- **FME** : Federal Ministry of Environment
- **FMWR** : Federal Ministry of Water Resources
- **GeoSFM**: Geospatial Stream Flow Model
- **HA** : Hydrological Area
- **HKYTF** : Hadejia Komadugu Yobe Trust Fund
- **IPCC**: Inter-governmental Panel on Climate Change

- **JICA** : Japanese International Cooperation Agency
- **NASA** : National Aeronautic and Space Agency
- **NASRDA** : National Space Research and Development Agency
- **NBA** : Niger Basin Authority
- **NEMA** : National Emergency Management Agency
- **NIHSA** : Nigeria Hydrological Services Agency
- **NiMet** : Nigerian Meteorological Agency
- **NIWA** : National Inland Waterways Authority
- **NIWRMC** : Nigeria Integrated Water Resources Management Commission
- **NWRI** : National Water Resources Institute
- **OSGOF** : Office of the Surveyor General of the Federation
- **PET** : Potential Evapotranpiration
- **RBDAs** : River Basin Development Authorities
- **SRP** : Seasonal Rainfall Prediction
- **SRTM** : Shuttle Radar Topography Mission
- **SWAT** : Soil and Water Assessment tool
- **WFP** : World Food Programme
- **USGS** : United State Geological Survey

# REFERENCES

**Association American of Geographers** 1969. *Perspectives on geomorphic processes*. Commission on College Geography Resource Paper No. 3. AAG, Washington D.C. 56p

**Bridge J.S.** 2003. *Rivers and floodplains: forms, processes and sedimentary record*. Blackwell Publishing Co. Oxford. 491p

European Commission's Directorate-General for European Civil Protection and Humanitarian Aid Operations (ECHO 9 Oct 2019)

**IPCC - Intergovernmental Panel on Climate Change (2007).** *Fourth Assessment Report (AR4) Climate Change 2007:* The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.) Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 996 pp.

**Ogunkoya O.O.** (2017) Physiography of Nigeria. *TheNigerian Field* 82 (2017)

# APPENDIX 1

## LIST OF FLOODED LGAs IN 2018 FLOODED LGAs IN 2018

| S/N | State | LGA | Source |
|---|---|---|---|
| 1 | Adamawa | Guyuk | Vanguard 18th Aug |
| 2 | Adamawa | Lamurde | Vanguard 18th Aug |
| 3 | Adamawa | Song | Vanguard 18th Aug |
| 4 | Adamawa | Yola North | Vanguard 18th Aug |
| 5 | Adamawa | Yola South | Vanguard 18th Aug |
| 6 | Anambra | Aghamelum | Vanguard 19th Sept |
| 7 | Anambra | Anambra East | Vanguard 19th Sept |
| 8 | Anambra | Anambra West | Vanguard 19th Sept |
| 9 | Anambra | Awka North | Vanguard 19th Sept |
| 10 | Anambra | Ekwusigo | Vanguard 19th Sept |
| 11 | Anambra | Idemili South | Vanguard 19th Sept |
| 12 | Anambra | Ihiala | Vanguard 19th Sept |
| 13 | Anambra | Ogbaru | Vanguard 19th Sept |
| 14 | Anambra | Onitsha North | Vanguard 19th Sept |
| 15 | Anambra | Onitsha South | Vanguard 19th Sept |
| 16 | Anambra | Oyi | Vanguard 19th Sept |
| 17 | Bayelsa | Brass | Vanguard 28th Sept |
| 18 | Bayelsa | Ekeremor | Vanguard 28th Sept |
| 19 | Bayelsa | Kolokuma/Opokuma | Vanguard 28th Sept |
| 20 | Bayelsa | Nembe | Vanguard 28th Sept |
| 21 | Bayelsa | Ogbia | Vanguard 28th Sept |
| 22 | Bayelsa | Sagbama | Vanguard 28th Sept |
| 23 | Bayelsa | Southern Ijaw | Vanguard 28th Sept |
| 24 | Bayelsa | Yenagoa | Vanguard 28th Sept |
| 25 | Benue | Agatu | Vanguard 19th Sept |
| 26 | Benue | Bukuru | Vanguard 19th Sept |
| 27 | Benue | Guma | Vanguard 19th Sept |
| 28 | Benue | Logo | Vanguard 19th Sept |
| 29 | Benue | Makurdi | Vanguard 19th Sept |
| 30 | Benue | Tarka | Vanguard 19th Sept |
| 31 | Cross River | Boki | Vanguard 11th Aug |
| 32 | Cross River | Calabar Municipality | Premium Times 13Sept |
| 33 | Cross River | Calabar South | Vanguard 11 Aug |
| 34 | Cross River | Ogoja | Premium Times 13Sept |
| 35 | Cross River | Yala | Vanguard 11Aug |

