



INITIATIVE ON
West and Central African
Food Systems Transformation



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Climate Resilience



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Fragility, Conflict
and Migration

Strengthening Anticipatory Action Through Flood Forecasting and Early Warning Systems to Mitigate Flood Impacts in Nigeria



Adebayo Oke, Giriraj Amarnath, Andrew Okem, Moctar Dembele

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The Authors:

Adebayo Oke, International Water Management Institute, Accra, Ghana.

Giriraj Amarnath, International Water Management Institute, Colombo, Sri Lanka.

Andrew Okem, International Water Management Institute, Accra, Ghana.

Moctar Dembele, International Water Management Institute, Accra, Ghana.

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Summary

Flood risks are a major concern in Nigeria, due to their consequences on human life and socioeconomic activities of the people. Floods are induced by high rainfall intensity resulting from climate change. Other factors identified as the drivers of the perennial flooding in Nigeria include, poor drainage systems, poor waste management, unregulated urbanization, weak implementation of planning laws and changes in land use without regard to ecological considerations.

Globally, the frequency and intensity of heavy rainfall events have increased since the 1950s. For each 1°C of global warming, extreme daily precipitation events are projected to intensify by about 7%. It is estimated that flood risks will expand, with three times as many people exposed to the equivalent of a 100-year flood event by the end of this century. Surface water flows and availability will become more variable between seasons and years. Soil moisture levels will decline in some critical farming areas, challenging rainfed agriculture and increasing irrigation needs.

In Nigeria, more than 2.3 million people were displaced, 363 lost their lives and 16 million were impacted in various ways, in 2012. The economic value of the loss was estimated at over US\$16.9 billion. In 2022, another major flood led to the loss of 600 lives and 3.2 million people were affected across 34 of the 36 states of the federation and the Federal Capital Territory. The Nigeria Bureau of Statistics in 2023 reported the devastation to be in the range of US\$3.79 billion to \$9.12 billion. The economic value of the agricultural-related losses due was estimated to be about N700 billion.

Coordinating Institutional Engagement for Flood Forecasting and Early Warning Systems Operation in Nigeria

There is a clear deficit of coordination among the ministries, departments, and agencies of government are responsible for weather and flood forecasting, early warning systems, flood, disaster, water and land resources management, climate resilience, and humanitarian affairs.

In the wake of loss of lives and infrastructure, agricultural land and produce, and widespread pollution of water bodies, the CGIAR Initiative on Transforming AgriFood Systems in West and Central Africa (TAFS) has taken steps to ensure the safety of the country's food systems and improving resilience and better landscape management. The Initiative explored strategic engagements among stakeholders towards addressing the flood early warning systems and anticipatory actions. The International Water Management Institute engaged strategic stakeholders in the water resources and disaster management sectors, to exchange technical information to help mitigate the impact of floods, co-identify Water Resources and Disaster Management Support Systems (WRDSS) and develop a strategy for the implementation of Flood Early Warning System (FEWS) in Nigeria.

IWMI and stakeholders in Nigeria explored the need for Water Resources Decision Support System (WRDSS) to trigger food systems transformation in selected West

and Central African countries. Water resources experts from Burundi, Côte d'Ivoire, Ghana, Rwanda, and Nigeria deliberated on the importance of robust WRDSS in flood management. Through the Mentimeter platform, participants indicated the existing Water DSS in their countries. Existing DSS include Water Evaluation and Planning Model (WEAP), using machine learning through Random Forest, AquaCrop Model, Soil and Water Assessment Tool (SWAT), GMet-WIDS, General Algebraic Modelling System (GAMS), Nimet report, Nile Basin DSS and Catchment-based landscape Restoration Opportunity mapping Decision Support System (CROM DSS).

The meeting identified the need for the implementation of WRDSS and a flood early warning platform, as tools for efficient coordination of relevant agencies, resource mobilization and facilitating responses during flood events.

Early Warning, Action and Finance: Lessons from IWMI's AWARE

The International Water Management Institute's AWARE platform is an appropriate tool that integrates the various institutions and resources in Nigeria. IWMI, promotes disaster risk management options using innovative tools and technologies in Africa and Asia. It has developed flood forecasting tools and drought early warning systems, employing advanced remote sensing technologies in developing countries.

