NIHSA

ANNUAL FLOOD OUTLOOK 2023

FED. MIN. OF WATER RESOURCES

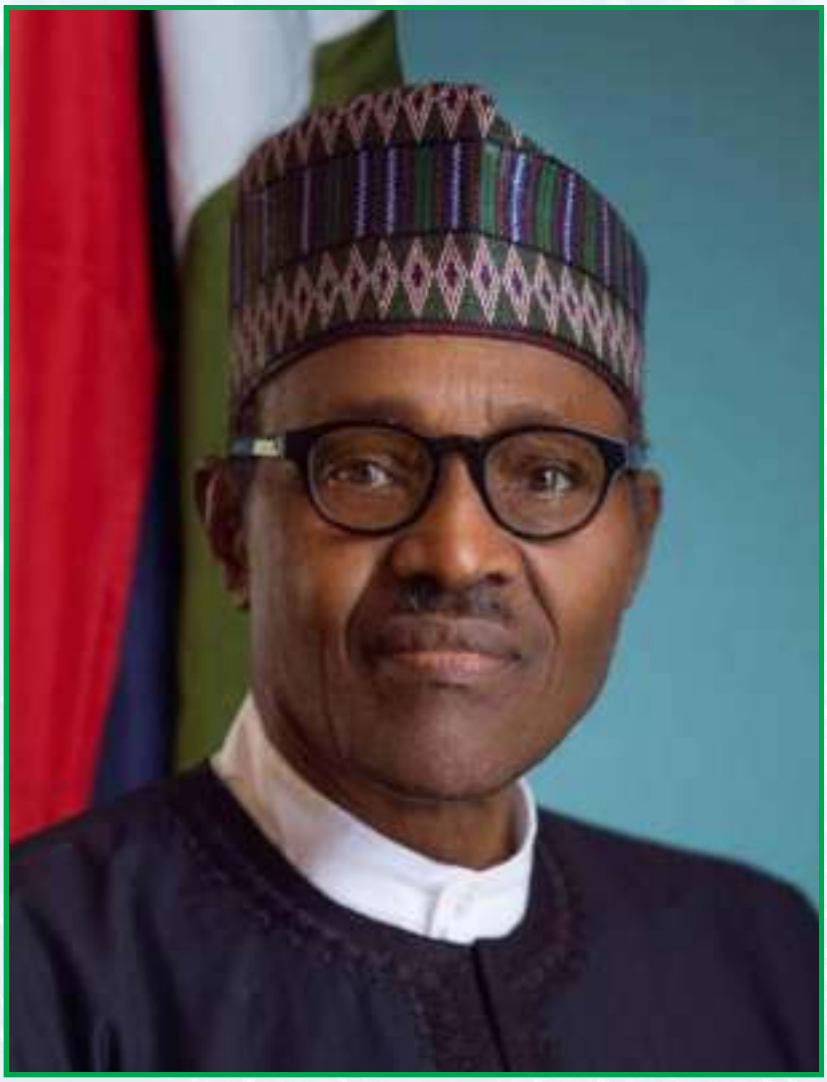
Water Resources Data for Sustainable Development

NIGERIA HYDROLOGICAL SERVICES AGENCY

“This Year’s Annual Flood Outlook (AFO) Publication serves as measures to sensitize the populace and create awareness on the inherent dangers of flooding in order to minimize its negative impacts.”

FED. MINISTRY OF WATER RESOURCES

Water Resources Data for Sustainable Development



His Excellency

MUHAMMADU BUHARI GCFR

PRESIDENT, COMMANDER-IN-CHIEF OF THE ARMED FORCES
FEDERAL REPUBLIC OF NIGERIA

His Excellency

PROF. YEMI OSINBAJO GCON

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FEDERAL MINISTRY OF WATER RESOURCES

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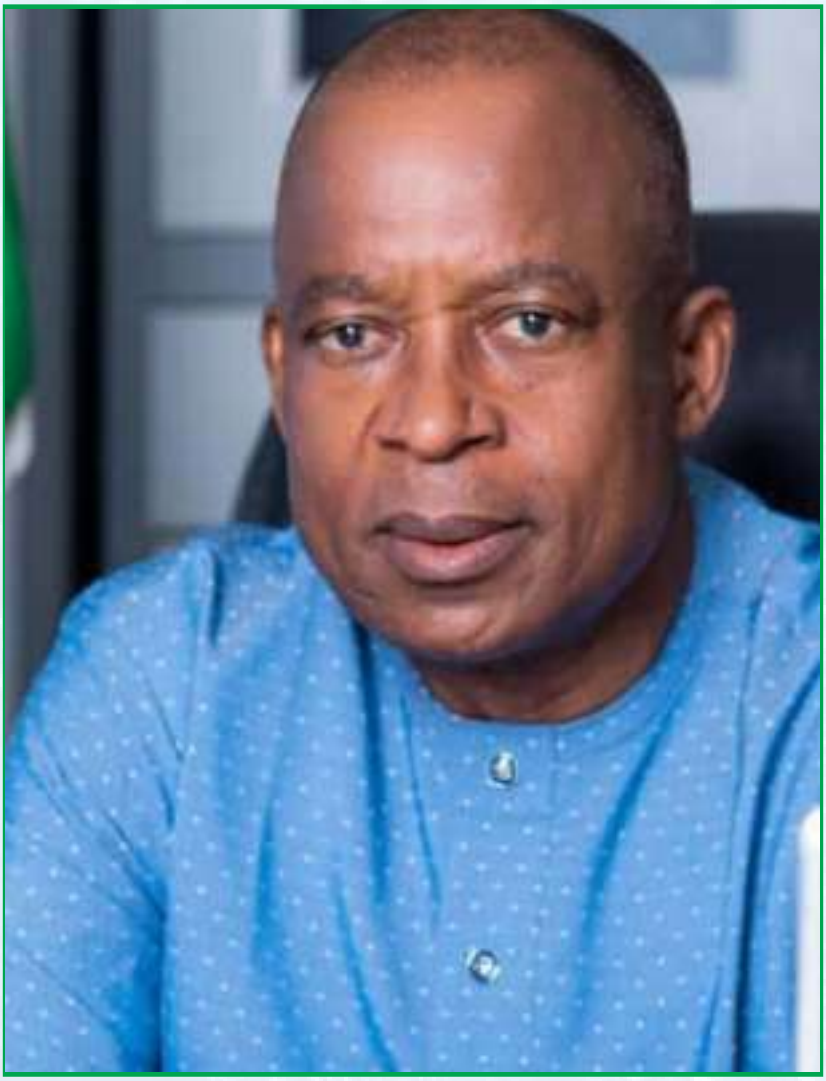


ENGR. CLEMENT ONYEASO NZE *FNSE, FNAHS*

DIRECTOR GENERAL

NIGERIA HYDROLOGICAL SERVICES AGENCY (NIHSA)

TABLE OF CONTENTS

CHAPTER THREE

3.0 2023 ANNUAL FLOOD OUTLOOK

CHAPTER FOUR

4.0 CONCLUSION AND RECOMMENDATIONS

FOREWORD

The effect of climate change is right at our door step. This is occasioned by the rise in temperature resulting in drier seasons in the North and unusually wetter seasons in the South which, coupled with anthropogenic activities, result in floods and drought in the country. In the North, agricultural lands are lost to desertification while other parts of the country especially, riparian communities, experience floods. The Southern extreme, on the other hand, experiences even more devastating floods, as it serves as a repository to flood waters that are generated from the hinterland and the contributions from the transboundary rivers (Niger and Benue) which drain 65% of Nigeria's land mass.

The 2022 flood is the worst recorded flood in the country so far in terms of impact. The 2022 flood affected all the 36 States and the FCT with resultant damages to property, built infrastructure and roads. Hundreds of thousands of cultivated farmlands were destroyed, over 1.4 million people were affected, more than 662 persons were killed and thousands of people were displaced. The economic damage to residential and non-residential buildings, infrastructure, productive sector and farmlands was estimated to be US $6.68 billion (World Bank, 2022).

In our concerted efforts to curtail the recurrence of devastating flood disasters in Nigeria, on the directive of President Muhammadu Buhari, I inaugurated the Presidential Committee for the Development of Action Plan for Preventing Flood Disaster in Nigeria on the 3rd of November, 2022. The Presidential directive was predicated on the periodic updates of the flood situation in the country which was a follow-up to the 2022 Annual Flood Outlook (AFO) by the Nigeria Hydrological Services Agency.

This 2023 AFO is therefore coming at the right time as it will serve as a valuable resource to enriching the work of the Presidential Committee. It is also aimed at detailing information on the probable flood risk areas in the current year, with their degree of vulnerability and is designed to serve as a working tool for various sectors including governments, agriculture, water corporations, humanitarian and donor aid organizations, town planners, disaster management agencies, health, national planning, security agencies and the general public.

As we learn from the catastrophic effect of the 2022 flood disaster, I am of the strong view that the 2023 Annual Flood Outlook (AFO) will serve as a veritable tool for effective strategic planning to avert loss of lives and property through adequate, coordinated and effective flood early warning and sensitization, awareness campaigns, improved flood mitigation strategies and preparedness for risk reduction.

Engr. Suleiman H. Adamu, ***FNSE, FAEng***
Honourable Minister of Water Resources
February, 2023

ACKNOWLEDGEMENT

I want to use this opportunity to appreciate the Honourable Minister of Water Resources, Engr. Suleiman H. Adamu, FNSE, FAEng, for his determined effort towards finding a lasting solution to the untold hardship that have befallen the citizens by the recurrent flood disasters in Nigeria. This is exemplified through the inauguration of the Presidential Committee for Development of a Comprehensive Plan of Action for Preventing Flood Disasters in Nigeria as directed by President Muhammadu Buhari, GCFR, President and Commander-in-Chief of the Armed Forces, Federal Republic of Nigeria on the 3rd of November, 2022. Since then, he has been supervising the work of the Committee.

This 2023 Annual Flood Outlook (AFO) is the 8th consecutive edition that is being launched by the Honourable Minister. It is a rare feat and demonstrates his huge commitment to not only seeing that the Nigeria Hydrological Services Agency (NIHSA) meets up with its mandate but also shows his desire at seeing that flood forecasting and early warning information are given the required attention so as to reduce the impacts of flood disasters on the vulnerable population and communities.
My deep thanks to the Permanent Secretary, Federal Ministry of Water Resources, Mrs. Didi Walson-Jack, *MCIPM, mni*, for her supportive role and guidance for the success of this publication.

I am also thankful to our team of consultants and technical experts for the hard work that was put into this edition of AFO. I equally appreciate our sister Agencies and Research Institutions for their support through the provision of relevant data for detailed analyses and modelling of flood scenarios.

I wish to acknowledge the huge support that the Agency has been receiving from the Nigeria Erosion and Watershed Management Project (NEWMAP) and Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) Project through the upgrading of hydrological and hydrogeological monitoring systems. The Hydrological Data Reception Centre put in place at NIHSA Headquarters by the Transforming Irrigation Management in Nigeria (TRIMING) project for seamless data acquisition from hydrological installations within the project catchment areas have also aided flood forecasting capabilities and improved data analyses and hydrologic modelling capacity of staff.

I am indebted to the management and staff of NIHSA for their dedication and ensuring the early production and publication of the AFO.
Considering the damages caused by the 2022 flood disaster, I am optimistic that the 2023 AFO will be given the attention it deserves and be propagated as required of stakeholders for flood mitigation and management through effective reservoir operations and other apparatus and elements that are necessary for flood disaster and risk reduction.

Engr. Clement O. Nze, *FNSE, FNICE, FNIWE, FNAH, FNAHS*
Director General/CEO
February, 2023.

EXECUTIVE SUMMARY

Flood disasters are exacerbated by climate change. The 2022 flood in Nigeria is the worst experienced in the country as it surpassed that of 2012 which was unprecedented according to the National Emergency Management Agency (NEMA).

The Federal Government in its bid to address this recurring hydrologic extreme (flood), constituted a **Presidential Committee for Development of a Comprehensive Plan of Action for Preventing Flood Disasters in Nigeria** with the mandate of finding a lasting solution to the flooding challenges and its negative impact on the nation. The Committee, understanding the urgency of conducting its mandate, has since been working assiduously to compile and submit its report.

The Nigeria Hydrological Services Agency (NIHSA), in its Annual Flood Outlook (AFO) of 2022 stated that due to rise in sea level, increased rainfall intensity and anthropogenic activities gave rise to heavy flooding in Bayelsa, Lagos, Jigawa, Niger States amongst others. However, this generated controversy as to the cause of the disaster. It then becomes imperative for more empirical and scientific research to be conducted in order to proffer a more lasting solution to the flooding.

The 2023 AFO is developed using Soil and Water Assessment Tool (SWAT) to provide relevant scientific information to all stakeholders to take commensurate actions to mitigate the negative impacts of flooding as predicted in AFO. Over the years, adherence to these predictions of AFO has to a large extent reduced the volume of loss of lives and property by communities.

The 2022 AFO was developed for three sessions during the rainy season in Nigeria. These include:

- Scenario I: Flood Outlook for the Months of April-June (AMJ).
- Scenario II: Flood Outlook for the Months of July – September (JAS)
- Scenario III: Flood Outlook for the Months of October - November (ON)

These three (3) scenarios were cumulatively aggregated to produce the 2023 AFO. The whole essence is to gradually move towards having a more dynamic flood forecast and Early Warning System (EWS) that can spatial-temporally aid developmental activities across sectors in Nigeria.

A total of 66 LGAs fall within the High Flood-risk Areas in the months of April, May and June; 148 LGAs in the months of July, August and September; and 100 LGAs in the Months of October and November.

In addition, a total of 41 LGAs fall within the Moderate Flood-risk Areas in the months of April, May and June; 199 LGAs in the months of July, August and September; and 72 LGAs in the Months of October and November.

Some States that are located along the coast such as Bayelsa, Delta, Lagos and Rivers are at high risk of coastal flooding due to rise in sea level and tidal surge which could negatively impact agriculture, habitation and transportation.

Owing to poor drainage systems which characterize most cities in the country, flash and urban floods are also expected to occur in some locations such as Abeokuta, Abakaliki, Asaba, Benin-City, Birnin-Kebbi, Ibadan, Kaduna, Lagos, Makurdi, Onitsha, Osogbo, Port-Harcourt, Warri, Sokoto, Yola etc.

The 2023 AFO contains useful information on the areas that are likely to be flooded, the probable months that the flood would occur and the severity of the expected flooding. Accordingly, it is recommended that continuous sensitization and awareness campaigns be intensified, as well as river training, clearing of the waterways and maintenance of hydraulic structures be maintained.

Stakeholders, decision and policy makers, relevant federal, state and local government agencies should take note of the information contained in the 2023 AFO and prepare in advance. Finally, it is advised that the predictions of flood for 2023 AFO be adhered to and all recommendations heeded.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Preamble

The common consensus among hydrologists is that "no one should be startled by flood events". However, the rapidity and frequency of occurrence these days are worrisome. While it is also true that natural hazards such as flood and drought cannot be eradicated, a timely and accurate prediction of hydrometeorological extremes helps communities to prepare for and mitigate disasters with a view to curtailing their deleterious impact. Over the years, flood menace all over the world has become a normal and recurring phenomenon with concomitant devastating imprints on human settlements, activities, livelihoods, and a series of infrastructures. Nevertheless, this unprecedented event, unlike certain natural disasters, can be contained with proper planning and the provision of necessary infrastructure.

The World Meteorological Organization (WMO) reports that the exponential rise in destruction and damages brought on by a series of flood disasters over the previous several decades can be traced to climate change. This trend has affected Nigeria, which has seen numerous flood disasters within the same period. The most significant occurrences were the terrible floods of 2012 and 2018, which claimed many lives, destroyed thousands of properties, inundated countless crop fields, and disrupted daily life with negative socio-economic implications. Last year (2022), a replica of 2012 was witnessed throughout the country with over 30 states experiencing some measures of flood-related destructions and damages. The preliminary details of the flood show that roughly 83,000 buildings were damaged, over 332,000 hectares of cultivated fields were affected, over 1.4 million persons were displaced internally and over 600 persons were killed (WMO, 2022).

The rainy season in Nigeria occurs annually with the greatest concentration of precipitation between the months of June and September. As a result, many states in Nigeria are affected by heavy rainfalls and associated floods which devastate various communities. Infrastructure, crops, and shelters are damaged which lead to decimated livelihoods and the displacement of numerous households. The efforts of the government to meet the United Nations Sustainable Development Goals (SDGs), aimed at achieving environmental and human development by 2030 are adversely affected in many parts of Nigeria.

In order to reduce the risk of flooding in Nigeria, the Nigeria Hydrological Services Agency (NIHSA), which is charged with amongst others, advising all levels of

government on all hydrology-related matters, has over the years continued to inform the Nigerian public about the potential flood scenarios in the country through its flagship publication – the Annual Flood Outlook (AFO). As a result, flood predictions have improved, which have reduced the adverse consequences of flooding on communities that heeded the warnings and implemented the corrective measures outlined in the AFOs. The Agency is also tenacious in ensuring that crucial elements of the integrated flood forecasting, early warning and response systems (consisting of a data source, communications, forecasts, decision support, notification/dissemination, coordination, and actions/responses) are followed through by all concerned. A key aspect of this is the Hydrological Information System Management Network (HYDRONET) which is a system of data collection platforms nationwide. Series of flood early warning systems have been installed in strategic riparian communities to give early warning of impeding flood event within their respective localities. The agency also operates and maintains Automatic Weather Observation System (AWOS) at specific locations for flood and drought assessment throughout the country.

The AFO for this year includes helpful details on the locations that are likely to experience flooding and the projected flood severity, similar to past editions. Additionally, this document includes explicit guidance on actions to take before, during, and after flooding. The implementation of appropriate counter-measures (structural and non-structural) to lessen the persistent threats of water-related disasters should continue to be a priority. The AFO, therefore, serves as an important guide in reducing flood risks and vulnerabilities, thereby contributing to economic growth and sustainable national development.

1.2 *Sectoral Analysis of Flood Impact in Nigeria*

Floods in Nigeria have had a major impact on the country's development goals in relation to health, Agriculture, transportation socio-economic well-being of the citizenry. In terms of health, floods cause erosion, pollution, and the spread of water-borne diseases, which can have long-term consequences on the populace. In terms of agriculture, floods have caused a huge impact due to the damage to hectares of farmlands, infrastructure, and reduction in crop yield, which lead to interruption of trade and commerce. This did not happen without warnings from the Nigerian Hydrological Services Agency as the Agency had predicted more floods in 2022 than in 2021 due to excessive rainfalls and contributions from external flows such as the Lagdo Dam in Cameroon. The impact analysis of the 2022 flooding is highlighted below.

1.2.1 Health Sector

The 2022 floods in Nigeria have had a significant impact on the health sector in the country. The flooding has caused an increase in waterborne illnesses, such as cholera, typhoid and dysentery. According to International Rescue Committee (IRC), in their publication titled "Deadly flooding in Nigeria leads to major cholera outbreak", the displacement of millions of people has also led to lack of access to basic healthcare services and a rise in mental health disorders. Additionally, the floodwaters have caused an outbreak of malaria, with millions of people at risk of contracting the disease (IRC, 2022).

The 2022 deadly floods in Nigeria, have killed over 600 people and displaced more than one million more, and have led to a major increase in cholera cases and other preventable diseases. The 2022 flooding has also strained health services due to damaged infrastructure, loss of health professionals, and access to medicine, as a result of delayed care or treatment for those who need it. On 14th September, the Government of Borno State, in the conflict-affected Northeastern part of Nigeria declared a cholera outbreak with over 700 suspected cases so far and 39 reported deaths (NOAA-CPC, media, 2022).

According to Nigeria Country Director of IRC, Babatunde Anthony Ojei, *"at least, 13 states experienced a deadly cholera outbreak with more than 6,000 cases and a four to five percent case fatality ratio*". The figures from the Nigeria Centre for Disease Control (NCDC) suggest that a total of 10,745 suspected Cholera cases, including 256 deaths, with case fatality ratio of 2.4 percent have been reported from 31 States in 2022. According to **Cholera Situation Report-Monthly Epidemiological Report 8**, published by NCDC, 31 States: Abia, Adamawa, Akwa Ibom, Anambra, Bauchi, Bayelsa, Benue, Borno, Cross River, Delta, Ekiti, Gombe, Imo, Jigawa, Kaduna, Kano, Katsina, Kebbi, Kwara, Lagos, Nasarawa, Niger, Ondo, Osun, Oyo, Plateau, Rivers, Sokoto, Taraba, Yobe and Zamfara.

Figure 1.1 Flood damage in Yobe, Nigeria, July 2022. Photo Credits: State Emergency Management Agency in Yobe

1.2.2 Agriculture

The impact of the 2022 floods on agriculture and food production has been devastating and has resulted in the loss of crops, livestock, and other essential agricultural infrastructure.

According to the Minister of Humanitarian Affairs, Disaster Management, and Social Development, Hajia Sadiya Umar Farouq, about 108,392 farmlands are partially decimated in the aftermath of the 2022 flooding. According to the president of the **All Farmers Association of Nigeria** (AFAN), Arc. Kabiru Ibrahim, in an interview with Leadership Newspaper, *"the 2022 floods remain the worst Nigeria experienced in the last ten years"*. Over 500,000 hectares of farmlands were estimated to have been destroyed. Sadly, the unprecedented losses have taken a toll on the federal government's efforts toward ensuring food security and a serious setback to the country's desire to drive goal 2 of the Sustainable Development Goals towards ending hunger by 2030.

Similarly, farmers and investors have suffered huge losses as floods have destroyed thousands of hectares of farmlands and food crops across the country. For instance, in Nasarawa State, 45,000 hectares of Olam Rice farm located in Rukubi, Doma local government area was washed away, amounting to over $15 million lost, in addition to farmlands belonging to small-holders being submerged. Similarly, a preliminary report by the State Emergency Management Agency (SEMA) said in Yobe communities including Jakusko, Bade, Gulani, Mutai, and Geidam show that over 196 communities across the 17 LGAs have lost hundreds of hectares of land due to the flood. Aside from financial losses incurred by farmers and agribusiness entrepreneurs, the destruction has been estimated to put 25.3million people across 26 states and the Federal Capital Territory (FCT) in acute food crisis. There is no doubt that flood hazards directly lead to a fall in food availability, food consumption and the welfare of vulnerable rural households.

Figure 1.2: Olam Rice farm submerged by flooding

1.2.3 TRANSPORTATION

The recent spate of flooding in Nigeria in 2022 has had a significant impact on transportation infrastructure in the country. According to Minister of Works and Housing, Babatunde Raji Fashola, SAN while speaking to the press on 27th October, 2022, "*Up to 154 locations, as well as transportation infrastructure worth N80 billion, have been affected by flooding*". Many roads have been flooded, submerging houses and disrupting supply routes. The flooding has also led to the displacement of millions of people. The damages could take 30 years of consistent investment to control the menace caused by the floods.

Flooding has affected roads, bridges, and some communication lines, leaving certain communities entirely inaccessible and cut off from services. For instance, as at 30th September, Rann and Damasak Local Government Areas in Borno state, which were hosting displaced people, were only accessible via helicopter (OCHA, 2022). As at 4th October, in Lokoja, Kogi state, roughly 113.3km of roads were submerged in floodwater (Int'l Charter, 2022). As at 9th October, the floods had destroyed a major road connecting eight communities to the rest of Anambra state, forcing people to rely on boats for access. In Ahoada West LGA of Rivers state, 150,000 people were reported to be displaced and inaccessible as at 20th October (Reuters, 2022).

Figure 1.3 Floods in Bayelsa State, Nigeria, October 2022. Photo credits: Government of Bayelsa State

1.2.4 Socio-economy

Floods have historically had strong adverse impacts on socio-economic livelihood of the citizens, with loss of arable land and the disruption of farming cycles. As communication links and infrastructure such as power plants, roads and bridges are damaged and disrupted, some economic activities may come to a standstill, people are forced to leave their homes and normal life is disrupted. In Nigeria, the 2022 flooding have an adverse effect on industries which led to loss of livelihoods. Damage to infrastructure also causes long-term impacts, such as disruptions to supplies of clean water, electricity, transport, communication, education and health care. The current insecurity situation in Nigeria has already placed the country in some discernible level of food insecurity. Factoring in additional pressures from the floods, the United Nations Food and Agriculture Organisation (FAO, 2022) estimated that 19.4 million Nigerians experienced food insecurity between June and August 2022. Additionally, businesses have been forced to close due to flooding and transportation disruptions, leading to a decrease in economic activities. Trade has also been disrupted, with goods and services unable to move between areas affected by floods.

1.3 Aim and objectives of the 2023 AFO

The 2023 AFO is aimed at providing an integrated national flood management information at different levels of governance; national, state, local governments and communities to ensure sufficient pre-flood occurrence measures, flood mitigation efforts for emergency management during flood and post-flood review and reassessment. This also aims to guide communities to take proactive measures at reducing their exposure to floods this year.