| S/N | State | LGA | Source |
|---|---|---|---|
| 36 | Delta | Aniocha South | Vanguard 5th Sept, Guardian 25 sept |
| 37 | Delta | Bomadi | Vanguard 5th Sept, Guardian 25 sept |
| 38 | Delta | Burutu | Vanguard 5th Sept, Guardian 25 sept |
| 39 | Delta | Ethiope West | Vanguard 5th Sept, Guardian 25 sept |
| 40 | Delta | Isoko North | **Vanguard 5 Sept, Guardian 25**sept |
| 41 | Delta | Isoko South | Vanguard 5th Sept, Guardian 25th sept |
| 42 | Delta | Ndokwa East | Vanguard 5th Sept, Guardian 25th sept |
| 43 | Delta | Ndokwa West | Vanguard 5th Sept, Guardian 25th sept |
| 44 | Delta | Oshimili South | Vanguard 5th Sept, Guardian 25th sept |
| 45 | Delta | Patani | Vanguard 5th Sept, Guardian 25th sept |
| 46 | Delta | Ughelli North | Vanguard 5th Sept, Guardian 25th sept |
| 47 | Delta | Ughelli South | Vanguard 5th Sept, Guardian 25th 25th sept |
| 48 | Delta | Ukwuani | Vanguard 5th Sept, Guardian 25th sept |
| 49 | Delta | Warri North | Vanguard 5th Sept, Guardian 25th sept |
| 50 | Ebonyi | Afikpo North | Blueprint 31st July |
| 51 | Ebonyi | Afikpo South | Blueprint 31st July |
| 52 | Ebonyi | Ohaozara | Blueprint 31st July |
| 53 | Edo | Esan South | Thisday 17th Sept, Leadership 9th Nov |
| 54 | Edo | Etsako East | Thisday 17th Sept, Leadership 9th Nov |
| 55 | Enugu | Enugu East | Eagle online 21st Sept |
| 56 | Enugu | Ezeagu | Eagle online 21st Sept |
| 57 | Enugu | Igbo-Etiti | Eagle online 21st Sept |
| 58 | Enugu | Igbo-Eze South | Eagle online 21st Sept |
| 59 | Enugu | Nkanu East | Eagle online 21st Sept |
| 60 | Enugu | Nsukka | Eagle online 21st Sept |
| 61 | Enugu | Uzo-Uwani | Eagle online 21st Sept |
| 62 | FCT | Municipal | Thisday 15th Oct |