Nigeria's stakeholder institutions have significant capacity and assets to undertake data gathering, analysis, predictions, and modelling scenarios. These in-country capacities also include a significant number of professionals who ensure the quality of operations and delivery of mandates. The NiMET and NIHSA for example, have extensive networks of meteorological and hydrometry stations where data is captured and deployed to their various databases and centres across the country. The NEMA and Federal Ministry of Humanitarian and Disaster Management have the administrative capacity to mobilize finance and other resources for the immediate succor of victims. Over the years, these capacities have been demonstrated, although, experts believe that there are still lapses in the response time, scope and modalities to reach the actual vulnerable people.

The implementation of the AWARE platform in the country will ensure a better coordination of relevant institutions to adopt a useful approach to data sharing, integration and usage, as well as to guarantee a proactive plan of early action and early finance. The 'Early Finance' mechanism ensures that institutions access adequate funding at an early stage of an unfolding extreme climate event. That ensures smooth evacuations, maintains food supply, and protects lives and livelihoods. The deployment of the AWARE platform in Senegal, Sri Lanka and Zambia has enabled a responsive institutional governance structure, ensuring inclusivity and resilience-building which are crucial to the implementation of sustainable FEWS. The platform is an example of an accountability framework that sets out the roles and responsibilities of key actors in ensuring the mechanism to tighten the links between early warnings and response could be sustainably established.

The WRDSS-FEWS workshop discussed issues that have implications for responses to flood challenges in Nigeria. While flood disasters are predictable, a strong synergy among the institutions will ensure a smooth coordination of response activities. Stakeholders strongly recommended the implementation of the AWARE platform as a tool for the integration of the institutions, data assets and other resources towards the implementation of FEWS in Nigeria.

1.0 INTRODUCTION

Floods and droughts are two natural disasters recurrent in Nigeria (UNICEF, 2022). Flood risks have assumed a major concern due to their consequences on human life and the socioeconomic landscape of the nation. Flooding is a major consequence of climate change due to more rain of higher intensity and duration. However, there are other factors identified as drivers of the perennial flooding in Nigeria which include: poor or non-existent drainage systems, increasing urbanization, poor waste management, unregulated urbanization, weak implementation of planning laws and changes in land use without recourse to ecological considerations (Echendu, 2020).

Flooding is a natural disaster; but its occurrences are predictable and could be anticipated. Past flood events have left the government, communities, and people helpless because of inadequate anticipatory planning.

little attention has been paid to flood control and management on a nationwide scale and efforts aimed at addressing the challenge have lacked proper coordination and have been ineffective. Climate-resilient landscapes require adaptation strategies to mitigate natural disasters, especially increased floods.

DEVELOPING A NEW APPROACH TO FLOOD DISASTER MANAGEMENT

The loss of life, infrastructure, agricultural lands and produce, widespread pollution of water bodies and destruction of landscapes compelled the [CGIAR Initiative on Transforming AgriFood Systems in West and Central Africa \(TAFS\)](#) to seek options for safeguarding lands to ensure sustainable food systems. This step is in alignment with the objectives of TAFS-WCA, towards improving resilience and better landscape management. To make the Nigerian hydrological areas and agricultural watersheds more resilient to flood disasters, a more coordinated anticipatory action, timely response to risks and efficient organization of resources will be required. This is currently a challenge in Nigeria. The CGIAR Initiative on TAFS-WCA activities in Nigeria explored strategic engagements among stakeholders to create a joint action towards addressing the flood early warning systems and anticipatory actions.

This report is based on a stakeholder engagement to address gaps in the coordination of and response to flood related disasters in Nigeria. The [International Water management Institute](#) and strategic stakeholders in the water resources and disaster management sectors, exchanged technical information on needs, current practices, and potential areas of collaboration. The aim was to

1. help to mitigate the impact of floods,
2. co-identify Water Resources and Disaster Management Support Systems (WRDSS) and
3. (3) develop a strategy for the implementation of Flood Early Warning Systems (FEWS) towards addressing flood challenges and harnessing available institutional resources in Nigeria.