In order to achieve this, the following are the objectives of the 2023 Annual Flood Outlook:

1. To provide flood hazard and risk information to guide and assist mitigation actions.
2. To help communities understand their exposure to localized flood risks and hazards.
3. To provide spatial information for the identification of flood-vulnerable lands and locations for effective and efficient sustainable drainage systems (SUDs) development.
4. Provision of information for locations that will require flood alleviation services and assistance as a result of flood occurrences through the use of flood warning app.
5. Provision of early-warning information for flood risk management from the national, state, local governments and communities.

Provision of data for early management of rivers, streams and drainages that will require series of measures for de-siltation, channelization, relocation of certain infrastructures and others with a view to reducing flood risks and impact on floodplain communities.

CHAPTER TWO

2.0 EVALUATION OF 2022 ANNUAL FLOOD OUTLOOK (AFO)

2.1 INTRODUCTION

The 2022/2023 Hydrological Year began in June, 2022, when rainfall runoff was effective with increasing water level and discharge in most river channels in most parts of the country and was marked with more severe flooding and flood disasters ever recorded in the country. The 2022 flooding was recorded to be more devastating than that of 2012, causing loss of hundreds of lives, displacement of millions of people and destruction of properties, farmlands and crops worth billions of Naira. The 2022 flooding was also with numerous challenges that included COVID-19 pandemic, insecurity and inflation among others, as the country struggled to achieve the Sustainable Development Goals (SDGs).

There were also abundant water releases from Kainji, Jebba and Shiroro Dams that are along the River Niger and from Dadinkowa, Kiri, Kashimbila and the Lagdo Dam (from Cameroon) along the River Benue that exacerbated the catastrophic flood disasters in country. Thirty three States out of the 36 States and FCT were affected while the most seriously affected States in Nigeria include; Abia, Akwa-Ibom, Anambra, Bauchi, Bayelsa, Benue, Cross-River, Delta, Ebonyi, Edo, Gombe, Imo, Jigawa, Kogi, Kwara and Niger as shown in Figure 2.1.

Figure 2.1: Areal View of Catastrophic Flood Disaster in Delta State.
Photo Credit: Aljazeera 2022

It should also be noted that the 2022 Annual Flood Outlook (AFO 2022) edition predicted that 233 Local Government Areas (LGAs) in 32 States of the Federation and the FCT will fall within the Highly Probable Flood Risks Areas which include Adamawa, Abia, Akwa-Ibom, Anambra, Bauchi, Bayelsa, Benue, Cross-River, Delta, Ebonyi, Ekiti, Edo, Gombe, Imo, Jigawa, Kaduna. Kano, Kebbi, Kogi, Kwara, Lagos, Nasarawa, Niger, Ogun, Ondo, Osun, Oyo, Rivers, Sokoto, Taraba Yobe, Zamfara and the FCT. It was also predicted that the rise in sea level and tidal surge leading to coastal flooding will affect Bayelsa, Rivers, Cross River, Delta, Edo, Lagos and Ogun during the 2022/2023 hydrological year which will negatively impact fishing, wildlife habitation and river navigation.

The unprecedented devastating flooding is also as a result of the global climate change that influenced torrential rainfall and emergency water releases from the dams. The manifestation of the AFO 2022 prediction was first noticed in Lagos state with heavy downpour that left some communities in Ikorodu, Yaba, Ago, Amuwo, Ikeja, Agege, Festac town and Maryland area to be heavily flooded.

Figure 2.2: Flood Disaster in Lagos State

States that failed to heed to NIHSA predictions and warnings were worst affected by the flooding and the flood disasters during 2022/2023 Hydrological Year. Hence, NIHSA is strongly appealing to the general public, relevant government agencies, research institutions and other stakeholders in the water and non-water sectors, to heed to the warnings during the 2023/2024 Hydrological Year and to as a matter of urgency, clear all blockages to ensure free flow of water in waterways, drainages and river channels to avert flood disasters in the coming rainy season.

2.2 2022/2023 FLOW DISCHARGES

2.2.1 River Niger Discharge in Niamey

The transboundary flow of River Niger in Niamey, Niger Republic has two distinct flood flow periods, known as the White and Black Floods that occur from June to September during the rainy seasons and in the dry season from October to May of the following year respectively. The transboundary River Niger Black flood is increasing in Niamey, as at November 2022 as a result of the torrential flood flow from upstream in Guinea with a maximum discharge of 1,765 m3/s that was observed on 30th November, 2022 and expected to attain the peak flow in December, 2022 or January 2023. The White Flood flow in 2022/2023 Hydrological Year was 1773 m^3/s that occurred on 1st September, 2022. It was noted to be lower than those in 2012/2013 and 2020/2021 but higher than that in 2021/2022 as shown in Figure 2.3.

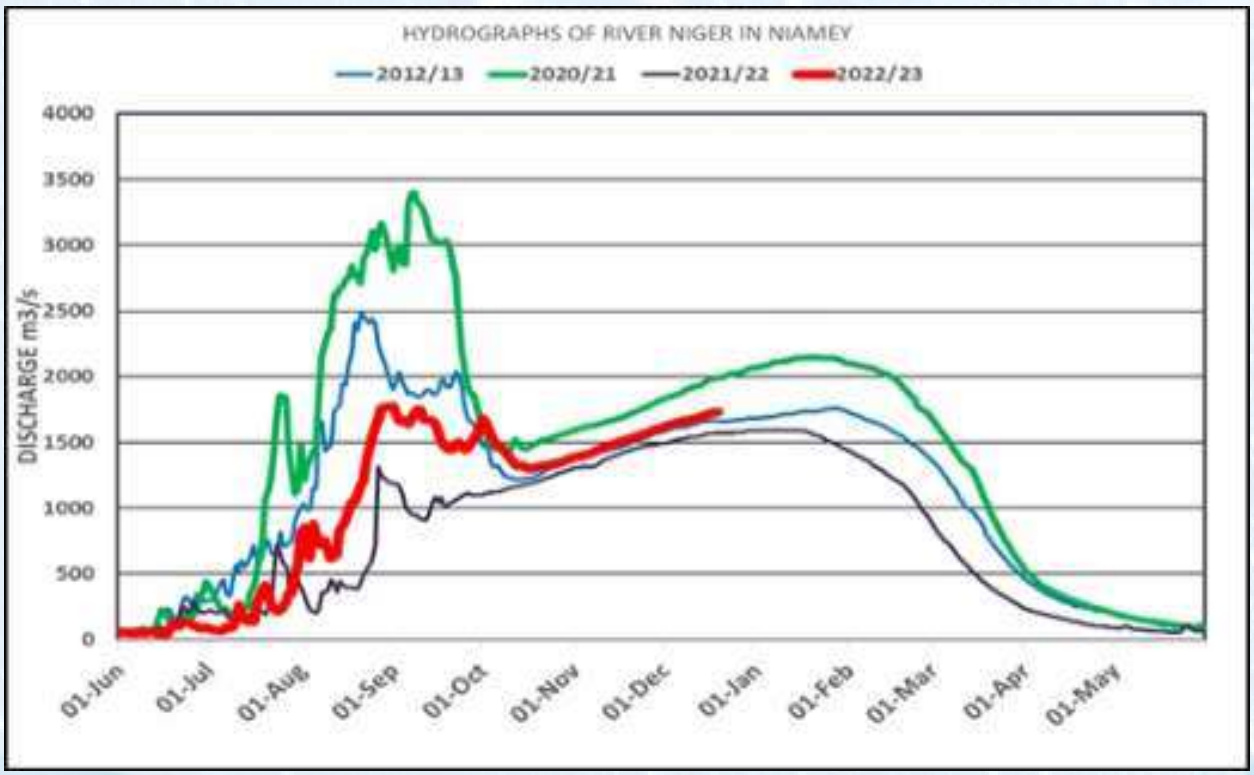


Figure 2.3: Comparative Hydrographs of River Niger in Niamey.

2.2.1 River Niger Discharge at Jiderebode

The 2022/2023 Hydrological Year of River Niger at Jiderebode upstream Kainji and Jebba dams, recorded an unprecedented heavy flood discharge in the zone of Red Alert, that resulted to enormous spillage from Kainji and Jebba dams that caused catastrophic flood disasters downstream. The maximum Water Level (WL) was 5.99m corresponding to discharge of 5,380 m^3/s, occurred on 15th September, 2022 which was the highest ever and minimum WL of 4.92m corresponding to discharge of 3,314 m^3/s occurred on 1st September 2022 while the mean WL was 5.66m corresponding to discharge of 4,685m^3/s with WL receding.

The Comparative Hydrographs of River Niger at Jiderebode in 2022/2023 Hydrological Year compared with 2020/2021, 2021/2022 and 2012/2013 showed that the discharge recorded in 2022/2023 Hydrological Year was highest ever as shown in Figure 2.4.

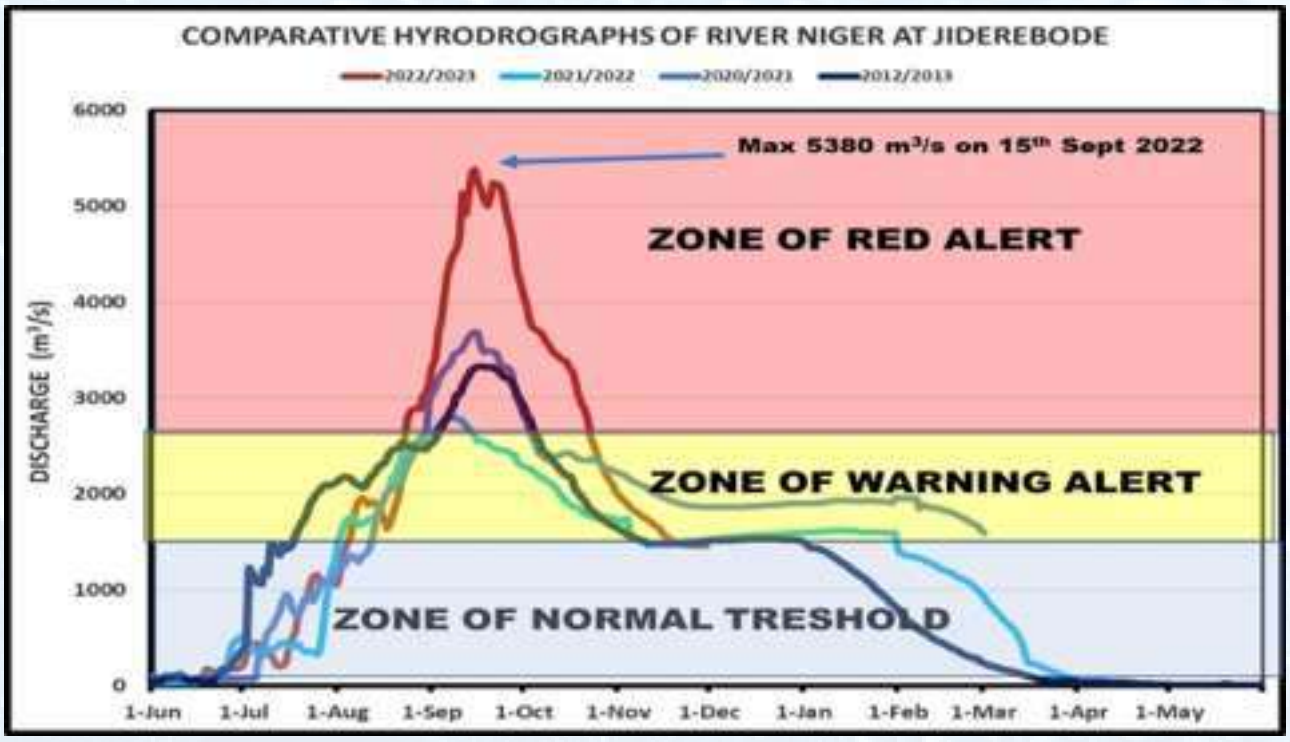


Figure 2.4: Comparative Hydrographs of River Niger at Jiderebode

2.2.3 Rivers Niger and Benue Discharge at Lokoja

The unprecedented flooding and flood disasters at the confluence of Rivers Niger and Benue at Lokoja (Kogi State), during the 2021/2022 Hydrological Year has a maximum WL of 13.22m corresponding to a discharge of about 25,424 m^3/s recorded on 6th October, 2022. The flow discharge during the 2022/2023 Hydrological Year was also the highest ever recorded, higher than those in 2012/2013, 2020/2021 and 2021/2022, as shown by Comparative Hydrograph in Figure 2.5.

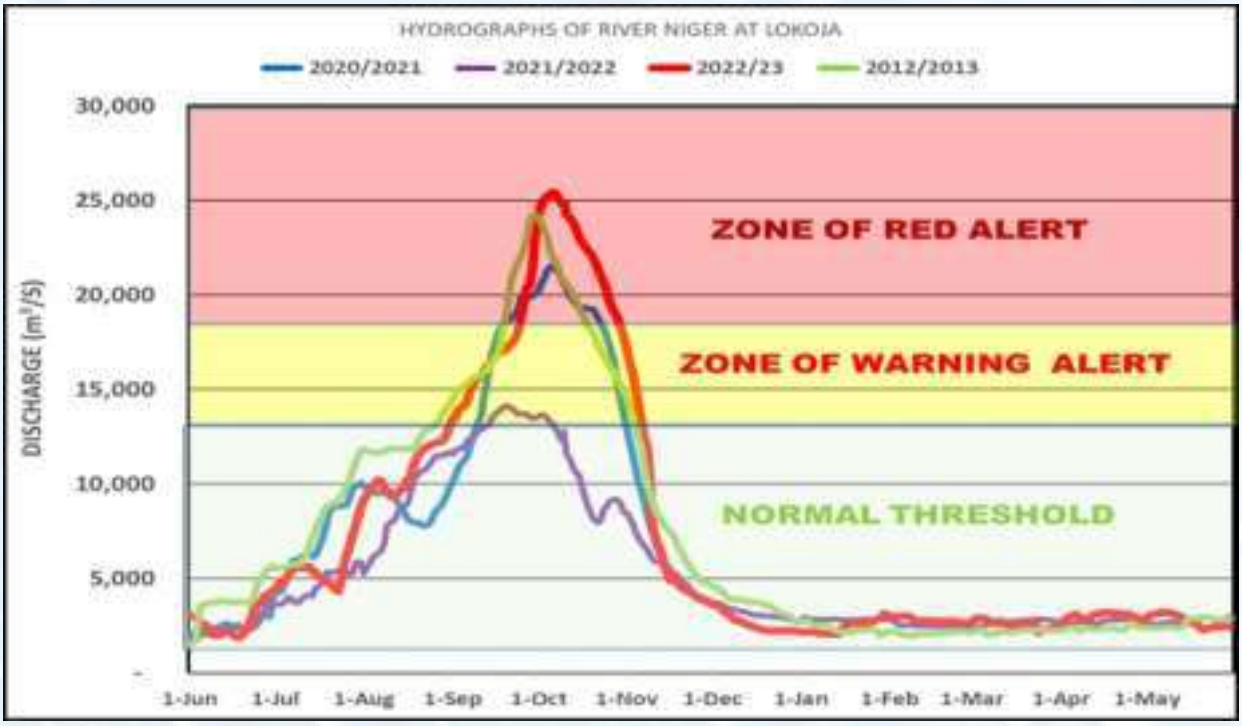


Figure 2.5: Comparative Hydrographs of Rivers Niger and Benue at Lokoja.

2.2.4 River Benue Discharge At Markurdi

The unprecedented flooding and flood disasters of River Benue at Makurdi (Benue State), during the 2022/2023 Hydrological Year has a maximum WL of 11.73m corresponding to a discharge of about 13,698 m^3/s recorded on 30th September, 2022. The Comparative Hydrograph of Benue flow of River Benue during the 2022/2023 Hydrological Year at Makurdi was lower than that in 2012/2013 but higher than those in 2020/2021 and 2021/2022 as shown in Figure 2.6.

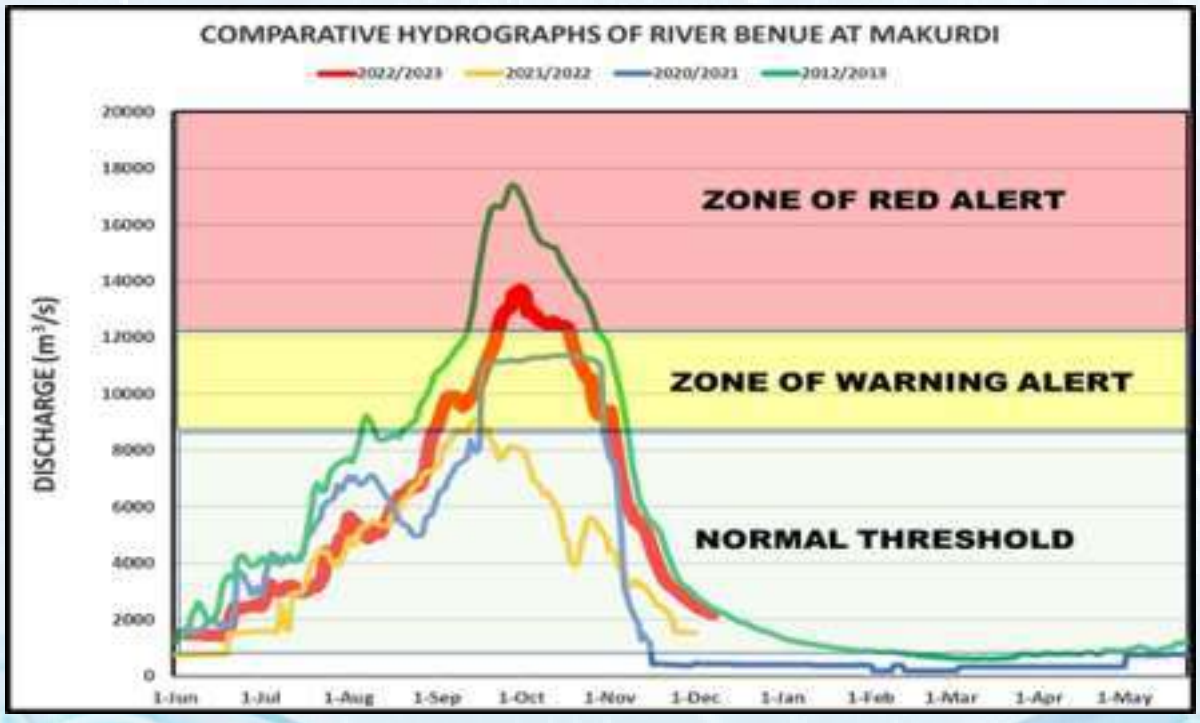


Figure 2.6: Comparative Hydrograph of River Benue at Makurdi

2.3 Analysis of 2022 Flood Scenarios

The performance of a hydrological model in hydrological research varies for different catchments as a result of distinct characteristics and scales. In order to obtain good results for hydrological research, suitable (well performing) hydrological models are required for different catchment sizes and data sets. The 2022 Annual Flood Outlook adopted two (2) models to simulate basins' hydrological processes. The models are: Hydrologic Engineering Center's Hydraulic Modeling System (HEC-HMS) and Soil Water Assessment Tools (SWAT). The models were calibrated in such a way that they do not only capture the floods generated due to intensive precipitation within the Nigeria Hydrological boundaries but also the contributions from external inflows.

Accordingly, there is a need to understand the accuracy and fidelity of these models in representing known processes to improve the predictive certainty for a range of intended application. There is also need to understand that river basins and watersheds are common boundaries of most hydrological models focused on non-point source as they provide integrated response to natural and anthropogenic processes. The review of the 2022 hydrological models' performance is thus presented below:

2.3.1 Comparative Analysis of Models and Actual Occurrences

The 2022/2023 Hydrological Year flood forecast was classified into three (3) categories: Highly Probable, Probable and Less Probable Risk Areas. It was observed that 33 out of 36 States of the Federation including FCT were actually flooded during the period as shown in Figure 2.7 (NEMA, 2022).

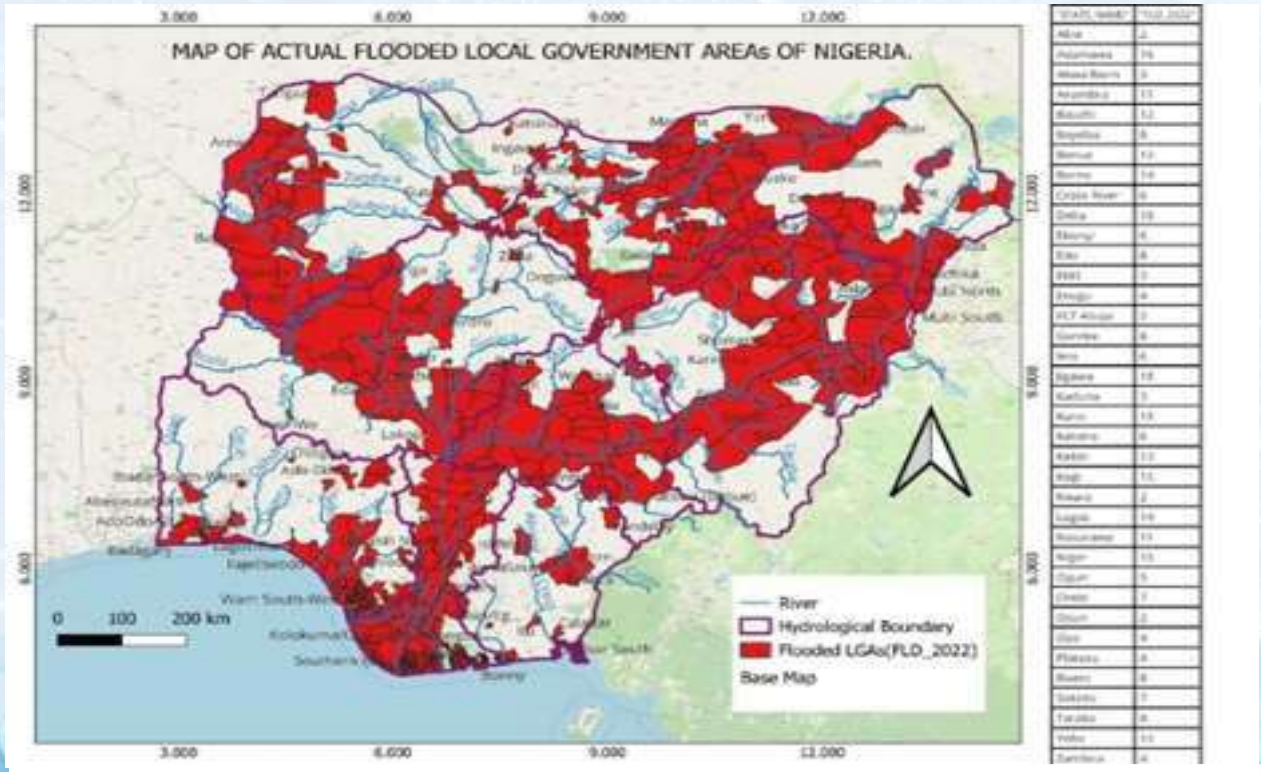


Figure 2.7: Map of Actual Flooded Local Government Areas of Nigeria

Furthermore, a total of 665 persons lost their lives; 4,476,867 persons were affected; 2,437,411 persons were displaced and 3,181 others suffered various degrees of injuries. A total of 174,281 houses were totally damaged and 174,281 farmlands were totally damaged (NEMA, 2022). As depicted in Figure 2.8 and 2.9.