| S/N | State | LGA | Source |
|---|---|---|---|
| 63 | Gombe | Balanga | Vanguard 31st March, PremiumTimes 13th Sept |
| 64 | Gombe | Billri | Vanguard 31st March, PremiumTimes 13th Sept |
| 65 | Gombe | Gombe | Vanguard 31st March, PremiumTimes 13th Sept |
| 66 | Imo | Oguta | Thisday 15th Oct |
| 67 | Imo | Ohaji/Egbema | Thisday 15th Oct |
| 68 | Imo | Owerri | Thisday 15th Oct |
| 69 | Imo | Owerri-West | Thisday 15th Oct |
| 70 | Jigawa | Ayu | The Sun, 6th Sept |
| 71 | Jigawa | Birnin-Kudu | The Sun, 6th Sept |
| 72 | Jigawa | Dutse | The Sun, 6th Sept |
| 73 | Jigawa | Guri | The Sun, 6th Sept |
| 74 | Jigawa | Hadejia | The Sun, 6th Sept |
| 75 | Jigawa | Jahun | The Sun, 6th Sept |
| 76 | Jigawa | Kaugama | The Sun, 6th Sept |
| 77 | Jigawa | Malam-Maduri | The Sun, 6th Sept |
| 78 | Jigawa | Miga | The Sun, 6th Sept |
| 79 | Jigawa | Ringim | The Sun, 6th Sept |
| 80 | Jigawa | Taura | The Sun, 6th Sept |
| 81 | Kaduna | Chikun | Vanguard 24th Aug, The Nation 15th Sept |
| 82 | Kaduna | Igabi | Vanguard 24th Aug, The Nation 15th Sept |
| 83 | Kaduna | Kaduna North | Vanguard 24th Aug, The Nation 15th Sept |
| 84 | Kaduna | Kaduna South | Vanguard 24th Aug, The Nation 15th Sept |
| 85 | Kaduna | Kaura | Vanguard 24th Aug, The Nation 15th Sept |
| 86 | Kano | Danbatta | Daily Trust 17th Sept, Leadership 09th Sept |
| 87 | Kano | Dawakin Tofa | Daily Trust 17th Sept, Leadership 09th Sept |
| 88 | Kano | Gabasawa | Daily Trust 17 Sept, Leadership 09 Sept |
| 89 | Kano | Gaya | Daily Trust 17 Sept, Leadership 09 Sept |
| 90 | Kano | Gezawa | Daily Trust 17th Sept, Leadership 09th Sept |

| S/N | State | LGA | Source |
|---|---|---|---|
| 91 | Kano | Gwarzo | Daily Trust 17th Sept, Leadership 09th Sept |
| 92 | Kano | Kabo | Daily Trust 17th Sept, Leadership 09th Sept |
| 93 | Kano | Kiru | Daily Trust 17th Sept, Leadership 09th Sept |
| 94 | Kano | Nassarawa | Daily Trust 17th Sept, Leadership 09th Sept |
| 95 | Kano | Rimin Gado | Daily Trust 17th Sept, Leadership 09th Sept |
| 96 | Kano | Tofa | Daily Trust 17th Sept, Leadership 09th Sept |
| 97 | Kano | Warawa | Daily Trust 17th Sept, Leadership 09th Sept |
| 98 | Kano | Wudil | Daily Trust 17th Sept, Leadership 09th Sept |
| 99 | Katsina | Bakori | Thisday 17th July, Guardian 14th Sept |
| 100 | Katsina | Batsari | Thisday 17th , Guardian 14th Sept |
| 101 | Katsina | Baure | Thisday 17th, **Guardian 14th Sept** |
| 102 | Katsina | Daura | **Thisday 17th July, Guardian 14 Sept** |
| 103 | Katsina | Dutsinma | Thisday 17th July, Guardian 14 Sept |
| 104 | Katsina | Faskari | Thisday 17th July, Guardian 14 Sept |
| 105 | Katsina | Jibia | Thisday 17th July, Guardian 14 Sept |
| 106 | Katsina | Kaita | Thisday 17th, Guardian 14th Sept |
| 107 | Katsina | Kankia | Thisday 17th July, Guardian 14th Sept |
| 108 | Katsina | Kurfi | Thisday 17th July, Guardian 14th Sept |
| 109 | Katsina | Kusada | Thisday 17th July, , Guardian 14th Sept |
| 110 | Katsina | Maiadua | Thisday 17th July, Guardian 14th Sept |
| 111 | Katsina | Mashi | Thisday 17th July, Guardian 14th Sept |
| 112 | Katsina | Musawa | Thisday 17th July, Guardian 14th Sept |
| 113 | Katsina | Rimi | Thisday 17th July, Guardian 14th Sept |