HISTORICAL TREND OF FLOODS IN NIGERIA

Globally, the frequency and intensity of heavy rainfall events have increased since the 1950s. For each 1°C of global warming, extreme daily precipitation events are projected to intensify by about 7%. Flood risks will expand, with three times as many people exposed to the equivalent of a 100-year flood event by the end of this century. Surface water flows and availability will become more variable between seasons and years. Soil moisture levels will decline in some critical farming areas, challenging rainfed agriculture and increasing irrigation needs. Drought has increased over the last five decades, and the area of land under drought conditions will double by 2050, with between 0.5 and 3.1 billion more people experiencing water scarcity conditions.

In the last 10 years, there has been increased flooding across many states in Nigeria. The disaster risks majorly impacted agricultural production and the livelihoods of people dependent on agriculture. Figure 1 shows the frequency of flood occurrences by states in Nigeria between 2011 and 2020. At least each state experienced one major flood event from 2011-2020 while states of Jigawa (7), Kano (6), Katsina (5), Kebbi (5), Jigawa (7), Niger (8) and Yobe (6) had more than five major floods. Increased variability in intra-annual precipitation will likely increase the frequency and intensity of these events, and increased temperature will raise evapotranspiration.

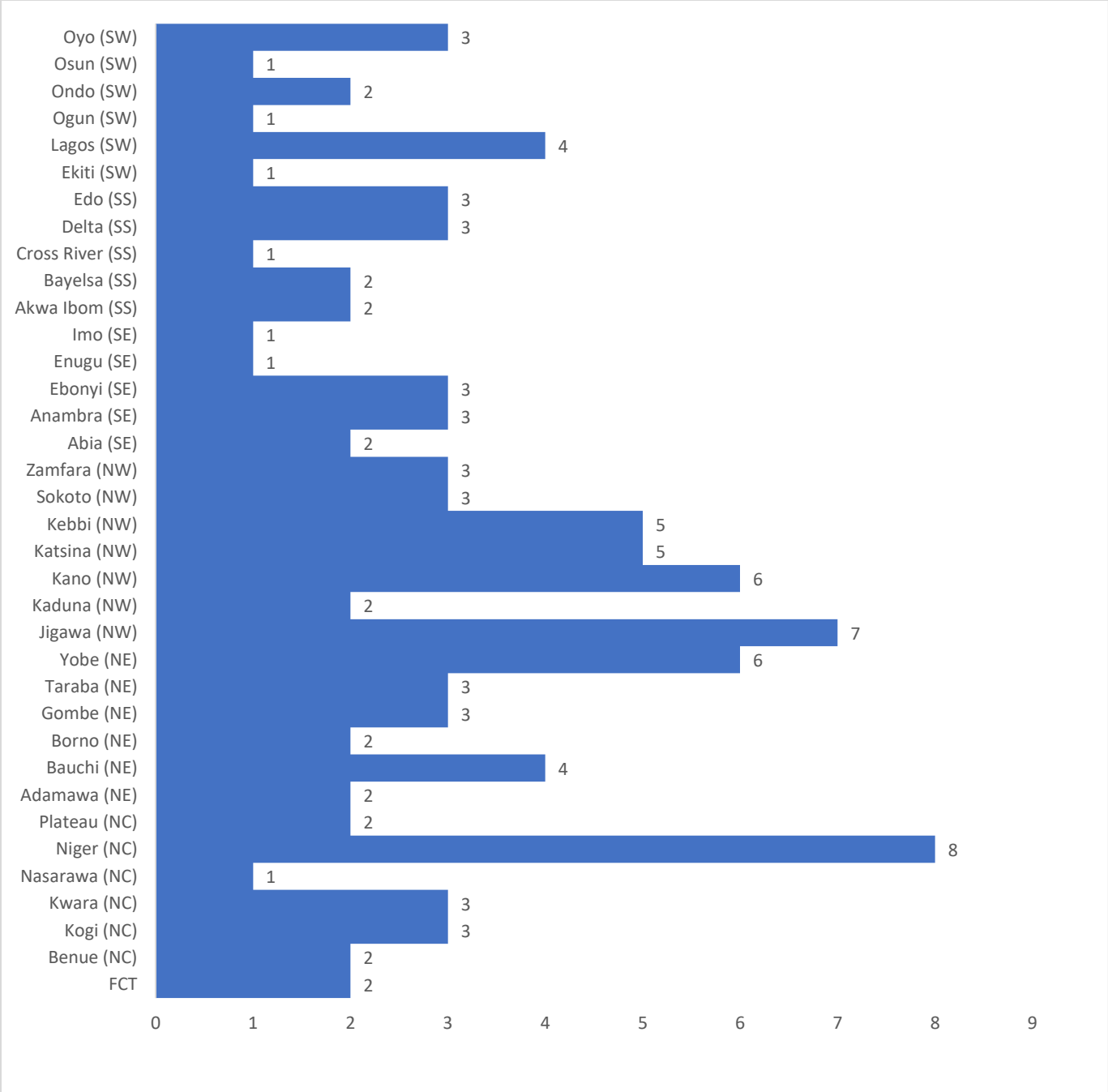


Figure 1: Frequency of flood across states in Nigeria between 2011 and 2020 (Data from Nura and Alison, 2022)

It has been established that nearly all the 36 states in Nigeria are at the risk of flood at different scales. In 2022, floods were recorded in 34 out of the 36 states (NBS, 2023). This level of devastation was predicted earlier by the NIHSA in the 2022 Annual Flood Outlook map (Figure 2). The high-risk probable flood prone areas were identified using the Global Flood Prediction Platform. Unfortunately, because of inadequate anticipatory actions, the eventual flood level recorded followed the

SOCIO-ECONOMIC IMPACTS OF FLOODS IN NIGERIA