Figure 2.8: Key Highlight of Flood Incidences in Nigeria

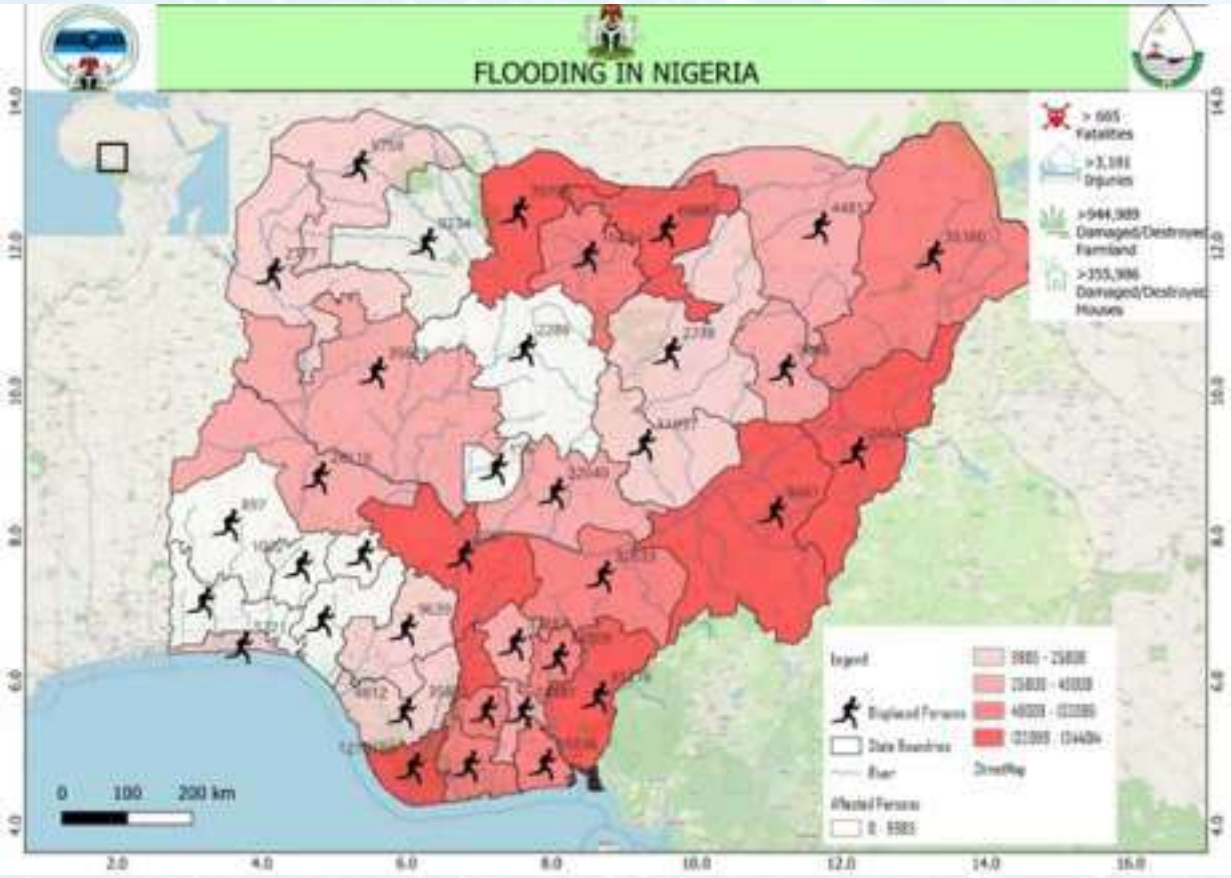


Figure 2.9: Flood Incident Map showing fatality rate

Several gauging stations were chosen to assess the performances of both models so as to compare simulated and actual flows for 2022. Figure 2.10 displays the comparative hydrograph of River Niger at Lokoja, Kogi State. The HEC-HMS model yielded a maximum flow rate of 33,478m³⁄s, while the SWAT Model projected 25,350m³⁄s. However, our monitored data from October, 2022 was 25,075m³⁄s. Comparatively speaking, prediction and observed figures remain in the same range.

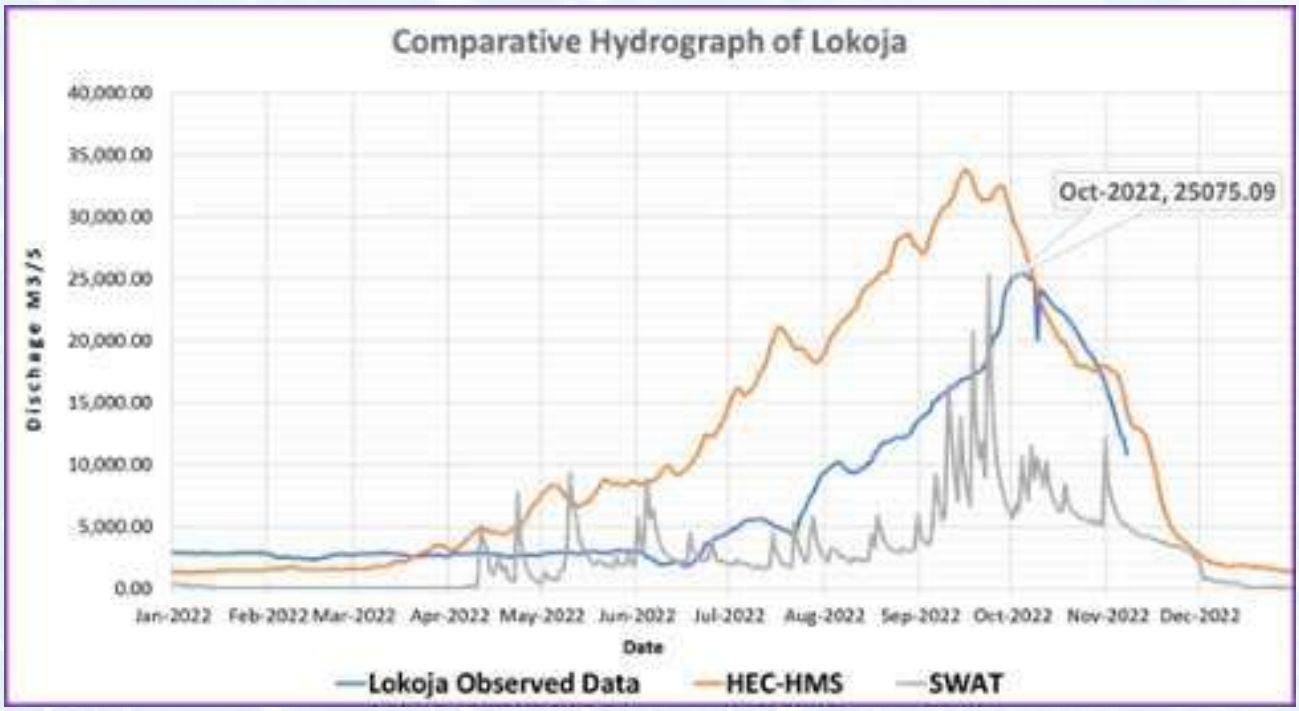


Figure 2.10: Comparative Hydrograph of Lokoja

On River Benue at Makurdi, the HEC -HMS recorded a peak flow of 8,263.8 m^3/s while SWAT recorded a peak flow of 2,684 m^3/s . However, the actual data recorded from the station is 13,360.8m^3/s . This shows that at Makurdi both models under predicted the flow situation at the station, this could be attributed to intense rainfall recorded and contributory transboundary waters flowing into the station as shown in figure 2.11 below.

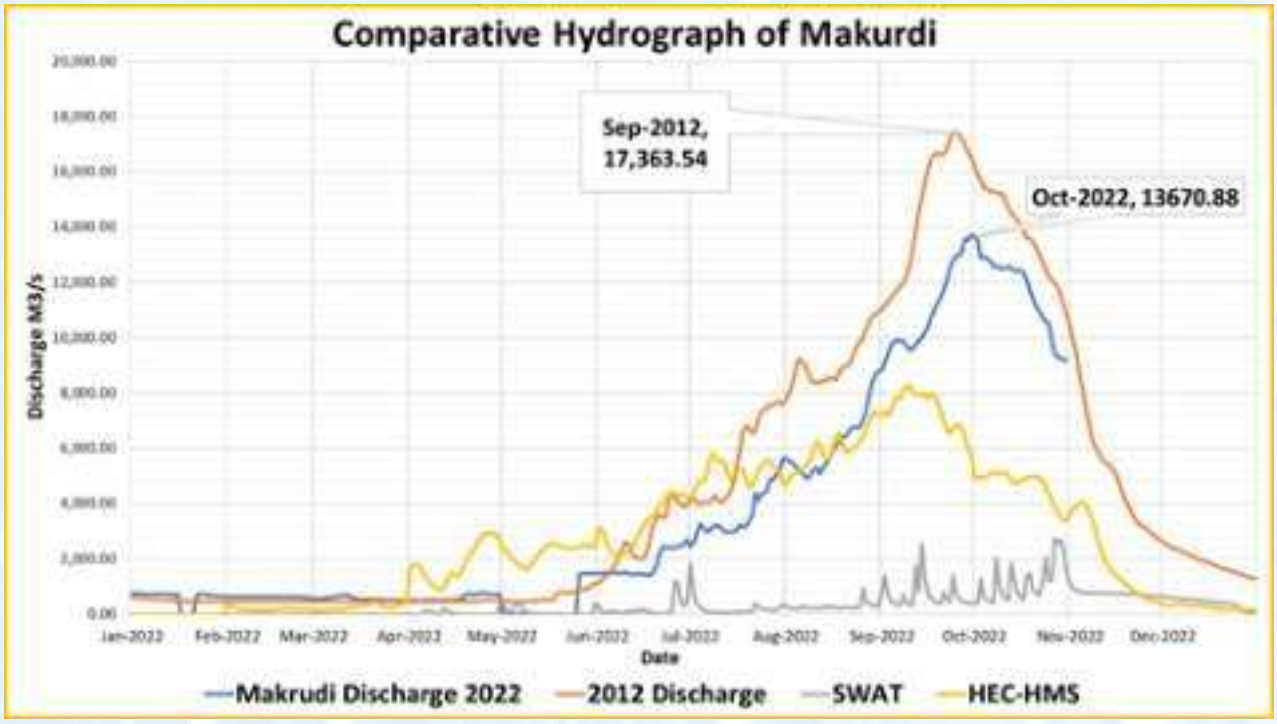


Figure 2.11: Comparative Hydrograph of Makurdi

Furthermore, a comparative Hydrograph of River Niger at Kainji was also plotted to analyse the performance of the model, Kainji recorded a peak flow of 5,323 m^3/s as at September however, HEC-HMS, predicted a peak flow of 17, 113.2 m^3/s within the same month as shown in Figure 2.12. From the comparative Hydrograph of Kainji, there is a significant variation between the predicted and actual data.

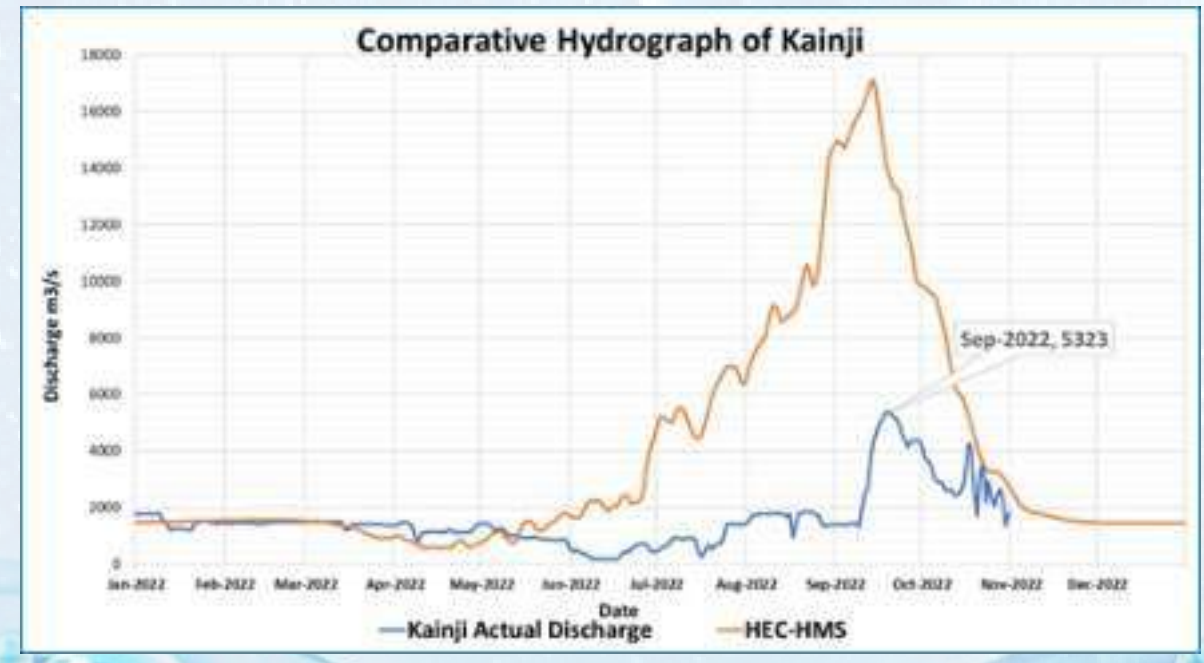


Figure 2.12: Comparative Hydrograph of Makurdi

In Figure 2 .13, the comparative hydrograph of River Sokoto at Kende, shows that the HEC-HMS recorded a peak flow of 4,595 m^3/s while SWAT recorded a peak flow of 2786.4 m^3/s , however, the actual recorded da ta from the station is 1,210 m^3/s . The comparative hydrograph shows that SWAT prediction is within the range of the actual recorded data while there is significant variation between the actual and HEC-HMS prediction for the Station.

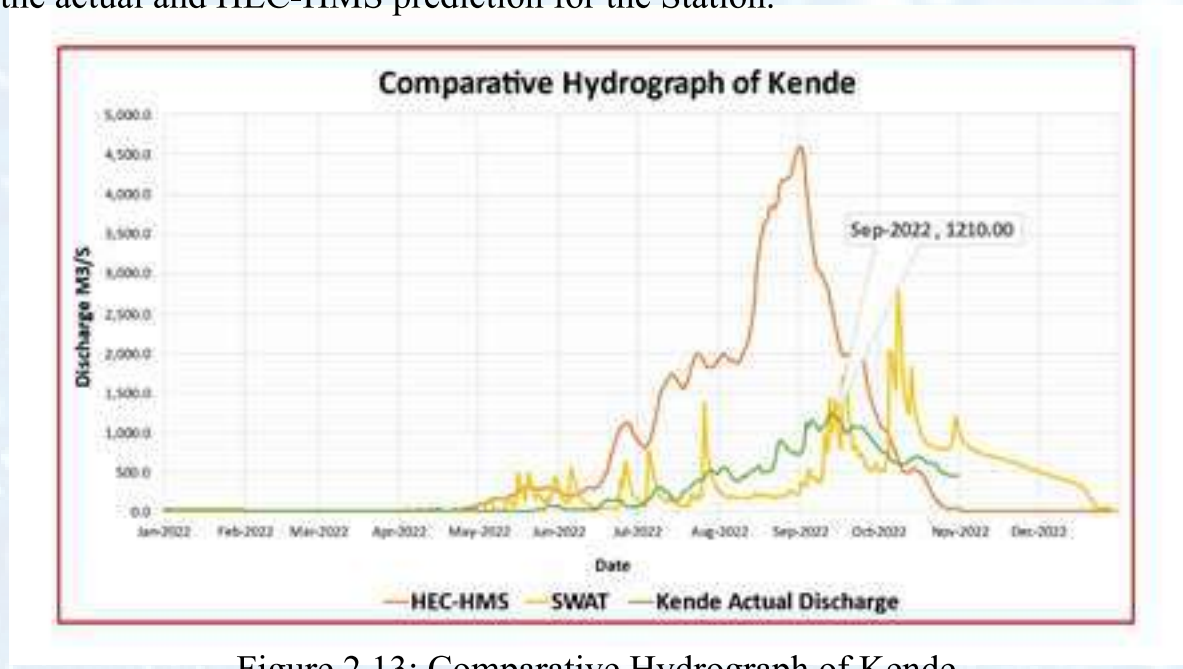


Figure 2.13: Comparative Hydrograph of Kende

Lastly, Figure 2.14 shows the comparative analysis of River Kaduna at Shiroro with the actual data recorded from the station show ing a peak flow of 740 m^3/s while HEC-HMS and SWAT predi cted a peak flow of 5,089.8 m^3/s and 7,039 m^3/s respectively. From this analysis, there is a significant variation between the actual recorded data and the simulated peak flow

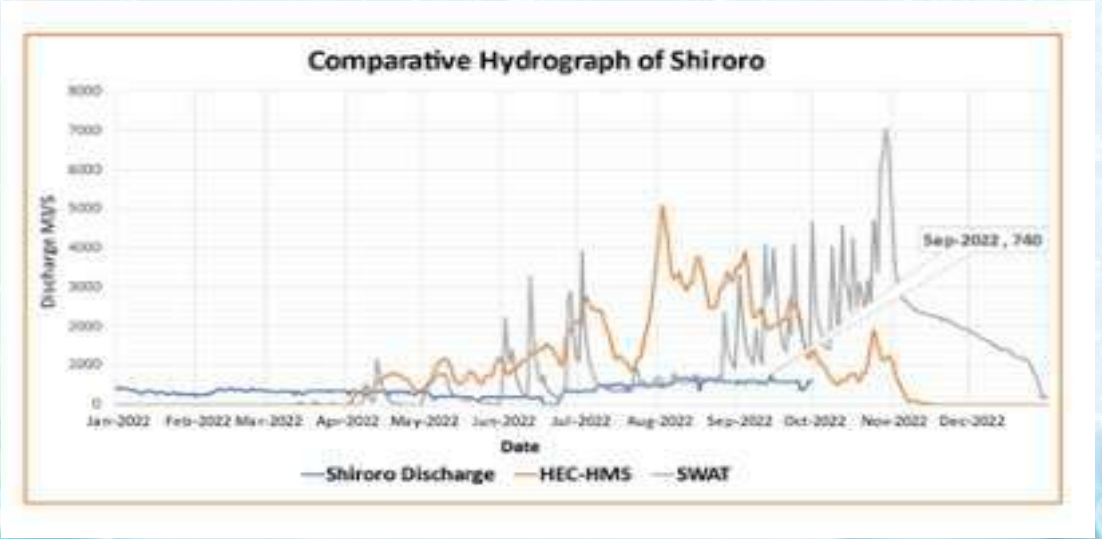


Figure 2.14: Comparative Hydrograph of Shiroro

The analysis of the model indicates that it has been effective; though flooding in Nigeria is mostly caused by anthropogenic activities. Furthermore, the reason for differentials in some of the observed stations may be attributed to dam management and operation. Additionally, poor or lack of drainage systems are a prominent issue and many residential areas dependent on natural drainage channels. Increasing urbanization also means more areas are built with concrete and cannot absorb water leading to increased runoff.

Poor waste management is a major source of flooding. Not only do people have poor attitudes to disposing of garbage, but municipalities also fail to provide adequate waste collection services. This often leads to clogged drainages in urban areas. Additionally, Nigeria's fast-paced urban expansion is not matched by the same rate of urban planning, infrastructure and other amenities. Residential developments are being built on areas that were once agricultural lands, yet planning regulations are not adequately enforced.

2.4 The Way Forward

Nigeria has traditionally focused on post-disaster flood response rather than risk control. As such, reducing and managing exposure to flood risk is now a prime focus of the government's disaster management efforts, with the establishment of both a Technical Working Group (TWG) and a Steering Committee (SC). There are also several research institutions and agencies that are well-equipped to design an effective flood risk management strategy, such as the Annual Flood Outlook by NIHSA, which forecasts likely flood scenarios in Nigeria, or the National Emergency Management Agency's department of planning with its use of GIS for flood data analysis. However, an efficient national flood early warning system needs to be implemented at various governing levels: Federal, State and Local - in order to truly address Nigeria's flood situation. Ultimately, it is vital that the causes of flooding (which may be human-induced) are confronted swiftly if the country is to continue advancing towards sustainable development.

CHAPTER THREE

3.0 2023 ANNUAL FLOOD OUTLOOK (AFO)

3.1 Preamble

Floods are one of the most devastating disasters in the world and a common, frequent threat to life, property, economy and environment. Mitigation measures and an improved flood forecasting system are therefore essential for effective flood management. The exponentially increasing impact of flooding has raised the profile of the practice of flood forecasting and warning. Thus, hydrological modelling has been used to predict river flows over time; with a fully developed forecasting system, precise, dependable warnings can be given with sufficient notice. Hydrological models are valuable tools for water resources planning, development, flood management and more. They play an essential role in predicting floods and crafting effective mitigation measures.

For the 2023 Annual Flood Outlook, the Soil Water Assessment Tools (SWAT) is adopted to simulate basins' hydrological processes. This model is calibrated in such a way that it does not only capture the floods generated by excessive rainfall within the Nigeria boundaries but also the contributions from external inflows from Jiderebode (River Niger) and Wuroboki (River Benue). These external inflows are routed through the river system for precise flood prediction.

The SWAT Model was selected for its broad use across the world and its effectiveness in simulating flood flows over time. It is easy to utilize, relying on both geographic and catchment features, so it can be trusted as providing reliable results. Utilizing distinct models offers a more comprehensive comprehension of hydrological processes, with analysis of these models lessening errors in simulation results from different areas of the watershed.

3.2 DATA USED AND SOURCES

Daily flow records (stage and discharge) from stations at Wuroboki, Jiderebode, Kainji, Jebba, Wuya, Afikpo, Ikom, Okitipupa, Siluko, Katsina-Ala, Apoje, Abeokuta, Shiroro, Baro, Umaisha, Dapchi, Ebba, Kurawa, Zungeru, Malabu, Otuocha, Onitsha, Makurdi, Geidam, Kende, Dadinkowa, Ologbo, Ogun, Chokocho, Tiga, Hadejia, Umuopara and Lokoja in the eight (8) Hydrological Areas of the country;

SWAT Model

- Grided daily rainfall data downloaded, httpd://esg-dn1.nsc.liu.se/search/cordex. Scenarios: RCP 4.5 and 8.5. Year 2023.
- Measured daily rainfall and temperature data, NiMet.
- 2023 NiMet Seasonal Climate Prediction (SCP).
- Soil and Landuse.
- DEM with vertical accuracy of +/-5meters (SRTM).

The 2023 AFO was created by combining the flood outlook for three different stretches of the rainy season in Nigeria: April-June (AMJ), July-September (JAS), and October-November (ON). The overall goal is to build a dynamic Early Warning System (EWS) with the ability to predict and forecast floods and inform developmental activities in all sectors of Nigeria.

Figure 3.1: Map Showing the Location of Data Collection Platforms (DCPs)

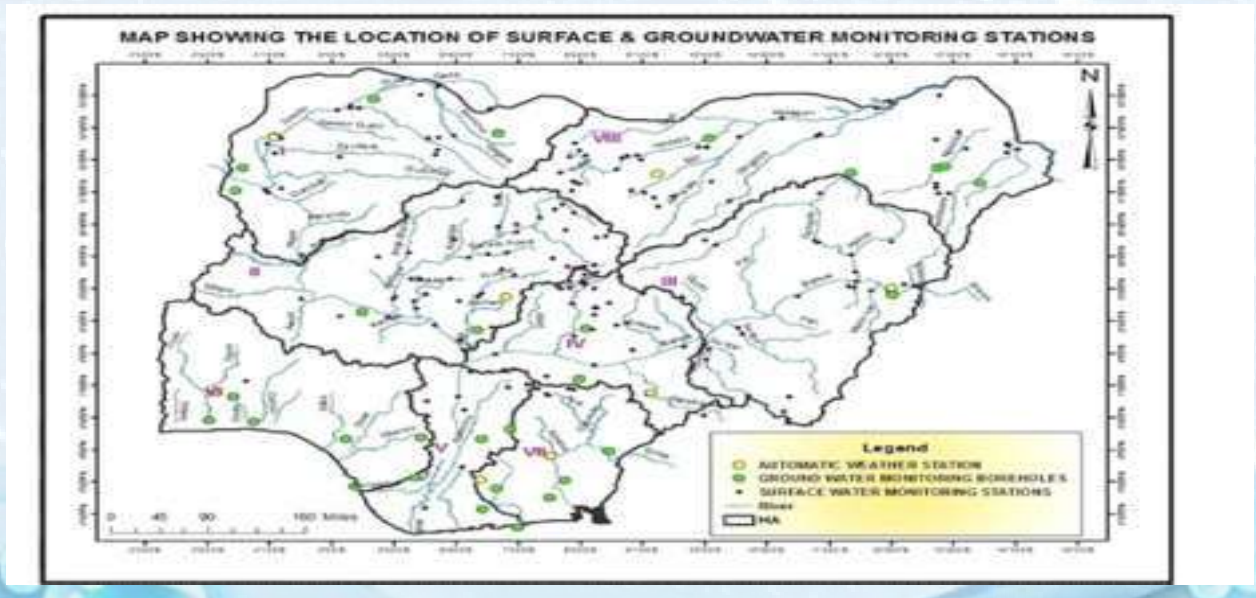


Figure 3.2: Network of NIHSA Ground water and Weather Stations

3.3 Overview of 2023 Annual Flood Outlook

An overview of the eight (8) Hydrological Areas with their hydrological and hydrogeological features, as well as flood simulations for 2023 will be examined and discussed in this section.

3.3.1 Hydrological Area I (Niger North)

Hydrological Area I comprises of Kebbi, Zamfara, Sokoto, and parts of Niger and Katsina States. This is drained mainly by the Rivers Niger, Sokoto, Rima, Gulbin Ka and Zamfara. It has two distinct geological features, mainly the Precambrian Crystalline Basement which covers 30% of the area and Sedimentary terrain which covers 70%.

The states that are categorized as Highly Probable in HA I are Kebbi, Sokoto, Zamfara and part of Niger. The details of the Highly Probable and Probable flood risk areas in Hydrological Area I are shown below in figure 3.1.