| S/N | State | LGA | Source |
|---|---|---|---|
| 114 | Katsina | Sandamu | Thisday 17th July, Guardian 14th Sept |
| 115 | Katsina | Zango | Thisday 17th July, Guardian 14th Sept |
| 116 | Kebbi | Argungu | Vanguard Aug, 16th |
| 117 | Kebbi | Augie | Vanguard Aug, 16th |
| 118 | Kebbi | Bagudo | Vanguard Aug, 16th |
| 119 | Kebbi | Birnin Kebbi | Vanguard Aug, 16th |
| 120 | Kebbi | Bunza | Vanguard Aug, 16th |
| 121 | Kebbi | Dandi | Vanguard Aug, 16th |
| 122 | Kebbi | Danko Wasagu | Vanguard Aug, 16th |
| 123 | Kebbi | Fakai | Vanguard Aug, 16th |
| 124 | Kebbi | Ngaski | Vanguard Aug, 16th |
| 125 | Kebbi | Shanga | Vanguard Aug, 16th |
| 126 | Kebbi | Yauri | Vanguard Aug, 16th |
| 127 | Kebbi | Zuru | Vanguard Aug, 16th |
| 128 | Kogi | Ajaokuta | Vanguard Sept, 1st |
| 129 | Kogi | Bassa | Vanguard Sept, 1st |
| 130 | Kogi | Ibaji | Vanguard Sept, 1st |
| 131 | Kogi | Idah | Vanguard Sept, 1st |
| 132 | Kogi | Igala Mela | Vanguard Sept, 1st |
| 133 | Kogi | Ijumu | Vanguard Sept, 1st |
| 134 | Kogi | Kogi | Vanguard Sept, 1st |
| 135 | Kogi | Kogi Lokoja | Vanguard Sept, 1st |
| 136 | Kogi | Ofu | Vanguard Sept, 1st |
| 137 | Kogi | Omala | Vanguard Sept, 1st |
| 138 | Kwara | Baruten | Thisday 28th Oct, Punch 17th Sept |
| 139 | Kwara | Edu | Thisday 28th Oct, Punch 17th Sept |
| 140 | Kwara | Ilorin West | Thisday 28th Oct, Punch 17th Sept |
| 141 | Kwara | Kaiama | Thisday 28th Oct, Punch 17th Sept |
| 142 | Kwara | Moro | Thisday 28th Oct, Punch 17th Sept |
| 143 | Kwara | Pategi | Thisday 28th Oct, Punch 17th Sept |
| 144 | Lagos | Alimosho | PM News Oct, 29th |
| 145 | Niger | Agaie | Premium Time Sept 15th |
| 146 | Niger | Bida | Premium Time Sept 15th |

| S/N | State | LGA | Source |
|---|---|---|---|
| 147 | Niger | Edati | Premium Time Sept 15th |
| 148 | Niger | Katcha | Premium Time Sept 15th |
| 149 | Niger | Kontagora | Premium Time Sept 15th |
| 150 | Niger | Lapai | Premium Time Sept 15th |
| 151 | Niger | Lavun | Premium Time Sept 15th |
| 152 | Niger | Mariga | Premium Time Sept 15th |
| 153 | Niger | Mokwa | Premium Time Sept 15th |
| 154 | Niger | Shiroro | Premium Time Sept 15th |
| 155 | Niger | Suleja | Premium Time Sept 15th |
| 156 | Ogun | Abeokuta North | Presidential Committee on Flood July, 13th |
| 157 | Ogun | Abeokuta South | Presidential Committee on Flood July, 13th |
| 158 | Ogun | Ogun-Waterside | Presidential Committee on Flood July , 13th |
| 159 | Ondo | Akoko North East | Punch July 27th |
| 160 | Ondo | Ilaje | The Cable July 18th |
| 161 | Rivers | Ahoada East | Vanguard Sept, 25th |
| 162 | Rivers | Ahoada West | Vanguard Sept, 25th |
| 163 | Rivers | Obio/Akpor | Vanguard Sept, 25th |
| 164 | Rivers | Ogba/Egbema/Ndoni | Vanguard Sept, 25th |
| 165 | Rivers | Oyigbo | Vanguard Sept, 25th |
| 166 | Rivers | Port Harcourt | Vanguard Sept, 25th |
| 167 | Taraba | Gassol | Punch Sept, 26th |
| 168 | Taraba | Wukari | The Eagle Net Online Sept, 19th |
| 169 | Yobe | Damaturu | The Nation July, 18th |
| 170 | Yobe | Tarmuwa | Premium Times Nigeria July, 25th |
| 171 | Zamfara | Gummi | The Sun Sept, Sept, 16th |
| 172 | Zamfara | Maru | Leadership July, 26th |