The socio-economic impact of floods in Nigeria, has been colossal. In 2012 more than 2.3 million people were displaced, 363 lost their lives and 16 million people were impacted in various ways. The economic value of the loss was over US\$16.9 billion (Echendu, 2020). Again ten years later in 2022, another major flood led to the loss of 600 lives. Also, 3.2 million people were affected across 34 of the 36 states of the federation and the Federal Capital Territory. The Nigeria Bureau of Statistics in 2023 reported the devastating impact of the 2022 flood to be in the range of US\$3.79 billion to \$9.12 billion, with the best (median) estimate at \$6.68 billion, based on total direct economic damages. Agricultural and non-agricultural sectors were severely affected leading to substantial income losses. The economic value of the agricultural-related losses due to the 2022 flood was estimated to be about N700 billion (NAERLS, 2023, NBS, 2023). The devastation affected residential and non-residential houses, and general infrastructure across the country.

The micro-level effects of the losses to households (using household surveys)¹ with a focus on six of the most affected states shows that the impact of the flood was significantly higher in rural areas (74 percent) compared to the urban areas. Expectedly, the overall impact of the flood varied across the selected states. Almost all (99 percent) households interviewed in Bayelsa State were affected by the floods in one way or the other, followed by Jigawa (94 percent), Nasarawa (70 percent), Kogi (70 percent), Delta (57 percent) and Anambra (23 percent). There is also gender disparity in the impact of the floods, with 66 percent of male-headed households affected compared to 57 percent of female-headed households.

¹ The National Bureau of Statistics (NBS) survey on 2022 flood impacts' on households in Nigeria covered the six most affected states of Anambra, Bayelsa, Delta, Jigawa, Kogi and Nasarawa – which accounts for a significant proportion of the total population affected by the 2022 floods. The survey was carried out in collaboration with NBS, NEMA and UNDP (<https://nigerianstat.gov.ng/download/1241417>)

2.0 STAKEHOLDERS ENGAGEMENTS

From May to August 2023, the IWMI team implemented a series of stakeholder consultations.