Flood-risk Areas in HA I (Upper Niger)

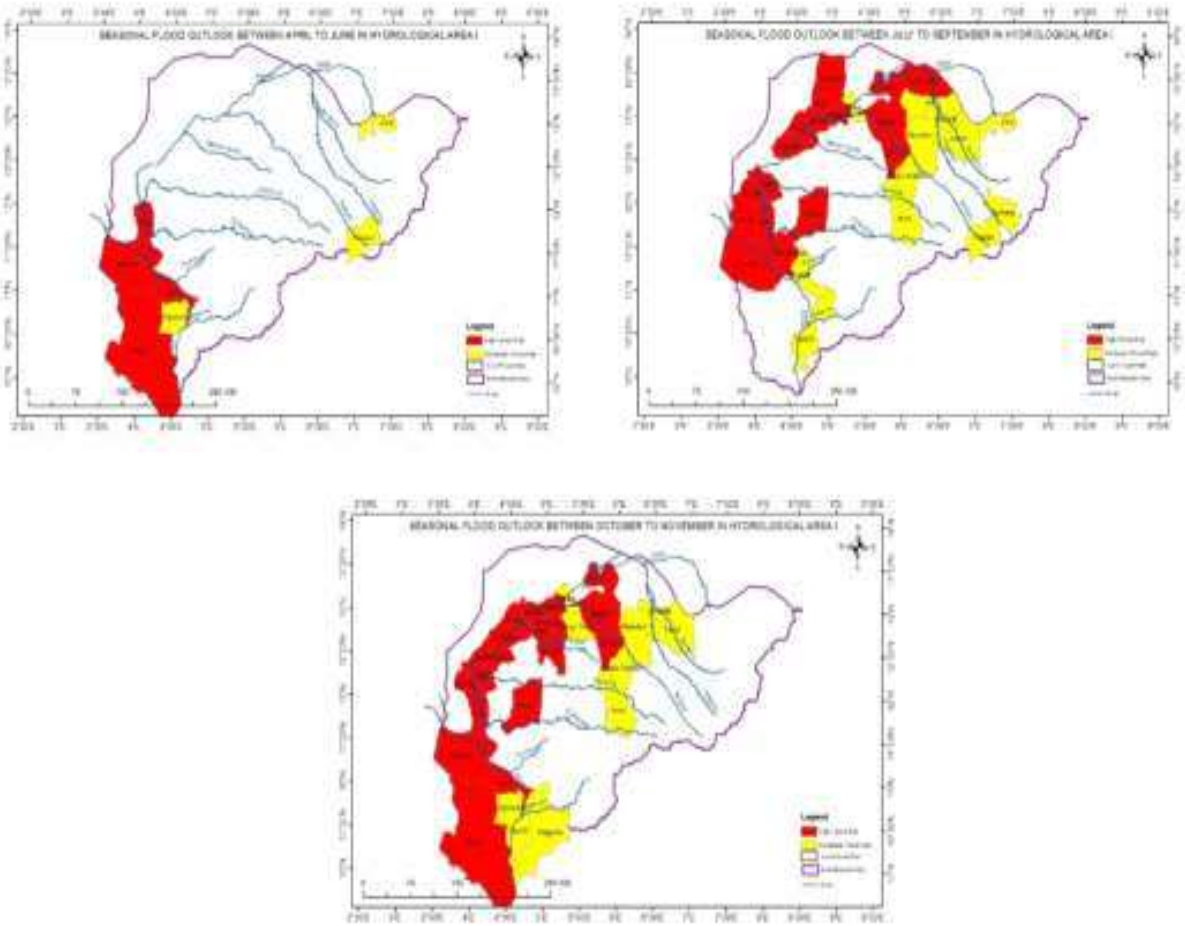


Figure 3.1: Maps Showing Flood-risk Areas in HA 1

3.3.3 Hydrological Area II (Niger Central)

Hydrological Area II covers Niger, Kwara, Kaduna, FCT and part of Kogi States. 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.

In Hydrological Area II, Kogi, Kwara, Kaduna, FCT and part of Niger are expected to be in the Highly Probable category. The details of Highly Probable and Probable flood risk areas are shown in Figure 3.2

Flood Risk LGAs in HA II (Niger Central)

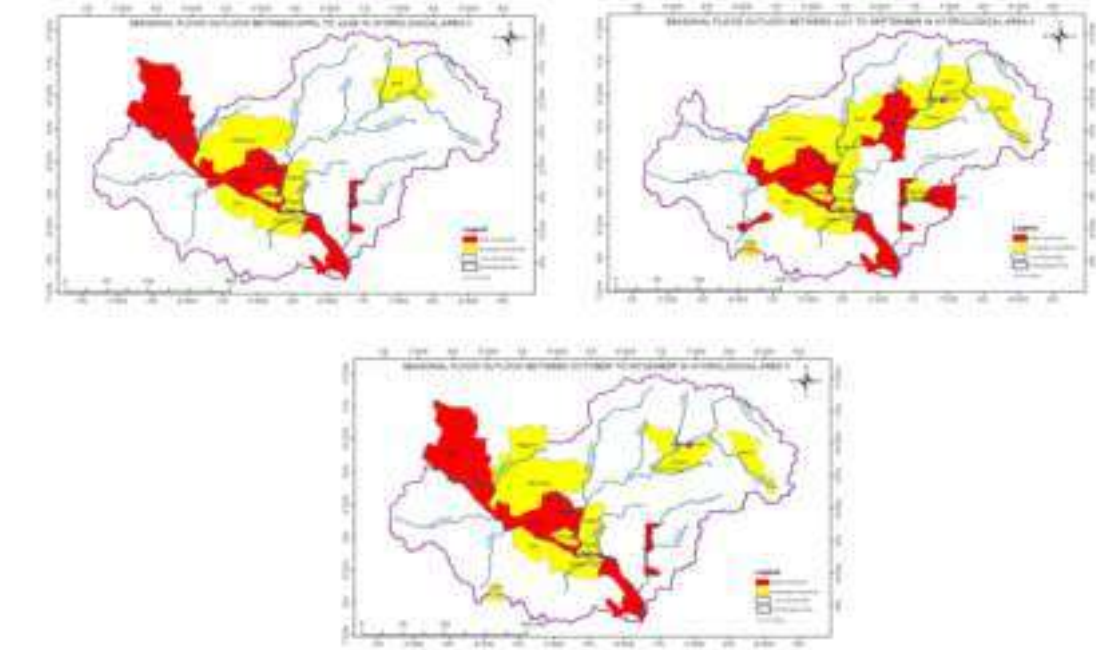


Figure 3.2 Maps Showing Flood-risk Areas HA II.

3.3.3. Hydrological Area III (Upper Benue)

Hydrological Area III comprises Adamawa, Taraba, Gombe, Bauchi and part of Plateau and Borno States. 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 States are Gombe and Taraba, while the States under the probable risk areas are Adamawa, Borno, Gombe, Plateau and Taraba. The details are shown in Figure 3.3.

Flood Risk LGAs in HA III (Upper Benue)

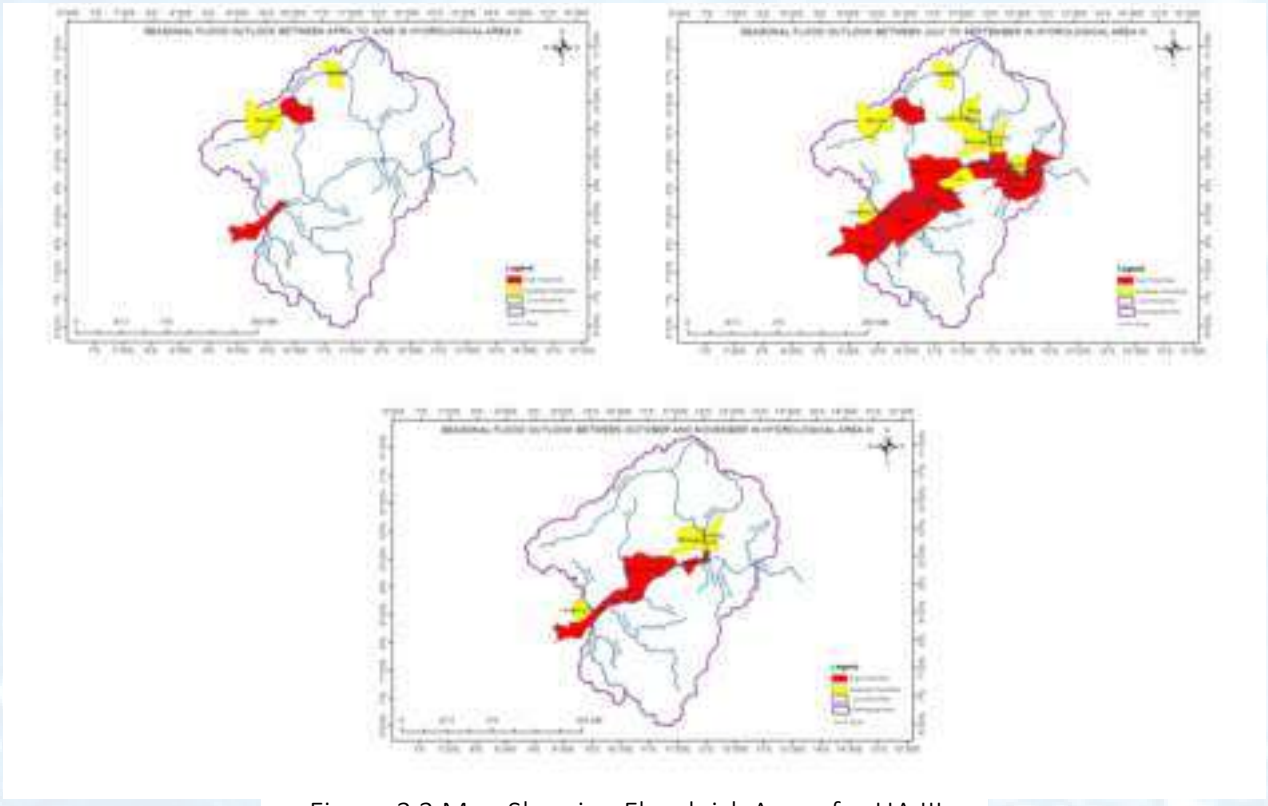


Figure 3.3 Map Showing Flood-risk Areas for HA III

3.3.4 Hydrological Area IV (Lower Benue)

Hydrological Area IV covers Plateau, Nasarawa, Benue, Taraba and parts of Kogi and Kaduna states. The Highly probable states consist of Benue, Kogi, Nasarawa and Taraba. The details of Highly Probable and Probable flood risk areas in Hydrological area IV are shown in Figures 3.4 The area is covered by 50% Sedimentary and 50% Basement and is drained mainly by Rivers Benue, Kastina-Ala, Dep and Mada.

Flood Risk LGAs in HA IV (Lower Benue)

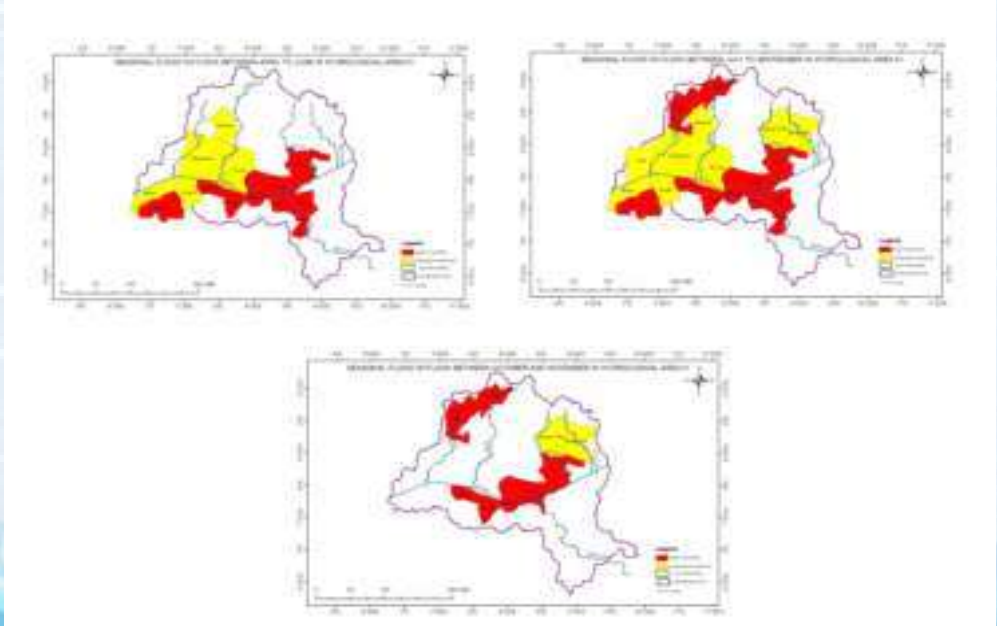


Figure 3.9 Map Showing Flood-risk Areas for HA IV

3.3.5 Hydrological Area V (Niger South)

Hydrological Area V includes: Anambra, Bayelsa, Delta, Edo, Enugu, Imo, Rivers and parts of Kogi State. The geology is 90% Sedimentary and 10% Basement. The major Rivers are: Niger, Anambra, Ase, Orashi, Nun and Forcados.

The States expected to be Highly Probable are Anambra, Bayelsa, Delta, Edo, Imo, Kogi and Rivers. Details of Highly Probable and Probable flood risk areas in Hydrological Area V are shown in Figure 3.5

Flood Risk LGAs in HA V (Niger South)

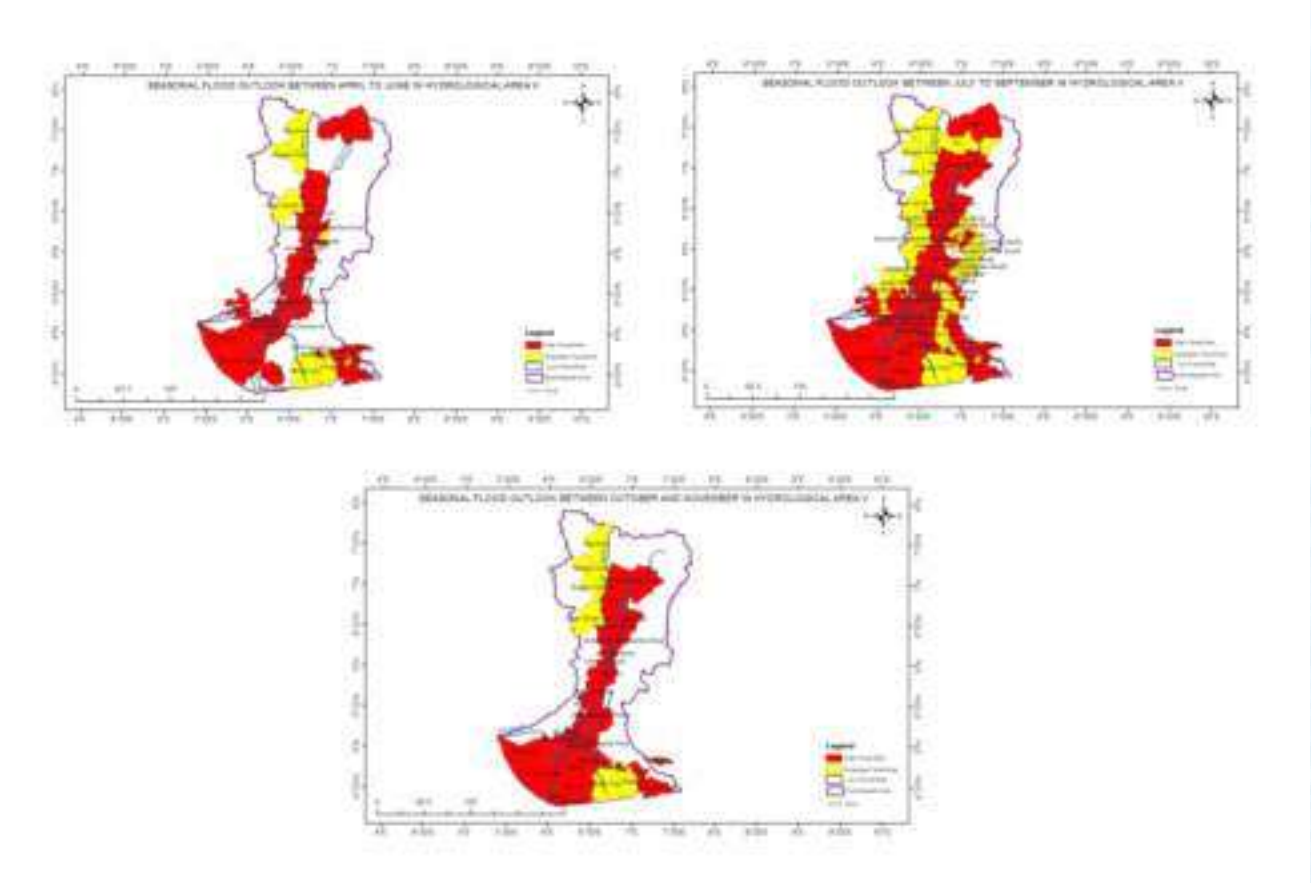


Figure 3.5 Map Showing Flood-risk Areas for HA V

3.3.6 Hydrological Area VI (Western Lithoral)

Hydrological Area VI comprises of the following States: Lagos, Ogun, Oyo, Osun, Ondo, Edo and parts of Delta and Ekiti States. 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 States are Delta, Ekiti, Lagos, Ogun, Ondo, Osun and Oyo. The details of the Highly Probable and Probable flood risk areas in Hydrological Area VI are shown in Figure 3.6.

Flood Risk LGAs in HA VI (Western Littoral)

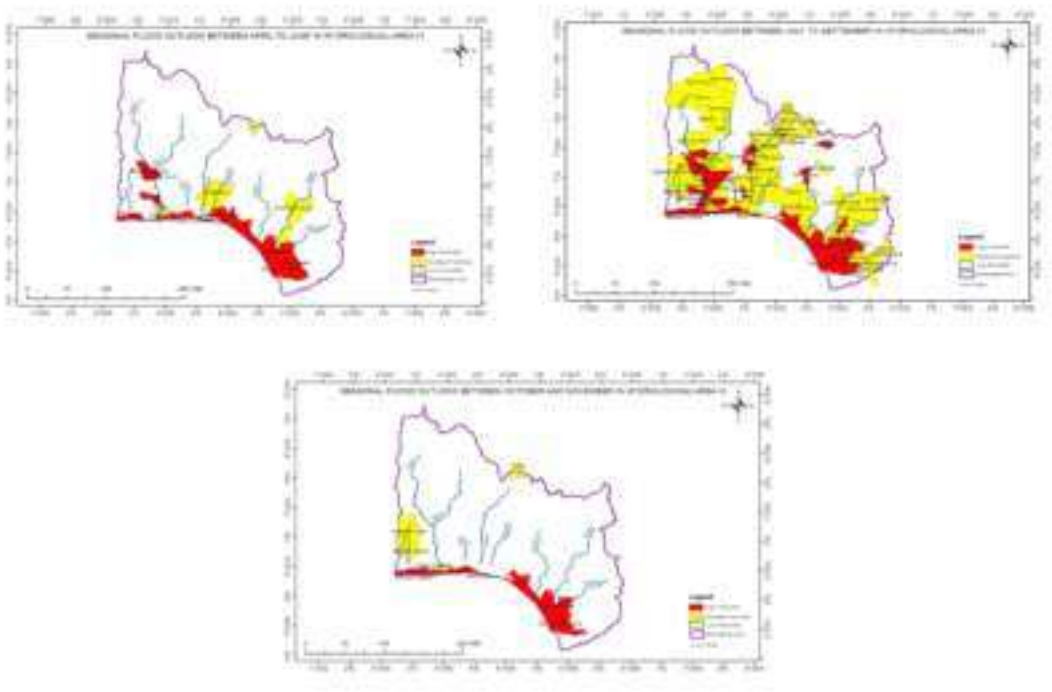


Figure 3.6 Map Showing Flood-risk Areas for HA VI

3.3.7 Hydrological Area VII (Eastern Littoral)

Hydrological Area VII comprises of Abia, Anambra, Imo, Enugu, Eboyi, Cross-River, Akwa-Ibom and Rivers States. The area is covered by 90% Sedimentary and 10% Basement and drained by Imo, Quo-Iboe, Calabar, Ivo, Asu, Cross River and Ebonyi River.

The State under the Highly Probable category are Abia, Akwa-ibom, Cross River, Ebonyi, Imo and Rivers. The details of Highly Probable and Probable flood risk areas in Hydrological Area VII are shown in Figure 3.7

Flood Risk LGAs in HA VII (Eastern Lithoral)

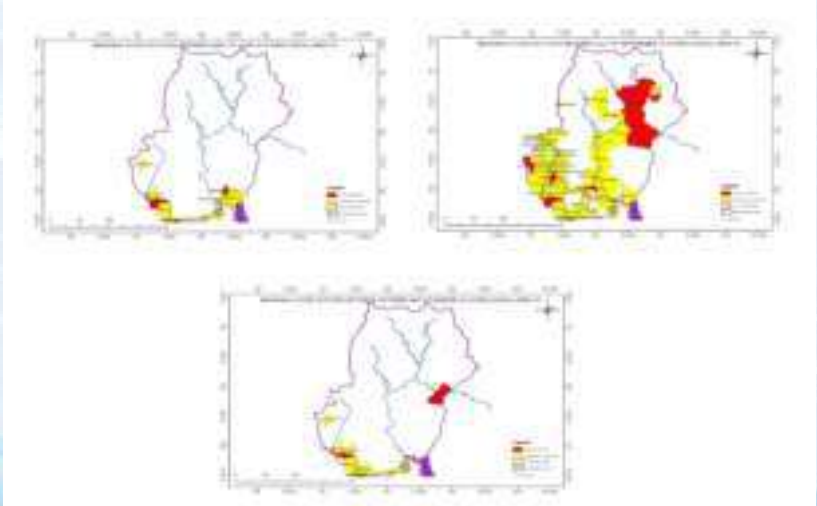


Figure 3.7 Map Showing Flood-risk Areas for HA VII

3.3.8 Hydrological Area VIII (Chad Basin)

Hydrological Area VIII (Figure 3.10) comprises of Kano, Jigawa, Yobe, Borno. 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 States under the Highly Probable category are Bauchi, Jigawa, Kano and Yobe. The details of Highly Probable and Probable flood risk areas in Hydrological Area VIII are shown in Figure 3.8

Flood Risk LGAs in HA VIII (Chad Basin)

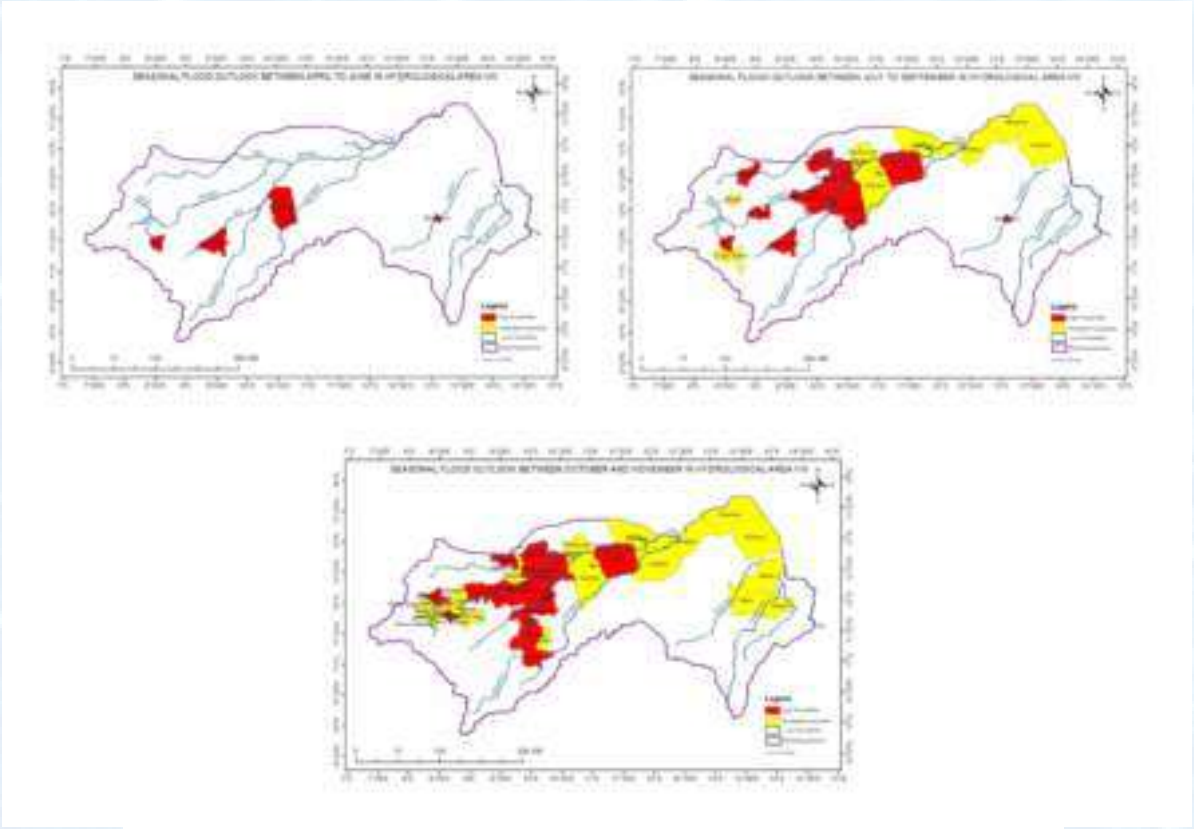
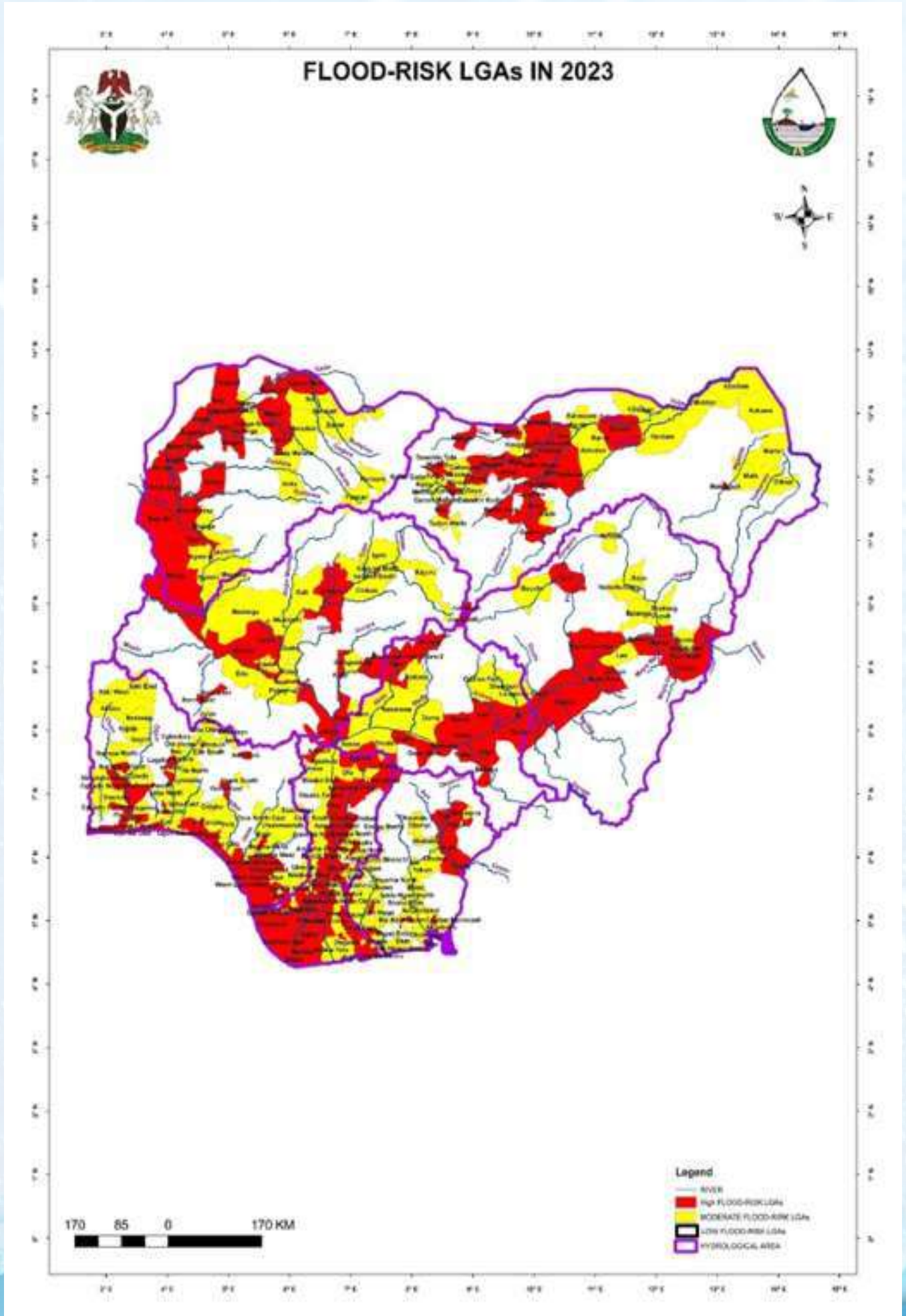