***(Other Sources are: On-Field Assessment by NIHSA Staff, Acaps brief note I & II reports 2019, NEMA 2019 Floods Summary)***

# APPENDIX 2

## LIST OF HIGHLY PROBABLE FLOOD RISK AREAS IN 2020

| S/N | STATE | LGAs |
|---|---|---|
| 1 | Abia | Umu-Nneochi |
| 2 | Adamawa | Yola North, Yola South,Larmurde. |
| 3 | Anambra | Ogbaru,Anaocha,Oyi, Anambra East, Onitsha North,Orumba South,Njikoka,Orumba North,Ayamelum,Aguata,Awka South, Anambra West,Dunukofia. |
| 4 | Bauchi | Zaki. |
| 5 | Bayelsa | Brass,Ogbia,Nembe. |
| 6 | Benue | Bukuru,Agatu,Gboko,Gwer East,Markurdi, Konshisha, Tarka |
| 7 | Cross River | Calabar South,Calabar Municipal,Akpabuyo, Abi, Obudu, Odukpani |
| 8 | Delta | Ndokwa West,Aniocha North,Oshimili South, Ughelli North,Ethiope West,Oshimili North, Warri North. |
| 9 | Ebonyi | Ezza South,Ezza North,Ikwo,Ohaukwu,Afikpo North. |
| 10 | Edo | Etsako East, Esan South-East, |
| 11 | Enugu | Enugu East, Udi,Nsukka, Enugu North, Enugu South, Oji-River. |
| 12 | Gombe | Balanga,Yamaltu/Deba |
| 13 | Imo | Ideato North,Okigwe |
| 14 | Kaduna | Kaura |
| 15 | Katsina | Jibia |
| 16 | Kebbi | Dandi,Bunza, |
| 17 | Kogi | Bassa, Dekina, Lokoja, Omala. |
| 18 | Kwara | Offa, Oyun. |
| 19 | Lagos | Lagos Mainland, Mushin, IbejuLekki, Ikorodu. |
| 20 | Nasarawa | Nasarawa, Toto. |
| 21 | Niger | Bida, Mokwa, Borgu, Mashegu. |
| 22 | Ogun | Abeokuta South, Ogun waterside, Ijebu East. |
| 23 | Osun | Ila. |
| 24 | Plateau | BarkinLadi. |
| 25 | Rivers | Degema,Akuku Toru,Asari-Toru. |
| 26 | Sokoto | Goronyo, Sokoto North, SabonBirni, Rabah, Isa,Sokoto South, Dange-Shuni, Kware,Wurno. |
| 27 | Yobe | Geidam. |
| 28 | Zamfara | Bakura, Maradun, Shinkafi, Zurmi |