Virtual Expert Consultation where TAFS explored the need for Water Resources Decision Support System (WRDSS) to catalyze food systems transformation in selected West and Central African countries. Water resources experts from Burundi, Côte d'Ivoire, Ghana, Rwanda, and Nigeria deliberated on the importance of robust WRDSS in flood management. Through the Mentimeter platform, participants indicated the existing Water DSS in their countries. Existing DSS include Water Evaluation and Planning Model (WEAP), using machine learning through Random Forest, AquaCrop Model, Soil and Water Assessment Tool (SWAT), GMet-WIDS, General Algebraic Modelling System (GAMS), NiMET report, Nile Basin DSS and Catchment-based landscape Restoration Opportunity mapping Decision Support System (CROM DSS).

The meeting identified the need for the implementation of WRDSS and a flood early warning platform, as tools for efficient coordination of relevant agencies, resource mobilization and facilitating responses during flood events. These were considered as immediate needs in Nigeria, Rwanda and other countries. It was agreed that the IWMI AWARE Platform has the potential for the coordination of institutions and resources to facilitate flood early warning system in Nigeria and Rwanda (Figure 4).

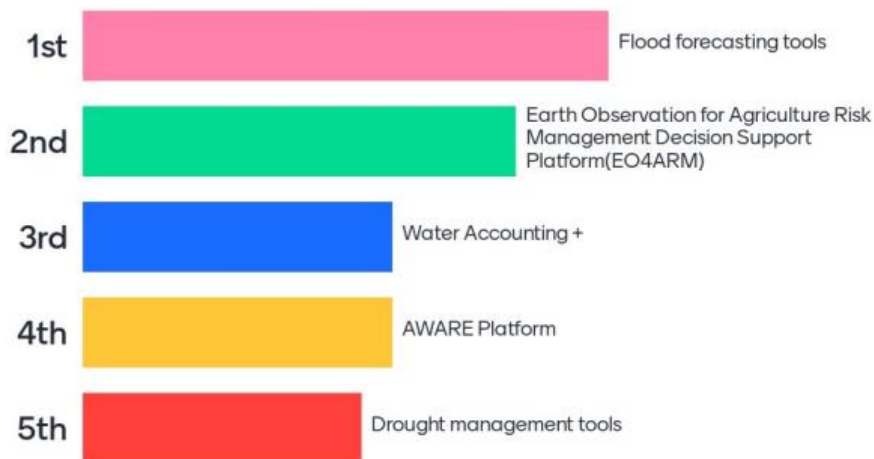


Figure 4: Responses of water resources experts at the regional virtual consultation

Institutional engagements and interviews

Institutional structures, frameworks, assets, and resources as well as operational strategies in the water resources and flood management sectors in Nigeria have been engaged in the period under consideration. The interviews involved the technical and administrative leadership in the institutions .



IWMI Team with NiMET staff



IWMI Team with NIHSA Management and staff



IWMI Team with FMWR-I&D Management & Staff



IWMI Team with Reps of NSRDA

STAKEHOLDERS' WORKSHOP

A major stakeholders' workshop involving about 40 experts (Appendix 1) from institutions, ministries, departments, agencies of the Nigerian government, as well as NGOs, deliberated on flood risks and disasters in Nigeria (Figure 5). The consultative workshop also examined the status of flood early warning systems, institutional capacities, assets, operations and available tools in the country. The stakeholders agreed that various factors are implicated in the current status and practices of early warning, early action and early finance of flood risk management in the country. The experts also considered the AWARE Platform which is being promoted by IWMI as a tool that could be leveraged.