Figure 3.9 Map Showing Flood-risk Areas for HA VIII


FLOOD-RISK LGAs IN 2023
Legend
170 85 0 170 KM

The flood risk area in Nigeria are located presented in Table 3.1 and 3.2 below

Table 3: High Flood-risk Areas

S/N	State	LGAs		
		April – June	July – September	October – November
1	**Adamawa**		Yola North, Yola South, Numan, Fufore, Demsa	Numan, Ogbaru, Anambra East, Onitsha North, Ayamelum, Onitsha South, Anambra West
2	**Abia**		Osisioma Ngwa	
3	**Akwa Ibom**		Uyo	
4	**Anambra**	Ogbaru, Idemili North, Anambra East, Onitsha North, Onitsha South, Anambra West	Ihiala, Ogbaru, Anaocha, Idemili North, Anambra East, Onitsha North, Ayamelum, Awka South, Onitsha South, Anambra West	
5	**Bauchi**	Gamawa, Kirfi	Gamawa, Kirfi, Zaki	Jama'are, Itas/Gadau, Shira, Zaki
6	**Bayelsa**	Southern Ijaw, Ekeremor, Kolokuma/Opokuma, Yenegoa, Sagbama, Nembe	Southern Ijaw, Ekeremor, Kolokuma/Opokuma, Yenegoa, Sagbama, Ogbia, Nembe, Brass	Southern Ijaw, Ekeremor, Kolokuma/Opokuma, Yenegoa, Sagbama, Ogbia, Nembe, Brass
7	**Benue**	Bukuru, Agatu, Markurdi, Tarka, Gwer West, Logo, Guma	Bukuru, Agatu, Markurdi, Tarka, Gwer West, Logo, Guma	Agatu, Markurdi, Gwer West, Guma
8	**Cross River**	Calabar Municipal	Yala, Etung, Ogoja, Ikom	Etung
9	**Delta**	Oshimili South, Warri South-West, Patani, Warri South, Ndokwa East, Ughelli South, Oshimili North, Warri North	Sapele, Oshimili South, Warri South-West, Patani, Warri South, Ndokwa East, Ughelli South, Ethiope West, Oshimili North, Warri North, Uvwie, Isoko South	Oshimili South, Warri South-West, Ndokwa East, Oshimili North, Warri North
	Edo		Oredo	

11	**Ekiti**		Ado-Ekiti	
12	**FCT Abuja**	Abaji	Municipal Area Council, Abaji	Abaji
13	**Imo**		Oguta, Owerri West	
14	**Jigawa**	Birnin Kudu,	Babura, Guri, Kiri Kasama, Auyo, Miga, Biriniwa, Birnin Kudu, Kafin Hausa	Taura, Guri, Kiri Kasama, Gwaram, Kafin Hausa, Jahun, Maigatari, Biriniwa, Ringim, Malam Maduri, Miga, Auyo, Hadejia
15	**Kaduna**		kaduna South, Jema'a	kaduna South, Jema'a
16	**Kano**	Rano	Ajingi, Rano	Ungongo, Dawakin Tofa, Dawakin Kudu, Dala, Kano Municipal
17	**Kebbi**	Suru, Bagudo, Yauri	Argungu, Suru, Koko/Besse, Bagudo, Dandi, Kalgo, Bunza, Augie	Argungu, Suru, Bagudo, Kalgo, Birnin Kebbi, Bunza, Yauri, Augie
18	**Kogi**	Dekina, Lokoja, Ibaji, Kogi	Idah, Dekina, Igalamela-Odolu, Lokoja, Ibaji, Kogi	Idah, Igalamela-Odolu, Lokoja, Ibaji, Kogi
19	**Kwara**		Ilorin West, Ilorin East	
20	**Lagos**	Lagos Island, Eti Osa, Apapa, Ibeju Lekki, Badagry	Lagos Island, Alimosho, Amuwo Odofin, Ikeja, Eti Osa, Apapa, Ojo, Ibeju Lekki, Oshodi/Isolo, Agege, Ikorodu, Ifako/Ijaye, Badagry	Lagos Island, Amuwo Odofin, Eti Osa, Apapa, Ojo, Ibeju Lekki, Badagry
21	**Nasarawa**	Awe	Karu, Awe	Karu, Awe
22	**Niger**	Mokwa, Borgu, Lavun	Mokwa, Shiroro, Lavun	Mokwa, Borgu, Lavun
23	**Ogun**		Abeokuta South, Abeokuta North, Obafemi Owode, Ijebu ode, Ifo	
24	**Ondo**	Abeokuta South, Abeokuta North, Ogun waterside, Ifo	Ondo East, Ilaje	Ilaje

25	**Osun**		Osogbo,	
26	**Oyo**		Ona ara, Lagelu, Ibarapa Central	
27	**Plateau**		Jos South	Jos South
28	**Rivers**	Ogba/Egbema/Ndoni, Andoni, Oyigbo, Bonny, Port-Harcourt, Gokana, Tai, Okrika, Asari-Toru, Eleme	Ahoada East, Ogba/Egbema/Ndoni, Andoni, Ahoada West, Oyigbo, Bonny, Abua/Odual, Port-Harcourt, Obio/Akpor, Ikwerre, Gokana, Tai, Okrika, Asari-Toru, Eleme	Ogba/Egbema/Ndoni,Andoni, Ahoada West, Oyigbo, Bonny, Abua/Odual, Port-Harcourt, Okrika, Asari-Toru
29	**Sokoto**		Goronyo, Tangaza, Sokoto North, Sabon Birni, Binji, Rabah, Silame, Wamako, Kebbe	Goronyo, Bodinga, Sokoto North, Rabah, Sokoto South,Silame, Shagari, Yabo, Wamako, Kebbe
30	**Taraba**	Ibi	Gassol, Ardo-Kola, Karim Lamido, Ibi, Jalingo, Wukari	Karim Lamido, Ibi
31	**Yobe**		Borsari	Borsari
32	**Zamfara**			Bakura

Table 3.2: Moderate Flood-risk Areas

S/N	State	LGAs		
		April – June	July – September	October – November
1	Abia	Ukwa West	Obi Nwga, Umu-Nneochi, Umuahia South, Umuahia North, Ukwa East, Ugwunagbo, Ukwa West, Isiala-Ngwa North, Isiala-Ngwa South	
2	Adamawa		Shelleng, Guyuk, Gombi	

3	Akwa Ibom	Mbo, Oron, Eastern Obolo, Ibeno	Mkpat Enin, Nsit Ibom, Nsit Atai, Okobo, Abak, Mbo, Udung Uko, Eket, Onna, Oron, Eastern Obolo, Etim Ekpo, Itu, Ikot Abasi, Ika, Ibiono Ibom, Uruan, Urue Offong/Oruko,	
4	Anambra	Oyi	Oyi, Orumba South, Njikoka, Nnewi North, Orumba North, Aguata, Idemili South, Awka North, Dunukofia	
5	Bauchi	Bauchi	Bauchi	Giade,
6	Borno		Abadam, Bayo, Kukawa, Mobbar	Marte, Abadam, Dikwa, Mafa, Kukawa, Mobbar
7	Cross River	Calabar South, Akpabuyo	Yakurr, Akpabuyo, Obubra, Abi, Bekwarra, Biase, Odukpani	
8	Delta		Ndokwa West, Aniocha North, Aniocha South, Ukwuani, Ughelli North, Udu, Ethiope East, Okpe, Isoko North	
9	Ebonyi		Ebonyi, Ohaukwu, Abakaliki	
10	Edo	Etsako East, Esan South-East, Ovia North-East	Ikpoba-Okha, Etsako East, Esan South-East, Egor, Etsako Central, Uhunmwonde, Esan West, Ovia North-East	Etsako East, Esan South-East, Etsako Central
11	Ekiti	Nafada	Ijero	
12	Enugu		Enugu North	
13	FCT Abuja		Gwagwalada	
14	Gombe		Nafada, Balanga, Yamaltu/Deba	Balanga

15	Imo	Owerri North	Ideato South, Ideato North, Ikeduru, Oru West, Njaba, Nkwerre, Ohaji/Egbema, Okigwe, Unuimo, Ngor-Okpala, Nwangele, Ihitte/Uboma, Ezinihitte, Isiala Mbano, Aboh-Mbaise, Obowo, Orsu, Oru East, Orlu, Owerri North	Owerri North
16	Jigawa			Kaugama
17	Kaduna	Igabi	Kajuru, Igabi, Kaduna North, Chikun	Kajuru, Kaduna North, Chikun
18	Kano		Tudun Wada, Minjibir	Tarauni, Garum Mallam, Rimin Gado, Rimin Gado, Gaya, Gezawa, Gwale, Tofa, Gabasawa, Kabo, Wudil, Kura, Madobi, Kumbotso, Warawa
19	Katsina	Jibia, Faskari	Jibia, Kankara, Faskari	
20	Kebbi		Shanga, Ngaski	Ngaski
21	Kogi	Bassa, Ajaokuta, Omala	Bassa, Ajaokuta, Ofu, Okene, Omala	Ajaokuta
22	Kwara	Pategi, Edu	Pategi, Offa, Edu, Oyun	Pategi, Edu, Oyun
23	Lagos	Kosofe, Surulere, Shomolu, Ajeromi/Ifelodun,Lagos Lagoon	Lagos Mainland, Kosofe, Mushin, Epe, Surulere, Shomolu, Ajeromi/Ifelodun, Lagos Lagoon	Lagos Mainland, Surulere, Ajeromi/Ifelodun, Lagos Lagoon
24	Nasarawa	Nasarawa, Kokona, Doma	Nasarawa, Kokona, Toto, Doma	
25	Niger	Agwara, Edati, Gbako, Mashegu	Edati, Gbako, Wushishi, Rafi, Mashegu	Magama, Agwara, Edati, Gbako, Mashegu
26	Ogun	Ijebu East	Ewekoro, Egbado North, Egbado South, Odeda, Shagamu, Ijebu North East, Ijebu North, Ijebu East	Egbado North, Egbado South
27	Ondo		Irele, Okitipupa, Odigbo, Akure South, Ese Odo	

28	Osun	Ila	Odo Otin, Irewole, Obokun, Isokan, Irepodun, Ilesha West, Ola oluwa, Olorunda, Orolu, Ila, Iwo, Ede North, Ife North, Boripe, Ifelodun, Ede South, Aiyedire, Egbedore, Aiyedade, Ifedayo	
29	Oyo		Kajola, Saki East, Egbeda, Saki West, Atisbo, Itesiwaju, Iseyin, Ibarapa North, Ibadan North East	
30	Plateau		Qua'an Pan, Shendam, Langtang South	Qua'an Pan, Shendam, Langtang South
31	Rivers	Degema, Ogu Bolo, Khana, Opobo/Nkoro, Akuku Toru	Ogu Bolo, Degema, Omumma, Etche, Khana, Opobo/Nkoro, Emuoha, Akuku Toru	Degema, Khana, Opobo/Nkoro, Akuku Toru
32	Sokoto		Isa, Kware	Dange-Shuni, Kware
33	Taraba		Lau	
34	Yobe		Barde, Jakusko, Karasuwa, Yunusari	Geidam, Barde, Jakusko, Karasuwa
35	Zamfara		Anka, Maradun, Talata Mafara, Shinkafi, Zurmi	Anka, Maradun, Talata Mafara, Shinkafi, Zurmi

3.4 Flood Vulnerability

River channels across the nation were subjected to proximity analysis (buffering) and areas within a radius of 2km, 4km, and 6km were categorized as high, medium and low zones of flood vulnerability respectively (Figure 3.25). Using bottom up grided population estimate for Nigeria, (Version 1.2), a proximity analysis was carried out within 2km radius of the major rivers that traverse the country. Summary of vulnerable communities in each of the Hydrological Area is in Tables 3.3 – 3.26.

Table 3.3: List of Vulnerable Communities in HA I with Expected Flooding Scenario April-May-June

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Kebbi	3	181	171	195
2	Niger	2	60	59	73
	Total	5	241	230	268

Table 3.4: List of Vulnerable Communities in HA I with Expected Flooding Scenario July-August-September

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Kebbi	12	394	397	500
2	Niger	2	72	69	86
3	Sokoto	9	107	110	139
4	Zamfara	4	15	13	26
	Total	27	588	589	751

Table 3.5: List of Vulnerable Communities in HA I with Expected Flooding Scenario October-November

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Kebbi	9	388	383	468
2	Niger	3	81	76	103
3	Sokoto	11	141	147	199
4	Zamfara	4	15	14	26
	Total	27	625	620	796

Table 3.6: List of Vulnerable Communit ies in HA II with Expected Flooding Scenario April-May-June

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Kwara	2	24	26	37
2	Niger	4	70	72	88
3	Total	6	94	98	125

Table 3.7: List of Vulnerable Communities in HA II with Expected Flooding Scenario July-August-September

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Kaduna	1	36	41	52
2	Kogi	1	29	35	43
3	Kwara	3	24	25	40
4	Niger	8	161	154	204
	Total	13	250	255	339

Table 3.8: List of Vulnerable Communities in HA I I with Expected Flooding Scenario October-November

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Kwara	2	24	26	37
2	Niger	4	70	121	88
	Total	6	94	147	125

Table 3.9: List of Vulnerable Communities in HA III with Expected Flooding Scenario April-May-June

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
Nil	Nil	Nil	Nil	Nil	

Table 3.10: List of Vulnerable Communities in HA III with Expected Flooding Scenario July-August-September

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Adamawa	8	150	163	183
2	Borno	1	23	23	25
3	Gombe	2	11	17	24
4	Taraba	5	39	42	53
	Total	16	223	245	285

Table 3.11: List of Vulnerable Communities in HA III with Flooding Scenario Expected October-November

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Adamawa	4	70	74	82
2	Gombe	1	0	1	2
3	Taraba	1	26	26	27
	Total	6	96	101	111

Table 3.12: List of Vulnerable Communities in HA IV with Expected Flooding Scenario April-May-June

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Benue	7	69	93	114
2	Kogi	3	20	26	32
3	Nassarawa	4	2	2	2
	Total	14	91	121	148

Table 3.13: List of Vulnerable Communities in HA IV with Expected Flooding Scenario July-August-September

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Benue	7	73	98	121
2	Kogi	3	26	32	38
3	Nassarawa	4	29	37	46
4	Taraba	2	57	62	73
	Total	16	185	229	278

Table 3.14: List of Vulnerable Communities in HA IV with Flooding Scenario Expected October-November

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Benue	4	69	93	114
2	Kogi	3	20	26	32
3	Nassarawa	1	8	10	13
4	Taraba	1	19	20	24
	Total	9	116	149	183

Table 3.15: List of Vulnerable Communities in HA V with Expected Flooding Scenario April-May-June

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Anambra	7	26	26	35
2	Bayelsa	6	159	171	195
3	Delta	5	70	84	96
4	Edo	2	6	7	10
5	Kogi	3	32	32	35
6	Rivers	7	105	112	121
	Total	30	398	432	492

Table 3.16: List of Vulnerable Commun ities in HA V with Expected Flooding Scenario July-August-September

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Anambra	19	46	57	81
2	Bayelsa	7	161	173	202
3	Delta	13	78	98	124
4	Edo	3	10	14	14
5	Kogi	7	54	57	64
6	Rivers	13	121	146	176
	Total	62	470	545	661

Table 3.17: List of Vulnerable Communities in HA V with Expected Flooding Scenario October-November

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Anambra	6	34	34	42
2	Bayelsa	7	160	172	201
3	Delta	3	36	38	39
4	Edo	3	9	10	13
5	Kogi	5	64	45	50
6	Rivers	8	107	116	122
	Total	32	410	415	467

Table 3.18: List of Vulnerable Communities in HA VI with Expected Flooding Scenario April-May-June

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Delta	3	44	54	64
2	Lagos	10	139	149	155
3	Ogun	5	93	107	135
4	Ondo	1	19	22	33
	Total	19	295	332	387

Table 3.19: List of Vulnerable Communities in HA VI with Expected Flooding Scenario July-August-September

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Delta	8	83	103	141
2	Edo	5	2	2	2
3	Lagos	20	244	271	300
4	Ogun	12	226	281	365
5	Ondo	7	19	22	33
6	Osun	20	112	149	217
7	Oyo	13	185	241	356
	Total	85	871	1069	1414

Table 3.20: List of Vulnerable Communities in HA VI with Expected Flooding Scenario October-November

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Delta	2	36	36	45
2	Lagos	10	151	160	169
3	Ogun	1	23	27	33
4	Ondo	1	19	22	33
	Total	14	229	245	280

Table 3.21: List of Vulnerabl e Communities in HA VII with Expected Flooding Scenario April-May-June

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Abia	1	2	3	5
2	Akwa-Ibom	4	20	20	23
3	Cross River	3	23	28	36
4	Rivers	7	39	47	67
	Total	15	84	98	131

Table 3.22: List of Vulnerable Communities in HA VII with Expected Flooding Scenario July-August-September

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Abia	10	15	24	47
2	Akwa-Ibom	21	56	75	112
3	Cross River	11	182	201	245
4	Eboyi	3	60	66	85
5	Imo	13	24	29	34
6	Rivers	9	69	86	115
	Total	67	406	481	638

Table 3.23: List of Vulnerable Communities in HA VII with Flooding Scenario Expected October-November

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Abia	2	3	4	8
2	Akwa-Ibom	4	15	19	27
3	Rivers	4	53	64	81
	Total	10	71	87	116

Table 3.24: List of Vulnerable Communities in HA VIII with Flooding Scenario Expected April-May-June

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
Nil	Nil	Nil	Nil	Nil	Nil

Table 3.25: List of Vulnerable Communities in HA VIII with Expected Flooding Scenario July-August-September

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Bauchi	1	14	20	25
2	Borno	3	14	16	27
3	Jigawa	6	43	49	63
4	Yobe	5	65	72	87
	Total	15	136	157	202

Table 3.26: List of Vulnerable Communities in HA VIII with Flooding Scenario Expected October-November

S/N	State	No. of LGAs	Affected Communities		
			2km	3km	5km
1	Bauchi	5	55	66	83
2	Borno	6	15	17	29
3	Jigawa	14	100	115	168
4	Kano	20	64	77	92
5	Yobe	6	87	97	114
	Total	51	321	372	486

3.5 Highly Flood-risk Areas

The probable high flood risk basins are: Upper and Lower Niger, Upper and Lower Benue, Anambra–Imo, Niger–Delta, lower fringes of Ogun–Osun part of Cross River, Sokoto–Rima and Komadougu–Yobe. A total of Two hundred and thirty-three 1(78) LGAs are predicted High Flood-risk for 2023/2024 Hydrological Year.

3.6 Moderate Flood-risk Areas

The level of floods in this category is expected to be moderate in terms of impact on the people. Two Hundred and Twelve (224) LGAs are predicted to fall within this category.

3.7 Coastal Flooding

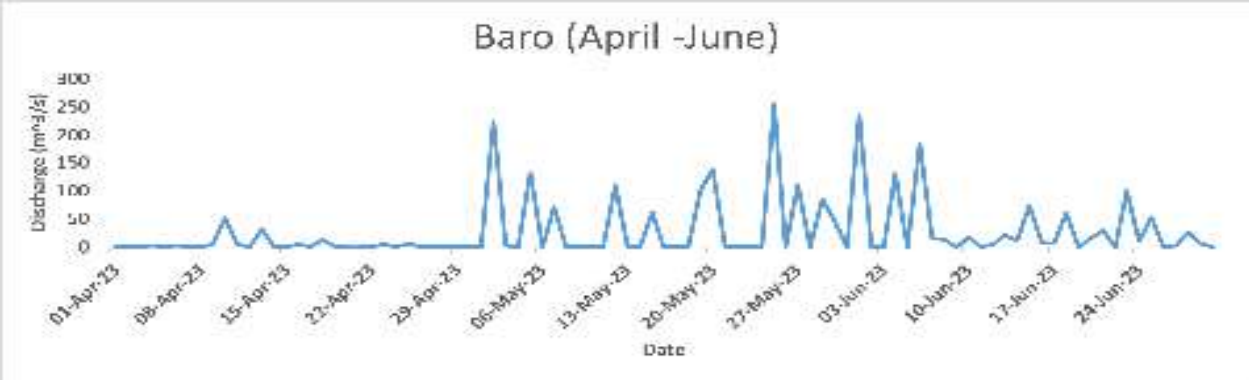
Some coastal States: Rivers, Bayelsa, Cross River, Delta, Edo, Lagos, Ogun and Ondo are expected to experience coastal flooding due to rise in sea level and tidal surge which would impact on fishing, habitation and coastal transportation.