# APPENDIX 3

## LIST OF PROBABLE FLOOD RISK LGAs in 2020

| S/N | STATE | LGAs |
|---|---|---|
| 1 | Abia | Osisioma Ngwa, Isiala-Ngwa North, Ukwa West, Ukwa East, Umuahia North, Umuahia North, Umuahia South, Obi Nwga. |
| 2 | Adamawa | Numan, Guyuk, Demsa. |
| 3 | Akwa Ibom | Nsit Atai, Okobo, Mbo, Udung Uko, Oron, Eastern Obolo, Itu, Ikot Abasi, Ibiono Ibom, Uruan, Uyo, Ibeno, Urue Offong/Oruko. |
| 4 | Anambra | Idemili North, Idemili South, Onitsha South, Awka North |
| 5 | Bauchi | Alkaleri, Bauchi, Jama'are, Itas/Gadau, Tafawa-Balewa, Shira, Ganjuwa, Kirfi, Bogoro |
| 6 | Bayelsa | Southern Ijaw, Ekeremor, Kolokuma/Opokuma, Yenegoa, Sagbama. |
| 7 | Benue | Gwer West, Logo, Ado, Kwande, Vandeikya, |
| 8 | Borno | Marte, Maiduguri, Abadam, Mafa, Kukawa. |
| 9 | Cross River | Yakurr, Obubra, Yala, Bakassi, Boki, Ogoja, Bekwarra, Biase. |
| 10 | Delta | Sapele, Warri South-West, Aniocha South, Patani, Warri South, Ndokwa East, Ughelli South, Ethiope East, Burutu, Ika North East, Ika South. |
| 11 | Ebonyi | Ebonyi, Ishielu, Ohaozara, Abakaliki. |
| 12 | Edo | Ikpoba-Okha, Oredo, Etsako Central, Esan North-East, Ovia North-East |
| 13 | Ekiti | Ijero, Irepodun/Ifelodun, Ado-Ekiti. |
| 14 | Enugu | Igbo-Etiti, Ezeagu, Uzo-Uwani, Nkanu East. |
| 15 | FCT , Abuja | Kwali, Municipal Area Council, Bwari, Gwagwalada. |
| 16 | Gombe | Nafada, Kwami, Dukku, Billiri, Gombe, Funakaye. |
| 17 | Imo | Ideato South, Owerri West, Owerri North, Njaba, Nkwerre, Mbatoli, Ezinihitte, Isu, Isiala Mbano, Aboh-Mbaise, Orlu. |
| 18 | Jigawa | Kaugama, Taura, Guri, Gwaram, Dutse, Auyo, Miga, Malam Maduri, Ringim, Biriniwa, Jahun, Kafin Hausa. |
| 19 | Kaduna | Zaria, Kaduna North, Chikun |
| 20 | Kano | Tarauni, Garum Mallam, Rimin Gado, Gaya, Gezawa, Gwale, Shanono, Gabasawa, Gwarzo, Ungongo, Warawa, Dawakin Kudu, Dambatta, Bebeji, Kabo, Wudil, Kura, Nassarawa, Kano Municipal, Kumbotso. |
| 21 | Katsina | Kankia, Sabuwa, Faskari, Mai'Adua, Musawa, |

| S/N | STATE | LGAs |
|---|---|---|
| | | Sandamu, Batsari, Dutsin Ma, Daura, Kusada, Zango, Funtua, Baure. |
| 22 | Kebbi | Argungu, Koko/Besse, Augie, Shanga, Bagudo, Ngaski, Birnin Kebbi, Zuru, Yauri. |
| 23 | Kogi | Idah, Igalamela-Odolu, Koton-karifi, Ajaokuta, Ofu, Adavi. |
| 24 | Kwara | Ilorin West, Pategi, Edu, Asa, Moro, Ilorin East, Ilorin South. |
| 25 | Lagos | Lagos Island, Alimosho, Amuwo Odofin, Ikeja, Kosofe, Eti Osa, Apapa, Ojo, Oshodi/Isolo, Agege, Ifako/Ijaye, Badagry, Surulere, Ajeromi/Ifelodun |
| 26 | Nasarawa | Nasarawa Egon, Keana, Doma, Karu, Awe, |
| 27 | Niger | Suleja, Magama, Agwara, Gbako, Shiroro, Bosso, Wushishi, Lavun, Lapai. |
| 28 | Ogun | Ewekoro, Abeokuta North, Odeda, Ifo. |
| 29 | Ondo | Irele, Ondo West, Ilaje, Akoko North West, Idanre, Ondo East, Ese Odo. |
| 30 | Osun | Odo Otin, Irewole, Obokun, Irepodun, Ilesha West, Atakunmosa West, Osogbo, Ifelodun, Ede South, Egbedore. |
| 31 | Oyo | Ona ara, Lagelu, Oyo East, Kajola, Egbeda, Ogbomosho South, Iseyin, Ibarapa North, Ibadan South West, Ibadan North West, Ibadan South East. |
| 32 | Plateau | Pankshin, Jos South, Jos North, Jos East, Kanke, Mangu |
| 33 | Rivers | Ahoada East, Ogba/Egbema/Ndoni, Andoni, Ogu Bolo, Ahoada West, Oyigbo, Abua/Odual, Etche, Port-Harcourt, Obio/Akpor, Gokana, Tai, Khana, Okrika. |
| 34 | Sokoto | Gada, Silame, Shagari, Yabo, Dange-Shuni, Wamako. |
| 35 | Taraba | Gassol, Ibi, Lau, Wukari. |
| 36 | Yobe | Barde, Borsari, Karasuwa, Yunusari. |
| 37 | Zamfara | Tsafe, Birnin Magaji/Kiyaw, Gusau. |