IWMI and stakeholders at consultative workshop

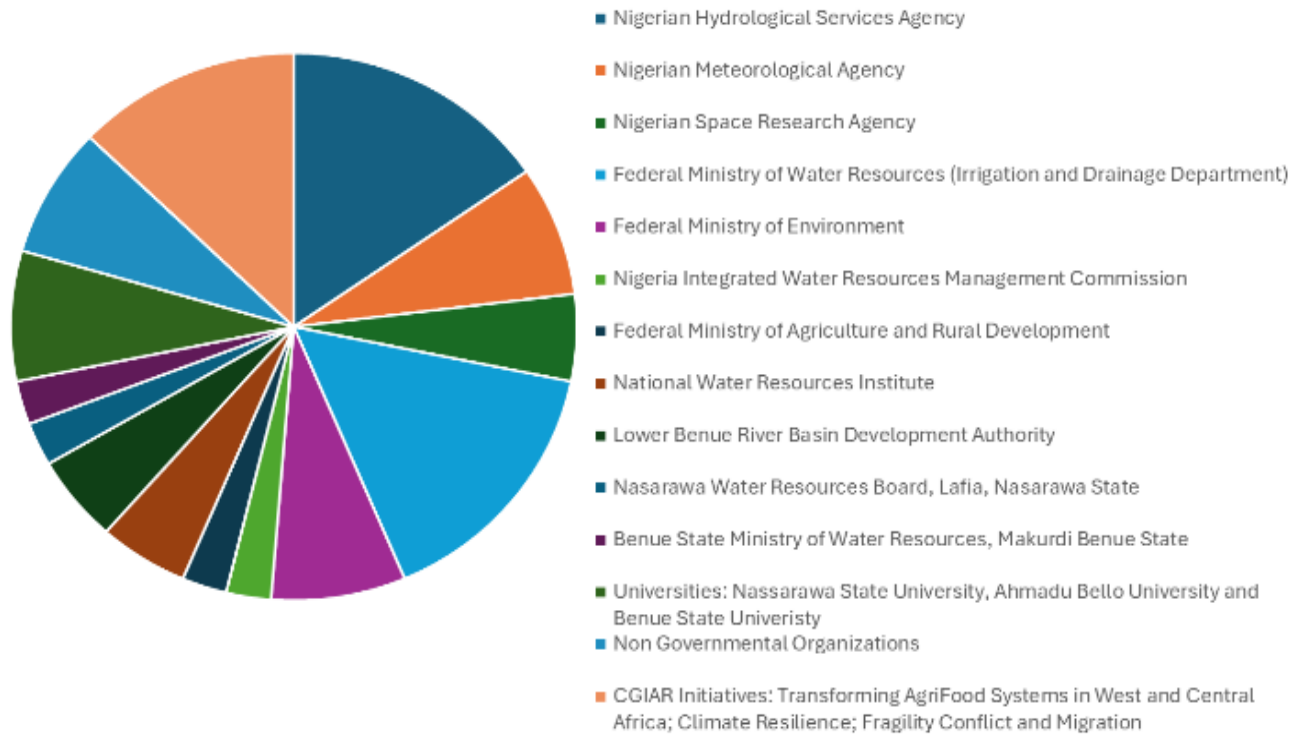


Figure 5. Organizations and number of participants at the Abuja consultative Workshop on FEWS

3.0 STRATEGIES FOR FLOOD FORECASTING AND EARLY WARNING INTEGRATION

INSTITUTIONS RESPONSIBLE FOR FLOOD FORECASTING AND EARLY WARNING SYSTEMS OPERATION IN NIGERIA

Several ministries, departments, and agencies of government are responsible for weather and flood forecasting, early warning systems, flood and disaster management, water and land resources management, climate resilience, disaster management and humanitarian affairs. Table 1 highlights their respective mandates, as well as areas of major operations.

Among the critical stakeholders in Nigeria's water resources and disaster management sector, the NIHSA, NiMET and FMEnv can provide flood predictions and early warning to the stakeholders. The NIHSA has the capacity to provide flood outlook including probable inundation area down to Local Government and community level. NIMET provides weather forecast and the implications for flooding, probable risks and disaster across the country.