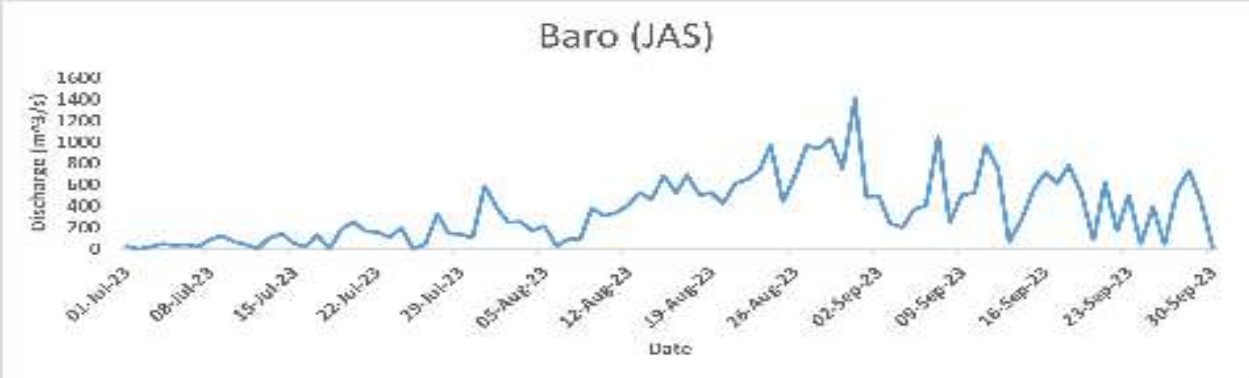
3.8 Flash and Urban Flooding

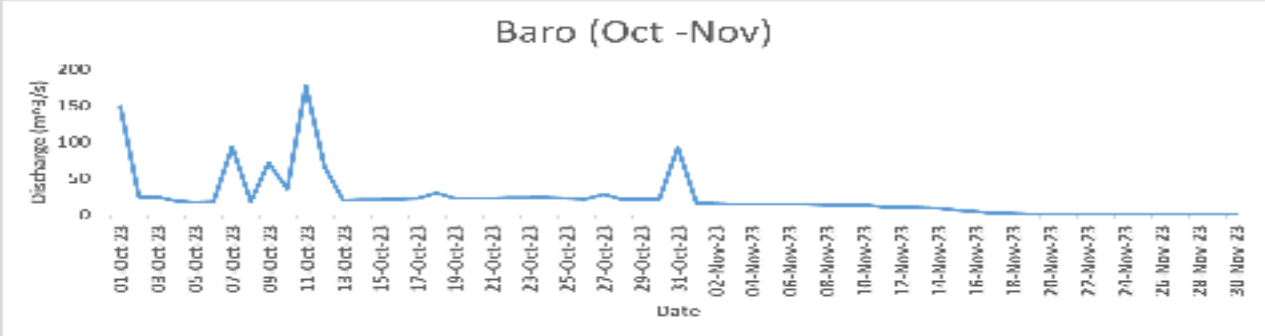
Flash and Urban Flood is also expected to occur in some locations such as: Lagos, Abeokuta, Osogbo, Ibadan, Benin City, Asaba, Warri, Onitsha, Port-Harcourt, Kaduna, Sokoto, Yola, Abakaliki, Birni-Kebbi, Makurdi and other cities with poor drainage systems.

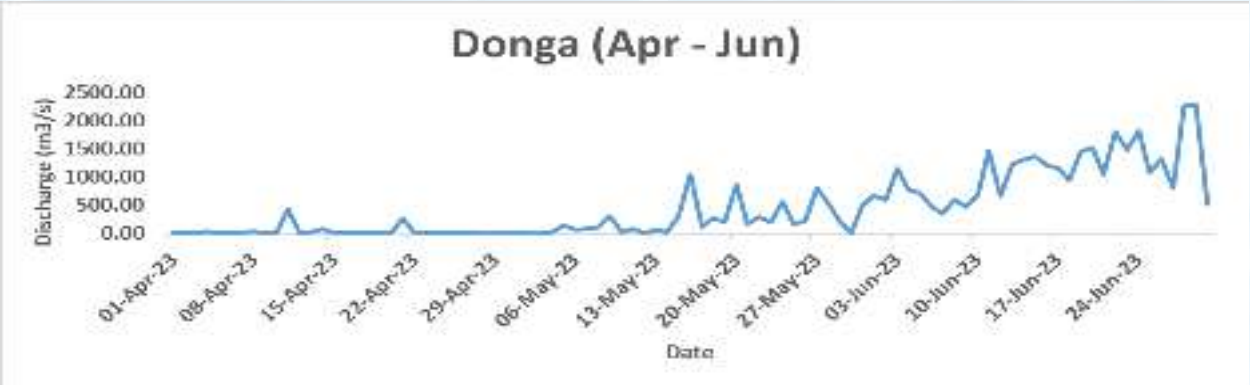
3.9 Simulated Hydrographs at selected stations

The simulated hydrographs of gauging stations at Baro, Donga, Ebba, Gongola, Hadejia, Ibi,Kastina -Ala, Lau, Lokoja, Malabu, Okitipupa, Onitsha, Osun Otuocha, Shiroro, Sokoto, Umaisha and Zugeru are presented below.


Baro (April -June)
Discharge (m^3/s)
300
250
200
150
100
50
0
01-Apr-23
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Baro (JAS)
Discharge (m^3/s)
1600
1400
1200
1000
800
600
400
200
0
01-Jul-23
08-Jul-23
15-Jul-23
22-Jul-23
29-Jul-23
05-Aug-23
12-Aug-23
19-Aug-23
26-Aug-23
02-Sep-23
09-Sep-23
16-Sep-23
23-Sep-23
30-Sep-23
Date


Baro (Oct -Nov)
Discharge (m^3/s)
200
150
100
50
0
01 Oct 23
03 Oct 23
05 Oct 23
07 Oct 23
09 Oct 23
11 Oct 23
13 Oct 23
15-Oct-23
17-Oct-23
19-Oct-23
21-Oct-23
23-Oct-23
25-Oct-23
27-Oct-23
29-Oct-23
31-Oct-23
02-Nov-23
04-Nov-23
06-Nov-23
08-Nov-23
10-Nov-23
12-Nov-23
14-Nov-23
16-Nov-23
18-Nov-23
20-Nov-23
22-Nov-23
24-Nov-23
26 Nov 23
28 Nov 23
30 Nov 23
Date


Donga (Apr - Jun)
Discharge (m3/s)
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2000.00
1500.00
1000.00
500.00
0.00
01-Apr-23
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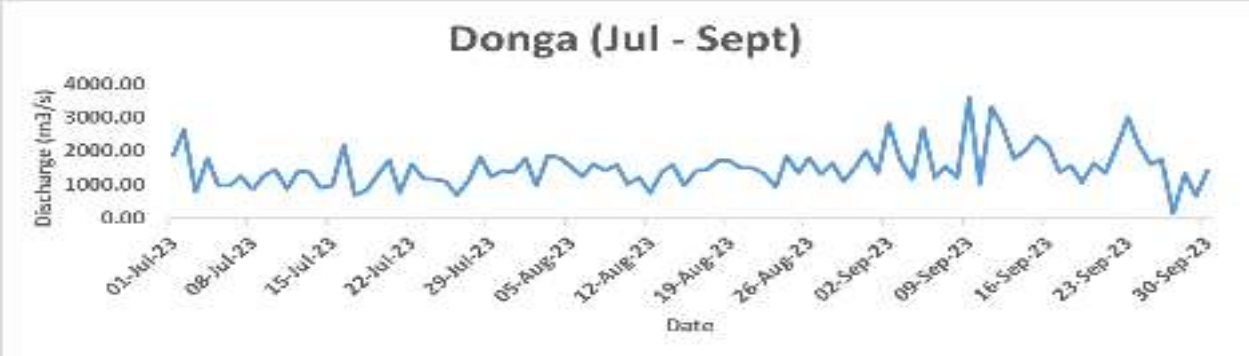
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Donga (Jul - Sept)
Discharge (m3/s)
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3000.00
2000.00
1000.00
0.00
01-Jul-23
08-Jul-23
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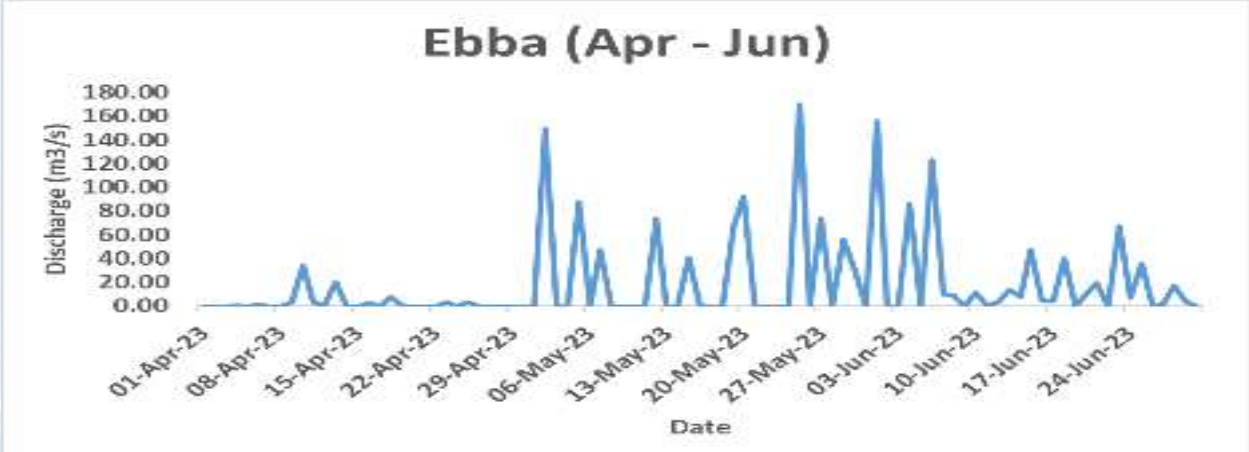
22-Jul-23
29-Jul-23
05-Aug-23
12-Aug-23
19-Aug-23
26-Aug-23
02-Sep-23
09-Sep-23
16-Sep-23
23-Sep-23
30-Sep-23
Date


Donga (Oct - Nov)
Discharge (m3/s)
2500.00
2000.00
1500.00
1000.00
500.00
0.00
01-Oct-23
08-Oct-23
15-Oct-23
22-Oct-23
29-Oct-23
05-Nov-23
12-Nov-23
19-Nov-23
26-Nov-23
Date


Ebba (Apr - Jun)
Discharge (m3/s)
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120.00
100.00
80.00
60.00
40.00
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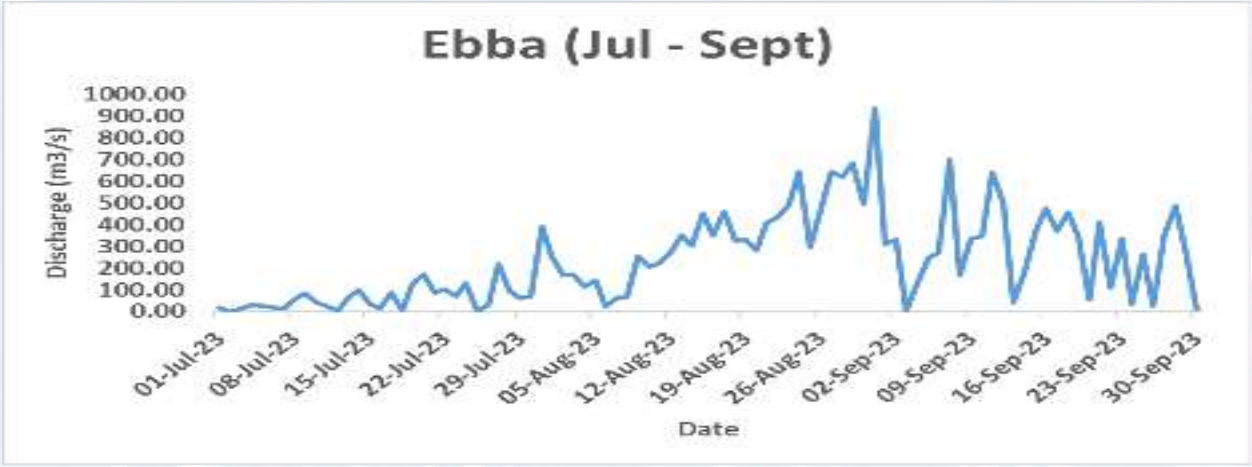
0.00
01-Apr-23
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date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Discharge (m3/s)
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100.00
0.00
01-Jul-23
08-Jul-23
15-Jul-23
22-Jul-23
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05-Aug-23
12-Aug-23
19-Aug-23
26-Aug-23
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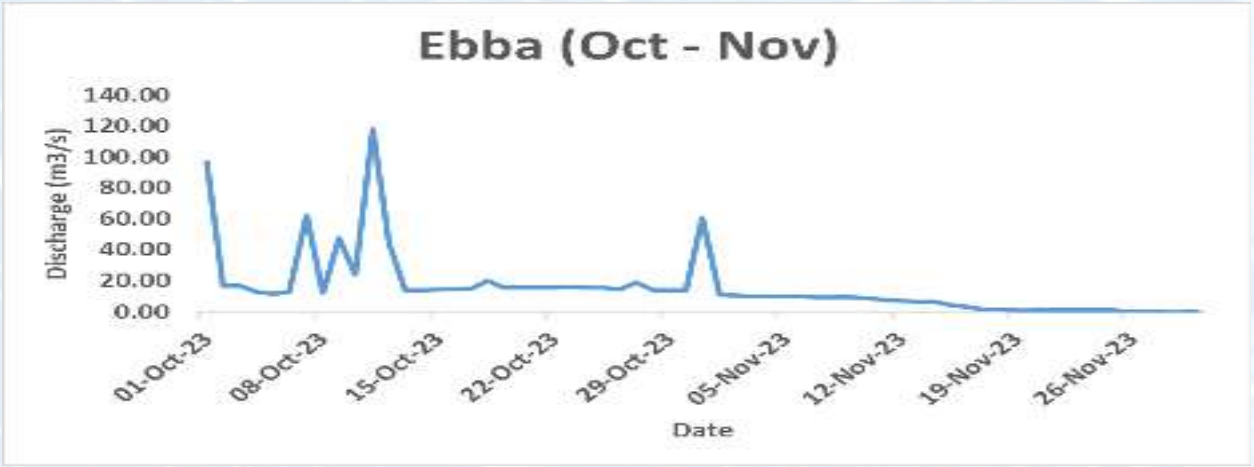
09-Sep-23
16-Sep-23
23-Sep-23
30-Sep-23
Date


Ebba (Oct - Nov)
Discharge (m3/s)
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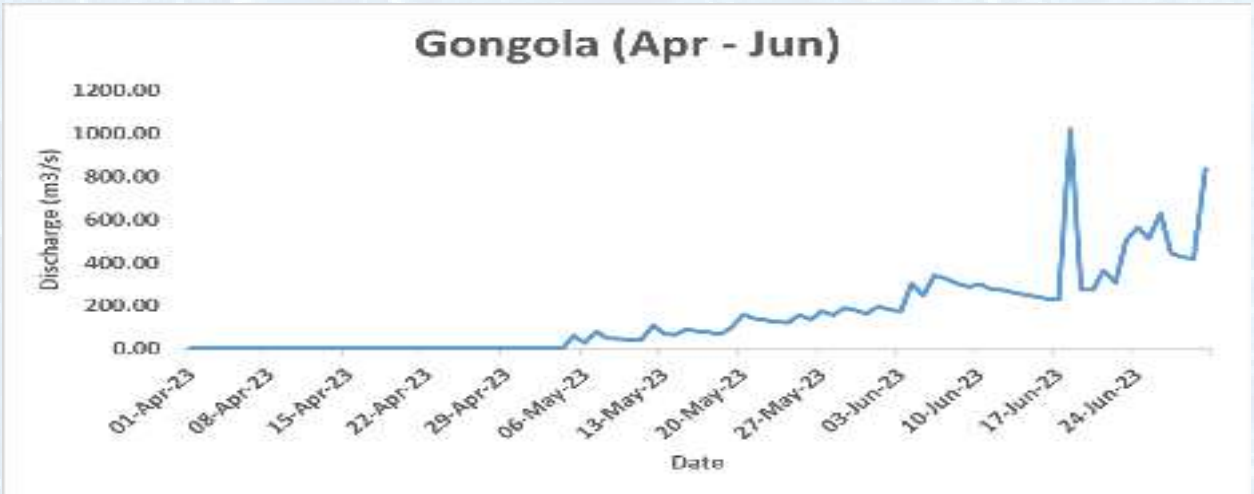
120.00
100.00
80.00
60.00
40.00
20.00
0.00
01-Oct-23
08-Oct-23
15-Oct-23
22-Oct-23
29-Oct-23
05-Nov-23
12-Nov-23
19-Nov-23
26-Nov-23
Date


Gongola (Apr - Jun)
Discharge (m3/s)
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1000.00
800.00
600.00
400.00
200.00
0.00
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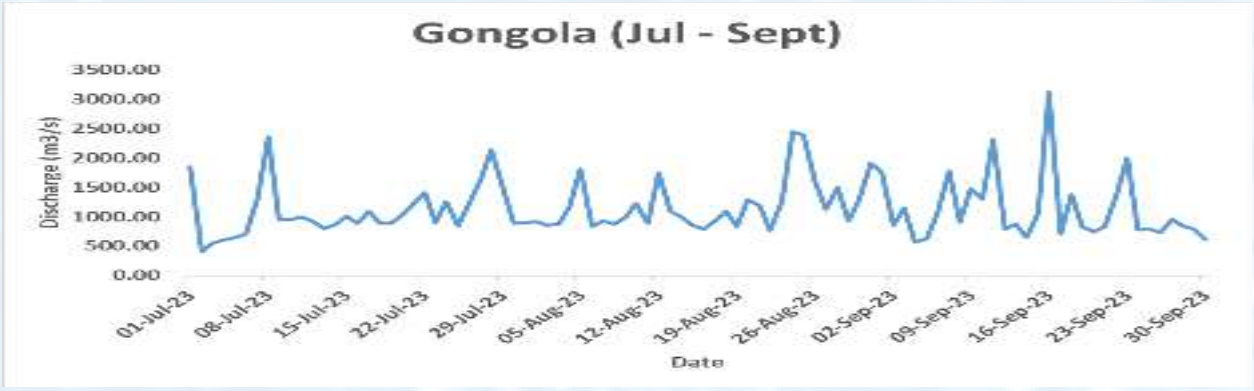
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Gongola (Jul - Sept)
Discharge (m3/s)
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2000.00
1500.00
1000.00
500.00
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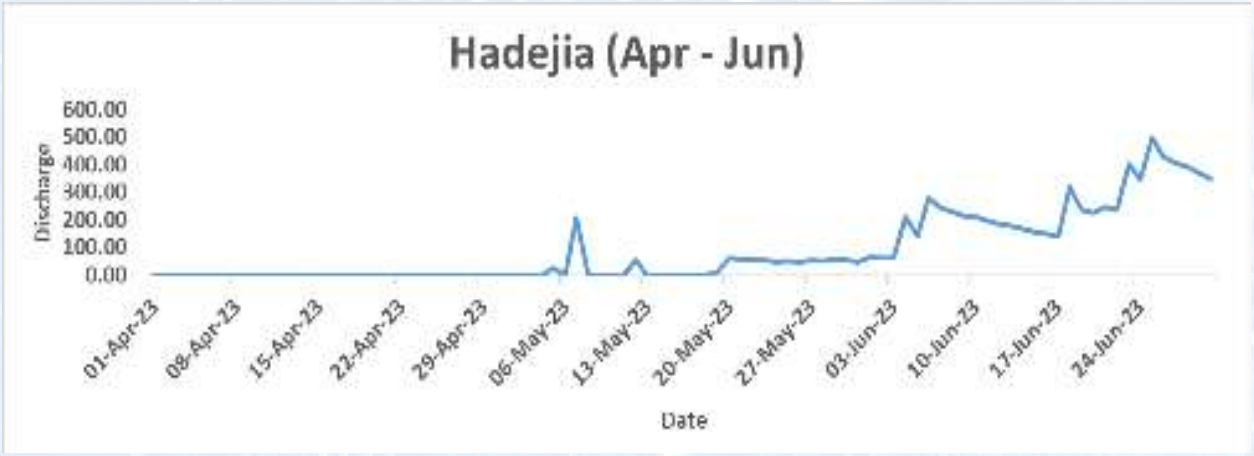
01-Jul-23
08-Jul-23
15-Jul-23
22-Jul-23
29-Jul-23
05-Aug-23
12-Aug-23
19-Aug-23
26-Aug-23
02-Sep-23
09-Sep-23
16-Sep-23
23-Sep-23
30-Sep-23
Date


Gongola (Oct - Nov)
Discharge (m3/s)
1600.00
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
01-Oct-23
08-Oct-23
15-Oct-23
22-Oct-23
29-Oct-23
05-Nov-23
12-Nov-23
19-Nov-23
26-Nov-23
Date


Hadejia (Apr - Jun)
Discharge
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500.00
400.00
300.00
200.00
100.00
0.00
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29-Apr-23
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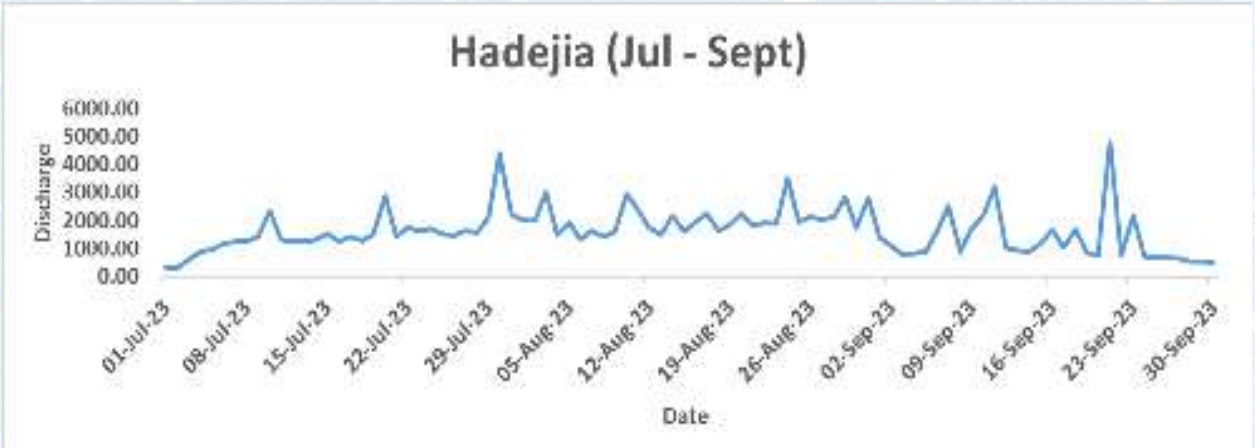
10-Jun-23
17-Jun-23
24-Jun-23
Date


Hadejia (Jul - Sept)
Discharge
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3000.00
2000.00
1000.00
0.00
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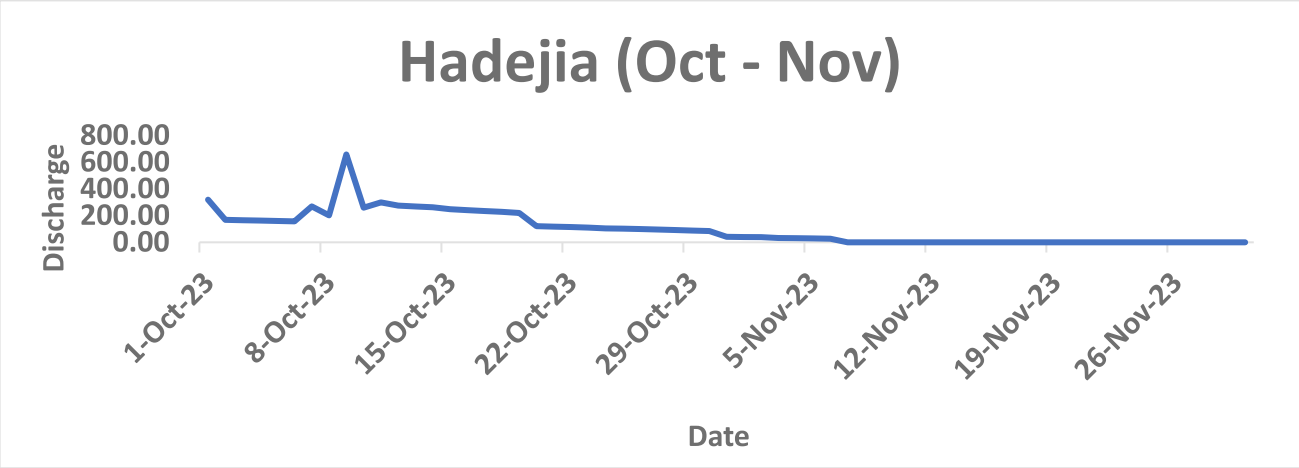
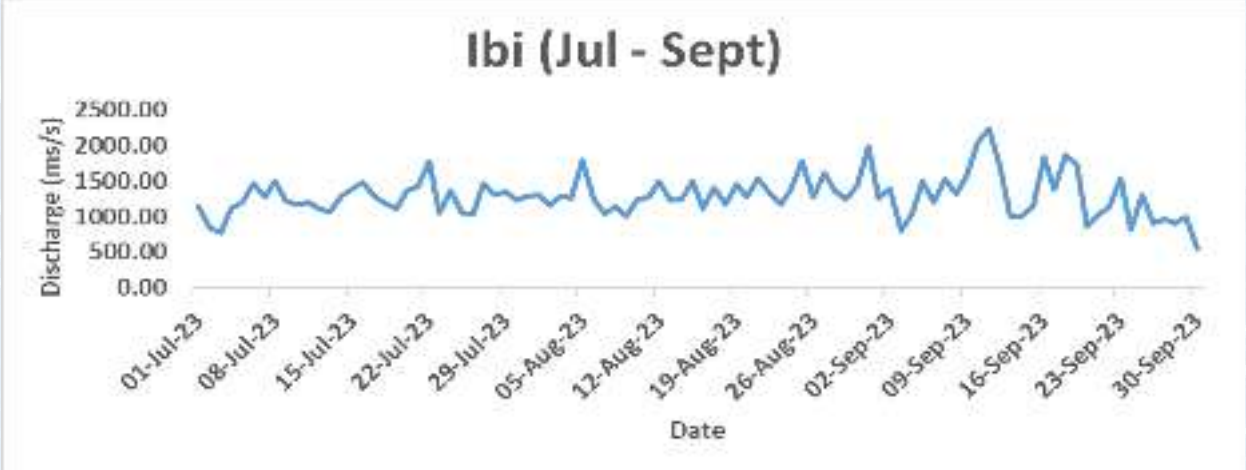
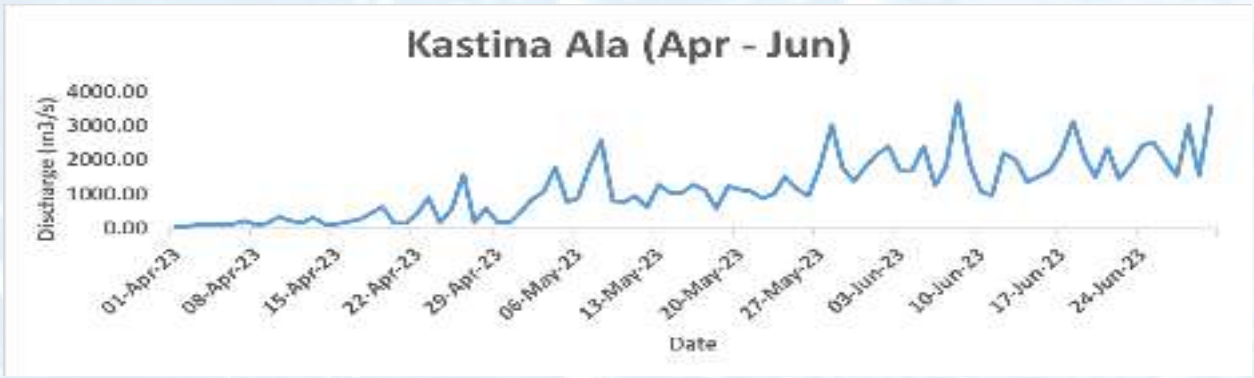
08-Jul-23
15-Jul-23
22-Jul-23
29-Jul-23
05-Aug-23
12-Aug-23
19-Aug-23
26-Aug-23
02-Sep-23
09-Sep-23
16-Sep-23
23-Sep-23
30-Sep-23
Date


Hadejia (Oct - Nov)
Discharge
800.00
600.00
400.00
200.00
0.00
1-Oct-23
8-Oct-23
15-Oct-23
22-Oct-23
29-Oct-23
5-Nov-23
12-Nov-23
19-Nov-23
26-Nov-23
Date


Ibi (Apr - Jun)
Discharge (m3/s)
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
01-Apr-23
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Ibi (Jul - Sept)
Discharge (ms/s)
2500.00
2000.00
1500.00
1000.00
500.00
0.00
01-Jul-23
08-Jul-23
15-Jul-23
22-Jul-23
29-Jul-23
05-Aug-23
12-Aug-23
19-Aug-23
26-Aug-23
02-Sep-23
09-Sep-23
16-Sep-23
23-Sep-23
30-Sep-23
Date


Ibi (Oct - Nov)
Discharge (ms/s)
1000.00
800.00
600.00
400.00
200.00
0.00
01-Oct-23
08-Oct-23
15-Oct-23
22-Oct-23
29-Oct-23
05-Nov-23
12-Nov-23
19-Nov-23
26-Nov-23
Date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Discharge (m3/s)
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1000.00
0.00
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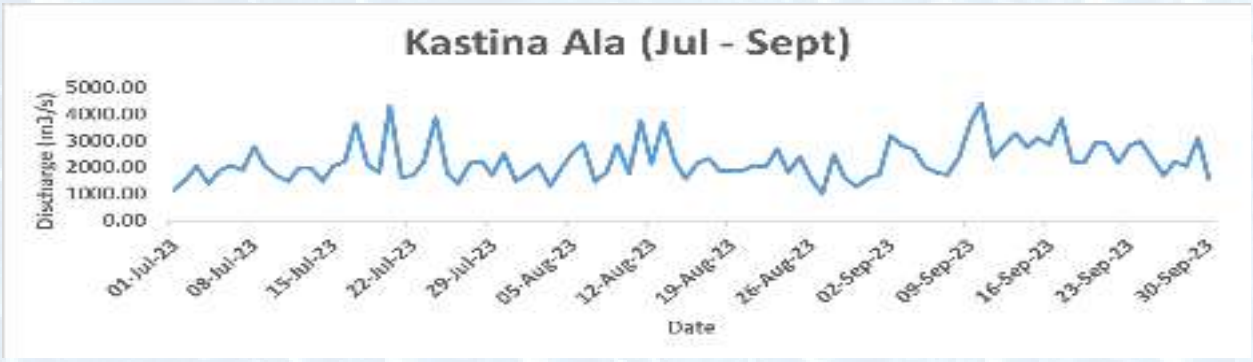
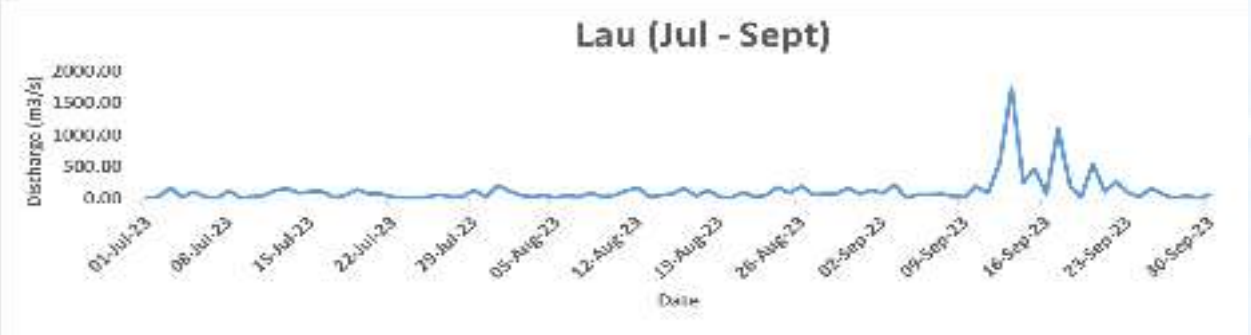
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Kastina Ala (Jul - Sept)
Discharge (m3/s)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
01-Jul-23
08-Jul-23
15-Jul-23
22-Jul-23
29-Jul-23
05-Aug-23
12-Aug-23
19-Aug-23
26-Aug-23
02-Sep-23
09-Sep-23
16-Sep-23
23-Sep-23
30-Sep-23
Date


Kastina Ala (Oct - N0v)
Discharge (m3/s)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
01-Oct-23
08-Oct-23
15-Oct-23
22-Oct-23
29-Oct-23
05-Nov-23
12-Nov-23
19-Nov-23
26-Nov-23
Date


Lau (Apr - Jun)
Discharge (m3/s)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
01-Apr-23
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Lau (Jul - Sept)
Discharge (m3/s)
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1500.00
1000.00
500.00
0.00
01-Jul-23
08-Jul-23
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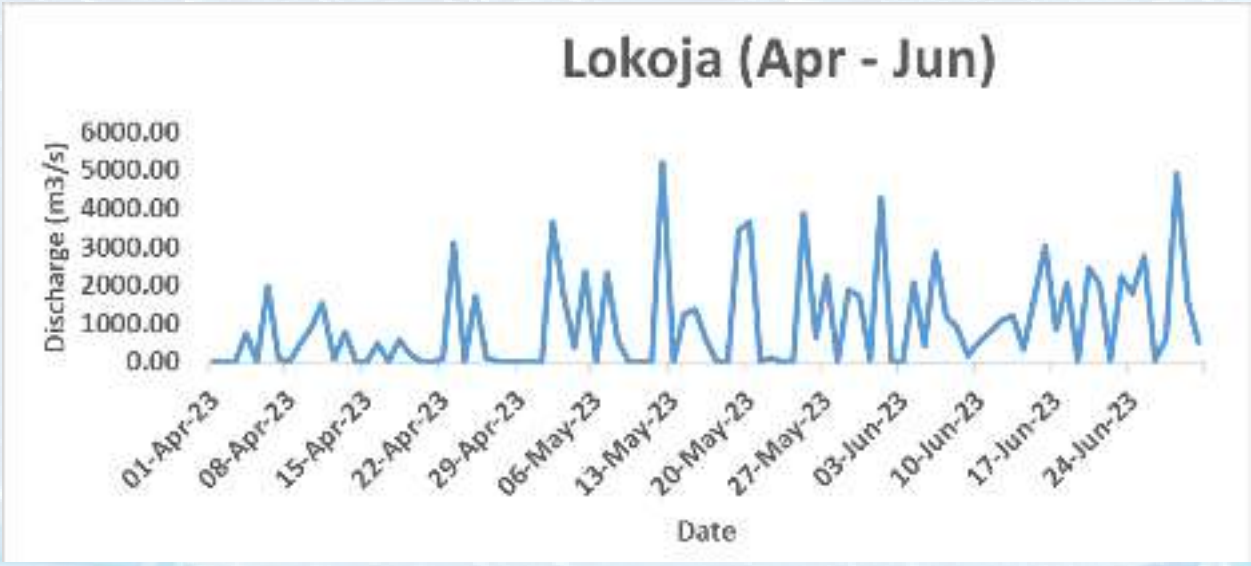
22-Jul-23
29-Jul-23
05-Aug-23
12-Aug-23
19-Aug-23
26-Aug-23
02-Sep-23
09-Sep-23
16-Sep-23
23-Sep-23
30-Sep-23
Date


Lau (Oct - Nov)
Discharge (m3/s)
1500.00
1000.00
500.00
0.00
01-Oct-23
08-Oct-23
15-Oct-23
22-Oct-23
29-Oct-23
05-Nov-23
12-Nov-23
19-Nov-23
26-Nov-23
Date


Lokoja (Apr - Jun)
Discharge (m3/s)
6000.00
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
01-Apr-23
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Lokoja (Oct - Nov)
Discharge (m3/s)
5000.00
4000.00
3000.00
2000.00
1000.00
0.00
01-Oct-23
03-Oct-23
05-Oct-23
07-Oct-23
09-Oct-23
11-Oct-23
13-Oct-23
15-Oct-23
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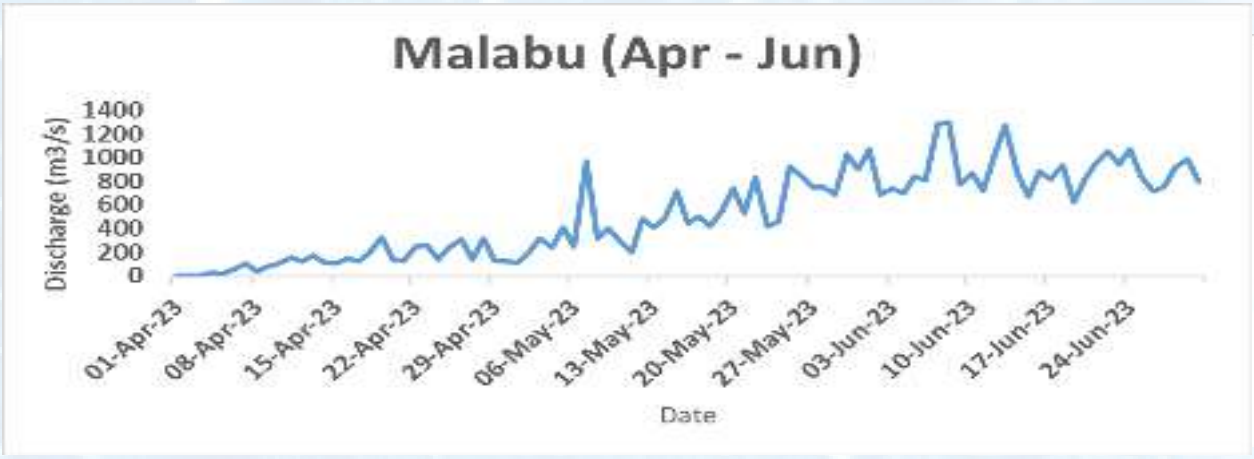
23-Oct-23
25-Oct-23
27-Oct-23
29-Oct-23
31-Oct-23
Date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Discharge (m3/s)
1400
1200
1000
800
600
400
200
0
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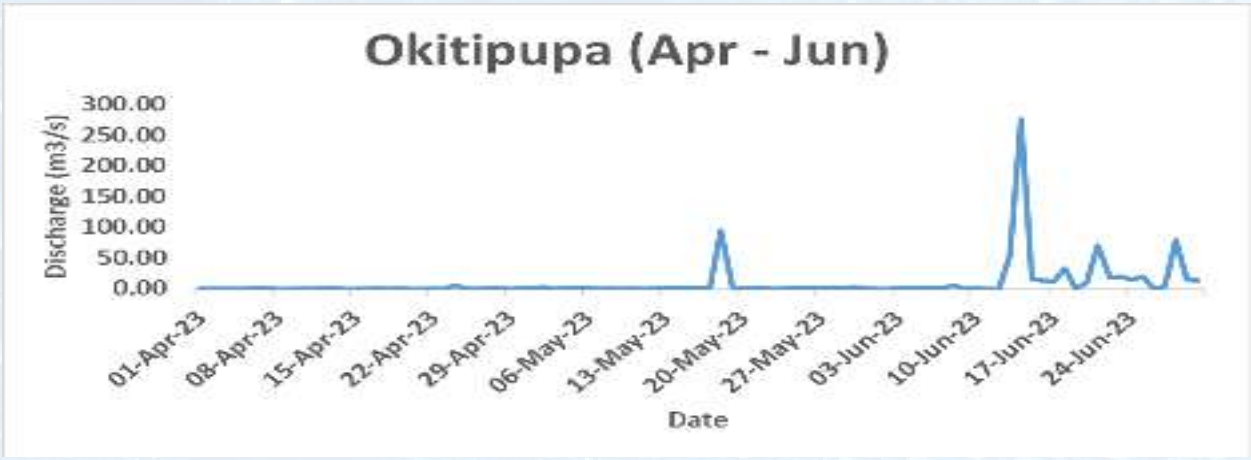
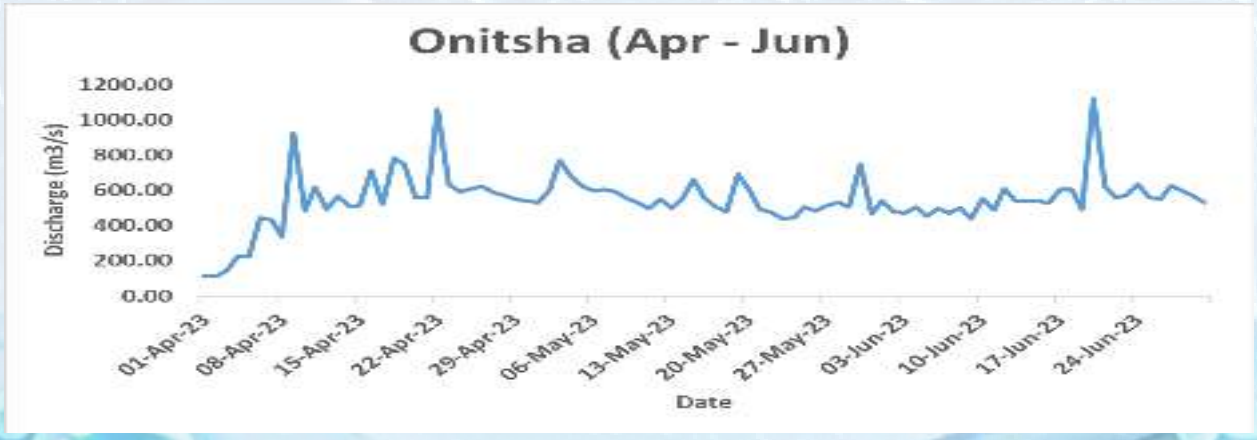
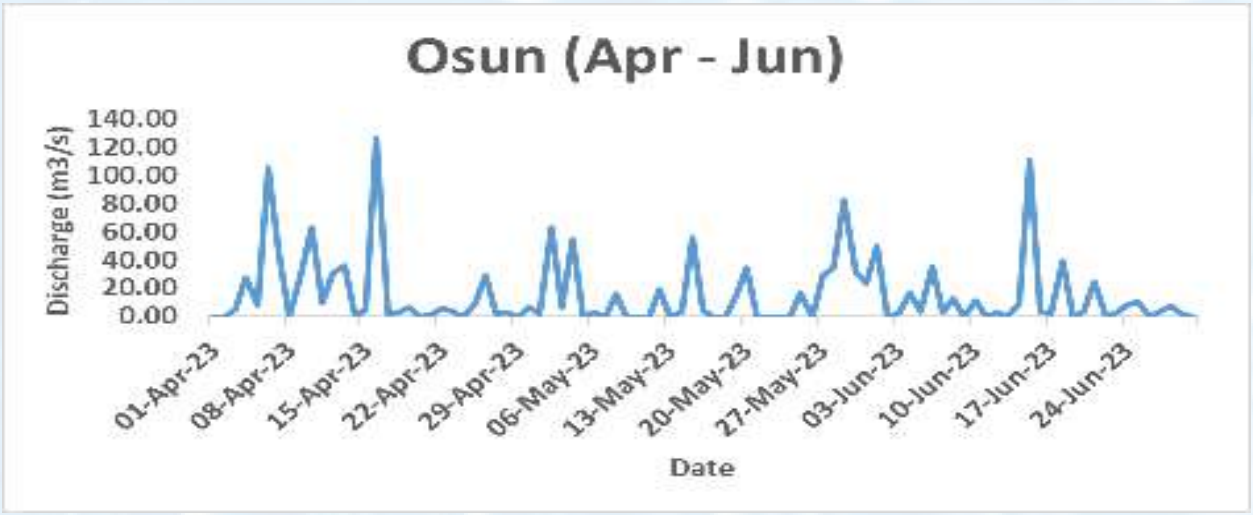
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Okitipupa (Apr - Jun)
Discharge (m3/s)
300.00
250.00
200.00
150.00
100.00
50.00
0.00
01-Apr-23
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Onitsha (Apr - Jun)
Discharge (m3/s)
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
01-Apr-23
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Osun (Apr - Jun)
Discharge (m3/s)
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120.00
100.00
80.00
60.00
40.00
20.00
0.00
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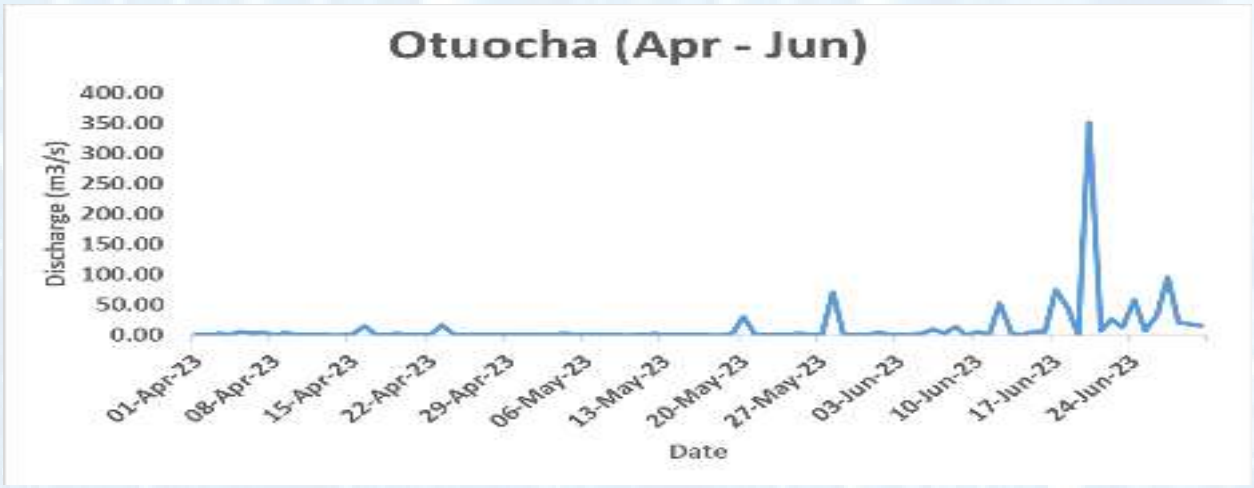
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Otuocha (Apr - Jun)
Discharge (m3/s)
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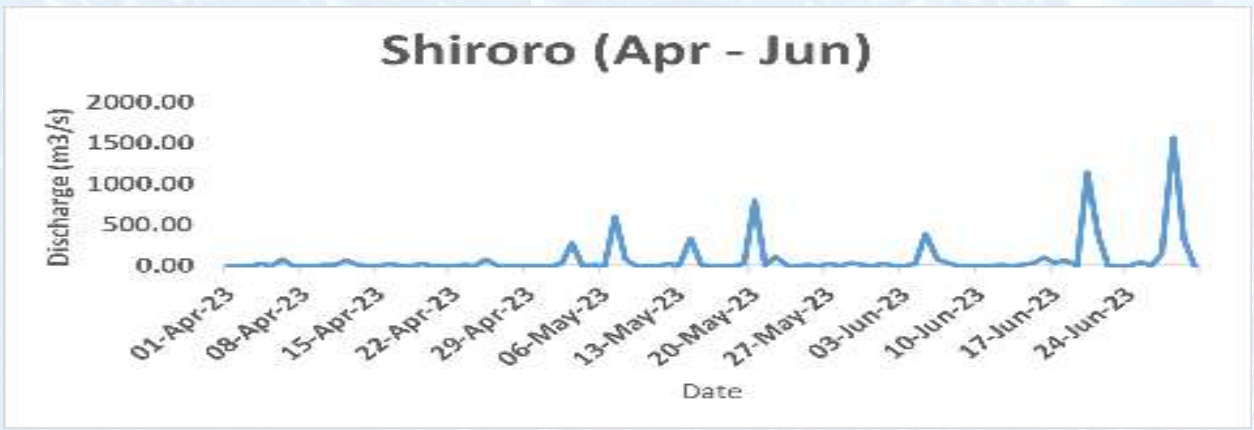
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
01-Apr-23
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Shiroro (Apr - Jun)
Discharge (m3/s)
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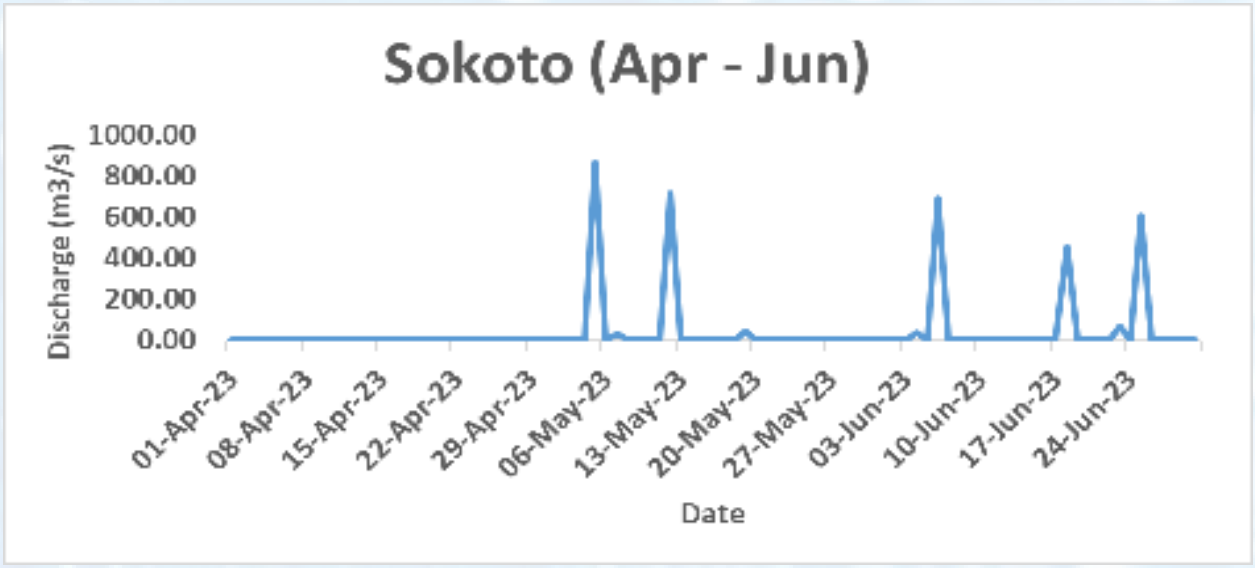
1500.00
1000.00
500.00
0.00
01-Apr-23
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Shiroro (Jul - Sept)
Discharge (m3/s)
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
01-Jul-23
08-Jul-23
15-Jul-23
22-Jul-23
29-Jul-23
05-Aug-23
12-Aug-23
19-Aug-23
26-Aug-23
02-Sep-23
09-Sep-23
16-Sep-23
23-Sep-23
30-Sep-23
Date


Shiroro (Oct - Nov)
Discharge (m3/s)
1000.00
800.00
600.00
400.00
200.00
0.00
01-Oct-23
08-Oct-23
15-Oct-23
22-Oct-23
29-Oct-23
05-Nov-23
12-Nov-23
19-Nov-23
26-Nov-23
Date


Sokoto (Apr - Jun)
Discharge (m3/s)
1000.00
800.00
600.00
400.00
200.00
0.00
01-Apr-23
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
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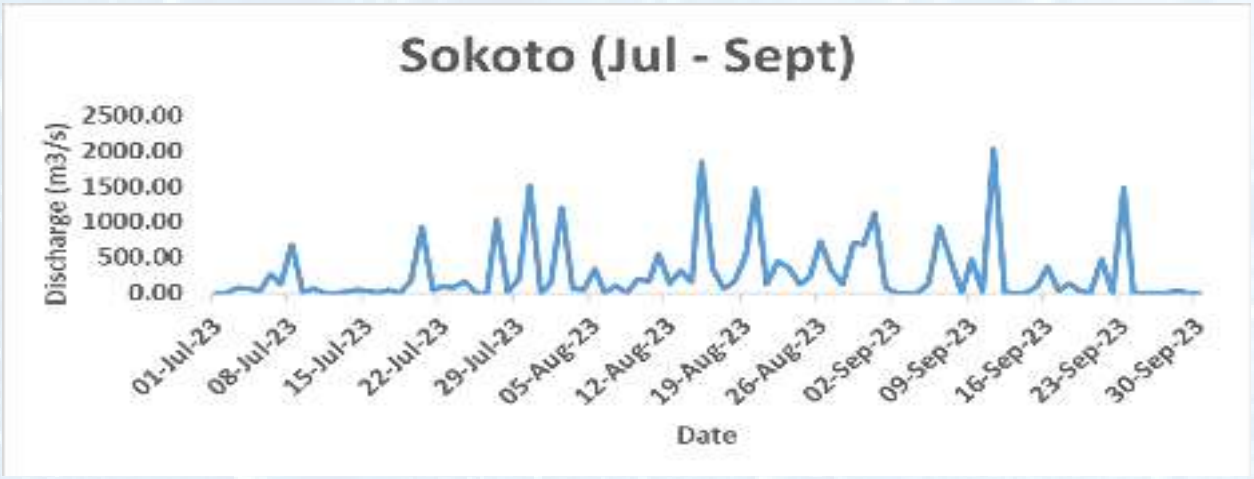
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Sokoto (Jul - Sept)
Discharge (m3/s)
2500.00
2000.00
1500.00
1000.00
500.00
0.00
01-Jul-23
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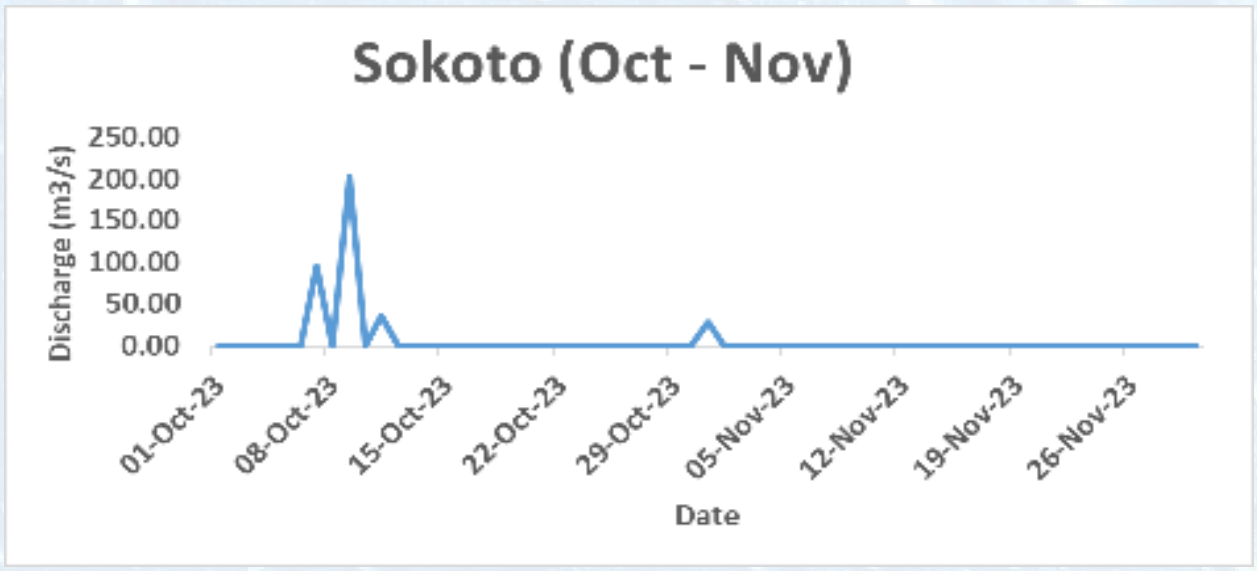
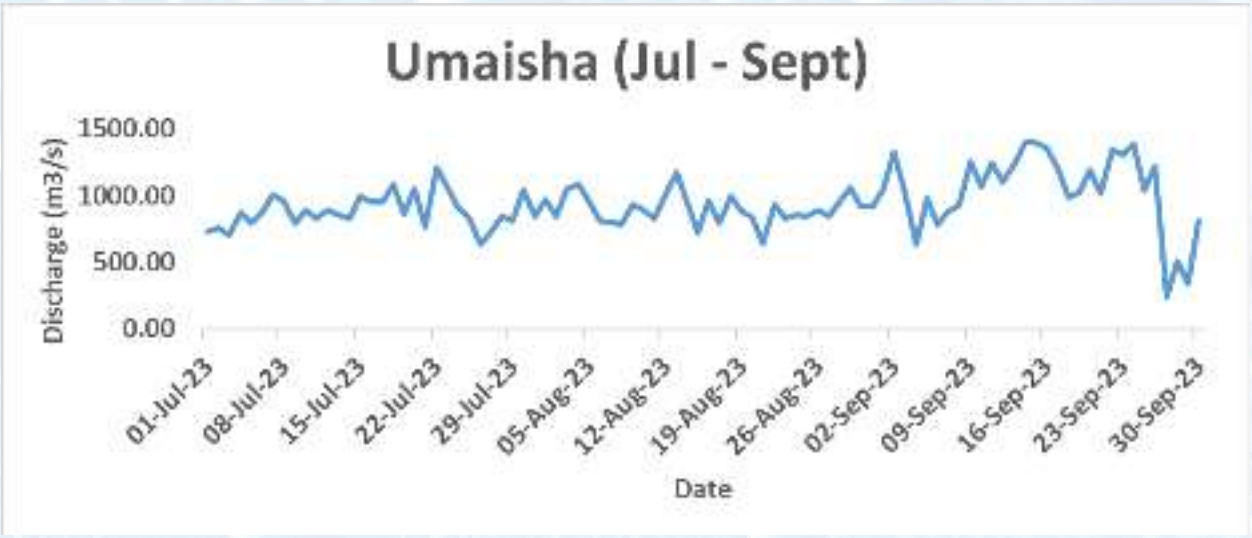
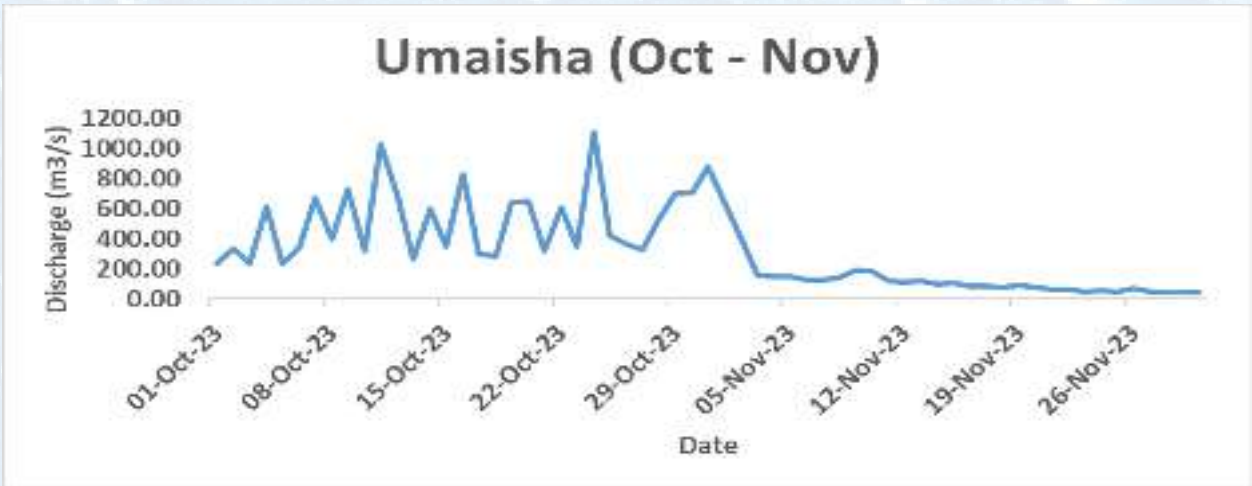
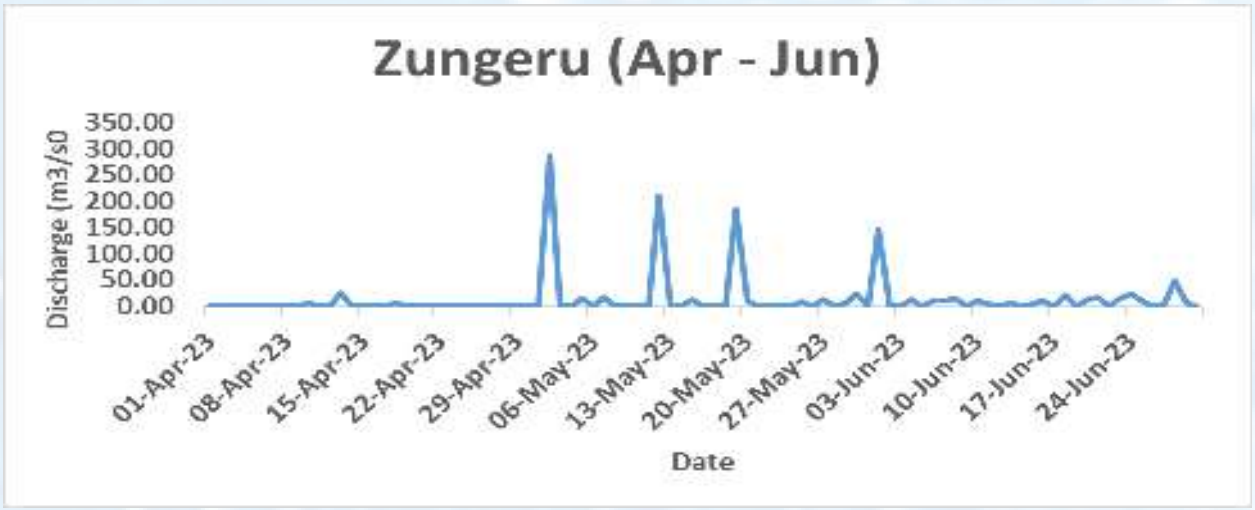
15-Jul-23
22-Jul-23
29-Jul-23
05-Aug-23
12-Aug-23
19-Aug-23
26-Aug-23
02-Sep-23
09-Sep-23
16-Sep-23
23-Sep-23
30-Sep-23
Date


Sokoto (Oct - Nov)
Discharge (m3/s)
250.00
200.00
150.00
100.00
50.00
0.00
01-Oct-23
08-Oct-23
15-Oct-23
22-Oct-23
29-Oct-23
05-Nov-23
12-Nov-23
19-Nov-23
26-Nov-23
Date


Umaisha (Apr - Jun)
Discharge (m3/s)
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
01-Apr-23
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
13-May-23
20-May-23
27-May-23
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Umaisha (Jul - Sept)
Discharge (m3/s)
1500.00
1000.00
500.00
0.00
01-Jul-23
08-Jul-23
15-Jul-23
22-Jul-23
29-Jul-23
05-Aug-23
12-Aug-23
19-Aug-23
26-Aug-23
02-Sep-23
09-Sep-23
16-Sep-23
23-Sep-23
30-Sep-23
Date


Umaisha (Oct - Nov)
Discharge (m3/s)
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
01-Oct-23
08-Oct-23
15-Oct-23
22-Oct-23
29-Oct-23
05-Nov-23
12-Nov-23
19-Nov-23
26-Nov-23
Date


Zungeru (Apr - Jun)
Discharge (m3/s0
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
01-Apr-23
08-Apr-23
15-Apr-23
22-Apr-23
29-Apr-23
06-May-23
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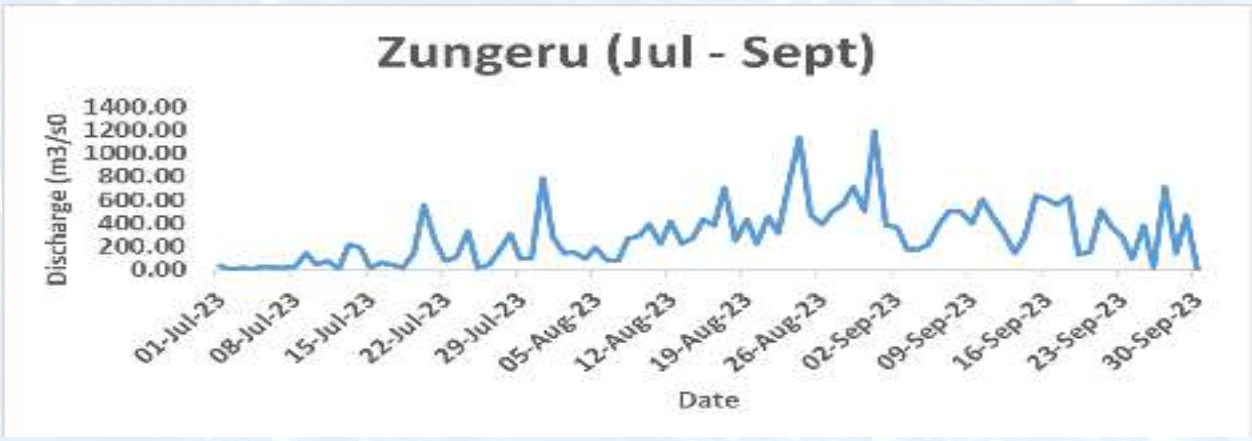
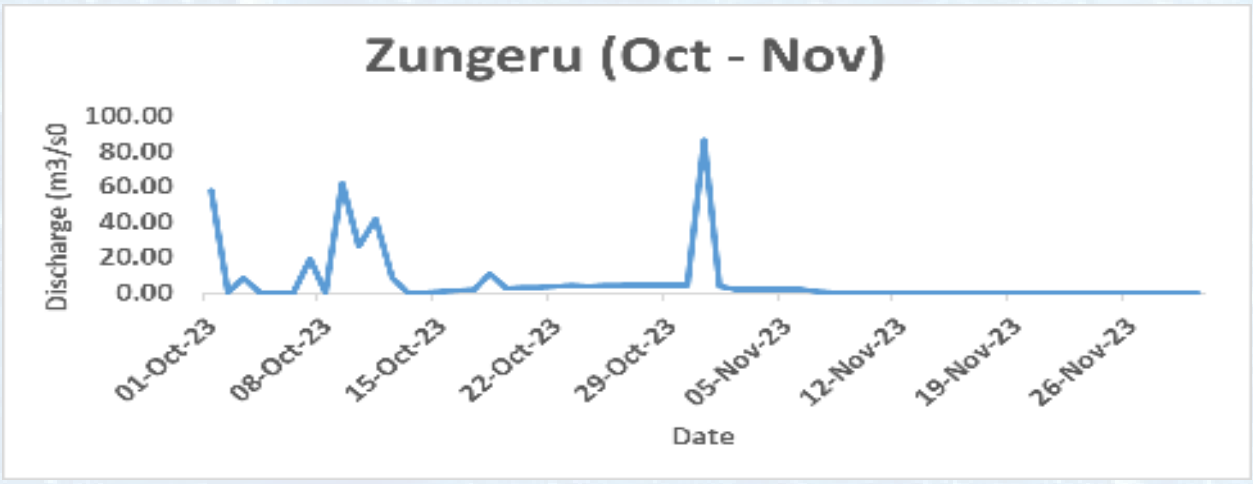
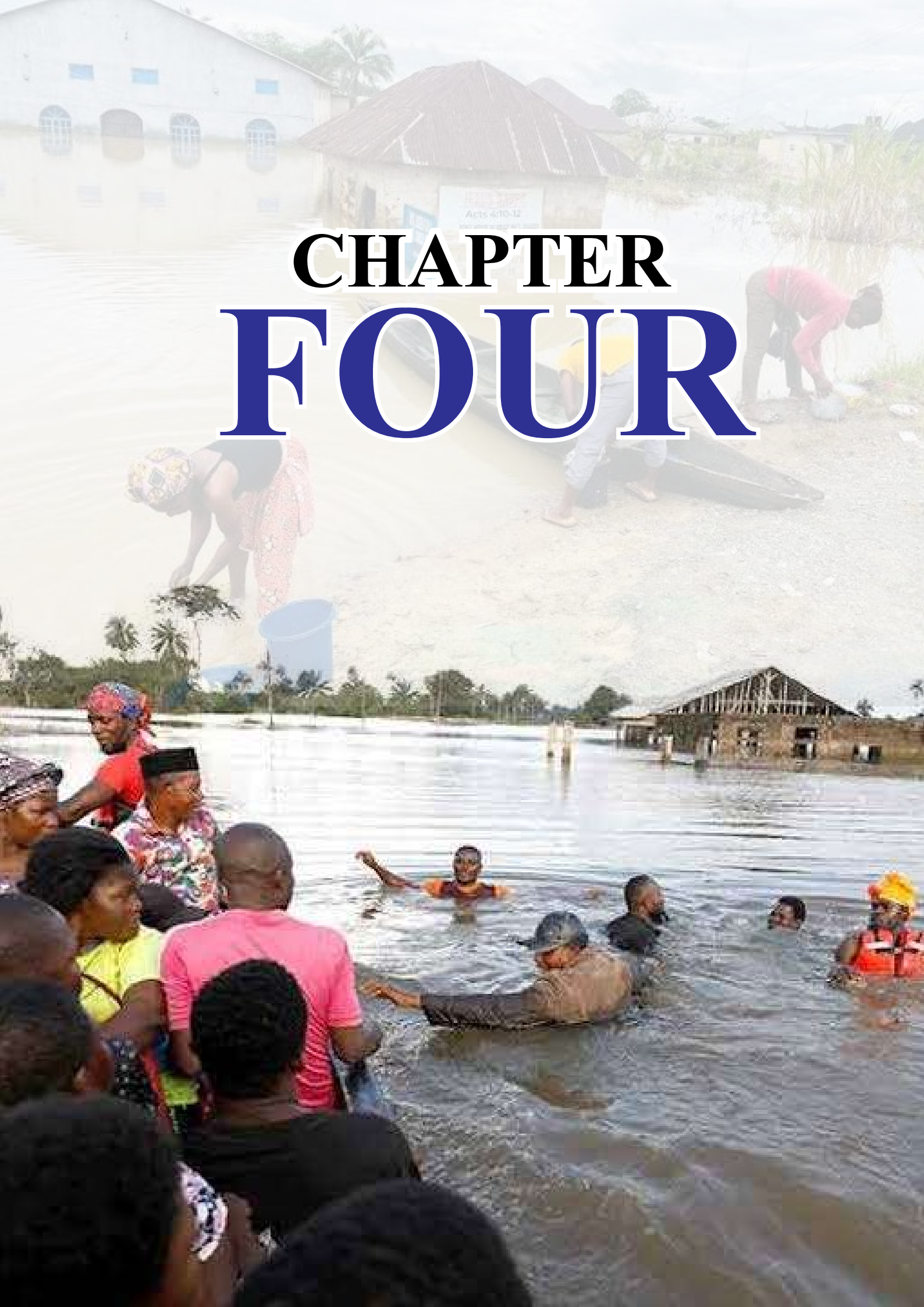
03-Jun-23
10-Jun-23
17-Jun-23
24-Jun-23
Date


Zungeru (Jul - Sept)
Discharge (m3/s0
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
01-Jul-23
08-Jul-23
15-Jul-23
22-Jul-23
29-Jul-23
05-Aug-23
12-Aug-23
19-Aug-23
26-Aug-23
02-Sep-23
09-Sep-23
16-Sep-23
23-Sep-23
30-Sep-23
Date


Zungeru (Oct - Nov)
Discharge (m3/s0
100.00
80.00
60.00
40.00
20.00
0.00
01-Oct-23
08-Oct-23
15-Oct-23
22-Oct-23
29-Oct-23
05-Nov-23
12-Nov-23
19-Nov-23
26-Nov-23
Date



CHAPTER FOUR

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The expectations for flood forecasts in terms of magnitude and timing have grown with the recognition of the importance of flood early warning as a contribution to flood management. Flood early warning relies on "triggers" relating to critical river levels or rainfall amounts that are indicative of flood states approaching or worsening. The triggers initiate certain actions or provision of information to external users. They are used to decide when to undertake certain actions during a flood event and are designed to give enough time to undertake the response action.

Flood disasters, unlike some natural disasters, can be controlled and the impacts mitigated through the use of both structural and non-structural measures. The non-structural measures include flood early warning systems, public awareness campaign and other stakeholders' engagements are highly effective in mitigating flood disaster if the warnings are taken seriously and appropriate measures put in place.
An effective flood early warning system is one that meets the needs of the people at risk of floods. It needs to be people-centred and inclusive. For early warnings to be effective they need to be accessible, easily understood, and actionable by those who are meant to receive them.

Things to consider when designing communications and information dissemination strategies include: people's access to technology, literacy, local languages, and how these factors might differ among groups within the same community. Regular review based on drills and real events should be carried out to identify gaps in flood management strategy and make improvements so early warnings can reach more people who depend on them.

The concept of AFO which is an Adaptation Benefits Mechanism (ABM) is to mobilize sector that is public for climate change adaptation through the identification of flood risk hotspots in the country. This ABM approach creates action that generates adaptation benefits in prominent decisions planning that is affecting development processes of critical sectors of the economy namely: Agriculture, Aviation, Water Resources, Power, Health, Environment and Education amongst others.

The flood scenarios as presented in 2023 AFO are derived from Soil and Water Assessment Tools (SWAT) Model and Digital Elevation Model (DEM). The SWAT model utilizes meteorological, hydrological, topographical data soil water balance indices, while DEM utilizes elevation data.

The 2023 AFO was developed for three sessions during the rainy season in Nigeria. These include:

- Scenario I: Flood Outlook for the Months of April-June (AMJ).
- Scenario II: Flood Outlook for the Months of July – September (JAS)
- Scenario III: Flood Outlook for the Months of October - November (ON)

These three (3) scenarios were cumulatively aggregated to produce the 2023 AFO. The whole essence is to gradually move towards having a dynamic flood forecast, prediction and Early Warning System (EWS) that can spatial-temporally aid developmental activities across sectors in Nigeria.

A total of 66 LGAs fall within the highly Probable risk areas in the months of April, May and June; 148 LGAs in the months of July, August and September; and 100 LGAs in the Months of October and November.

In addition, a total of 41 LGAs fall within the Probable risk areas in the months of April, May and June; 199 LGAs in the months of July, August and September; and 73 LGAs in the Months of October and November.

A total of One Hundred and Seventy-Eight (178) LGAs are predicted to be High Flood-risk for 2023/2024 Hydrological Year while Two Hundred and Twenty-Four (224) LGAs are predicted to fall within Moderate Flood-risk category.

In conclusion, it is advised that the predictions of flood for the year 2023 be adhered to and Government at all levels (Local, State and Federal) should take the recommendations in 2023 AFO seriously and work with NIHSA to ensure a disaster free 2023.

4.2 Recommendations

The 2023 AFO provides a critical review and characterisation of flood risk management (FRM) with a view to providing recommendations for improvement.

The Agency hereby recommends that:

a. An efficient national flood early warning system needs to be implemented at various governing levels: Federal, State and Local - in order to truly address Nigeria's flood situation.

b. Communications and dissemination of AFO information strategies should include people's access to technology, literacy, local languages, and how these factors might differ among groups within the same community.

GLOSSARY

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

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.

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.

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

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.

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.

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.

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.

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 permeability 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 permeability, low elevation areas, and unrestrained/sustained inundation of communities.

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.

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.

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.

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

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.

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

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

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.

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.

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

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.

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

AMJ: April, May, June

AMESD: African Monitoring of Environment for Sustainable Development

ArcGIS: Arc Geographic Information System

AWOS: Automatic Weather Observation Station

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

HBV: Hydrologiska Byråns Vattenbalansavdelning model

HEC-HMS: The Hydrologic Engineering Center, Hydrologic Modeling System

HKYTF: Hadejia Komadugu Yobe Trust Fund

IPCC: Inter-governmental Panel on Climate Change

JAS: June, July August

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

ON: October, November

OSGOF: Office of the Surveyor General of the Federation

PET: Potential Evapotranpiration

RBDAs: River Basin Development Authorities

SCP: Seasonal Climate Prediction

SRTM: Shuttle Radar Topography Mission

SWAT: Soil and Water Assessment tool

USGS/EROS: United States Geological Survey Centre for Earth Resources Observation and Science

USGS: United State Geological Survey

WFP: World Food Programme

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