Table 1: Major Institutions in Water Management, Flood and Early Warning System in Nigeria

		Tasks							
		Climate data	Hydrometry	Climate information services	Flood forecasting	Early warning	Early mitigation actions	Finance mobilization	Public awareness
Institution	Major mandates								
Nigerian Meteorological Agency	<ul style="list-style-type: none"> All aspects of meteorology – aviation, agriculture marine and maritime, water resources, disaster management, oil and gas, environment sectors and General advisories to the Government 								
Nigerian Hydrological Agency	<ul style="list-style-type: none"> Assessment of Nigeria’s surface and groundwater resources – quantity, quality, distribution, and spatial characteristics, Flood forecasting and prediction of inundation across rivers and catchments 								
Federal Ministry of Environment – Flood and Erosion Control Department	<ul style="list-style-type: none"> Flood prediction, early warning system establishment and implementation, erosion control, Awareness creation on flood and early actions 								
National Space Research and Development Agency	<ul style="list-style-type: none"> Development of indigenous capabilities in space science and technology, providing satellite data and services – early warning signals of environmental disaster; national planning, and Advisories to the government 								
Federal Ministry of Humanitarian and Disaster Management	<ul style="list-style-type: none"> develop humanitarian policies and provide effective coordination of National and International humanitarian interventions. 								

Federal Ministry of Water Resources – Irrigation and Drainage Department	<ul style="list-style-type: none"> • Implementing irrigation and drainage programs and policies of the Federal Government of Nigeria 								
National Emergency Management Agency	<ul style="list-style-type: none"> • Coordinating federal emergency preparedness, planning, management, and disaster assistance functions 								

The NIHSA Annual Flood Risk Outlook

One of the major responsibilities of the National Hydrological Services Agency (NIHSA) is to provide information on the flood outlook and predictions in Nigeria. The NIHSA Annual Flood Outlook (AFO) provides a comprehensive view of the national flood risk in Nigeria. These risk classifications allow stakeholders, policymakers and government departments to take appropriate action to ensure flood preparedness (GPF, 2020). The NIHSA provides flood risks at the Local Government level. Key risk zones and communities could also be identified. The States and LGAs that were predicted to be vulnerable in the year 2020 were flooded in the flood events of 2022 (Figure 3).

NiMET Weather Predictions

The NiMET uses a three-prong approach to addressing the issues of flood early: 1) Climate monitoring, 2) forecasting for early warnings, and timely dissemination of vital information on impending disasters and 3) providing early warning and advisory services on severe meteorological phenomena especially extreme weather and climate events that could lead to disasters.

NiMET processes rainfall Intensity Duration Frequency Curve (IDF), carrying out studies in collaboration with stakeholders on weather-related issues i.e. floods, drought and desertification. The organization publishes and disseminates different bulletins on Flood and Drought and Hydrometeorological Bulletins. The NiMET is the knowledge hub for government and contributes relevant hydrometeorological information to the Ministries, Departments and Agencies (MDA) on climate studies and decisions.

-Flood Forecasting and Erosion Control Department - The Federal Ministry of Environment

This department

- carries out Flood Risk and Vulnerability Studies and Mapping of Nigeria
- produces Flood Vulnerability Maps for the twelve River Basins in the country.
- Identifies floodable areas/settlements at risk in the country.

In one of the projects carried out in collaboration with the UNDP in 2009, suitable locations within hydrological areas nationwide where observation stations for the Flood Early Warning Systems can be sited, were identified.

Over the years, NiMET, NIHSA and FMEnv have executed projects of major national importance relating to flood predictions and management. The UNDP, BMGF and World Bank are among the donor agencies that have shown interest in flood disaster management and coordination in Nigeria.

Despite the existence of these institutions, flooding has exacerbated across the country. Stakeholders are unanimous in identifying synergy, platform for coordination and partnership as lacking among these institutions. This is evident in

the inadequate preparedness, resource mobilization strategies, weak intervention management and responses/actions. Similarly, Nigeria has not been able to develop a functional national Flood Risk Management (FRM) strategy and comprehensive flood risk maps. Flood management requires the development of wholistic strategies and platforms that enable the coming together of the technical and non-technical institutions.

DEPLOYING AVAILABLE TOOLS: IWMI AWARE PLATFORM

Harnessing relevant tools and resources within the national institutions as well as support from the development partners is critical to addressing the coordination of national response to floods in Nigeria. The responses of the participants during the consultation further buttressed the need to improve on synergy, partnership, and the development of appropriate coordinating platforms to build an inclusive and sustainable FEWS in Nigeria (Table 2).

The International Water Management Institute’s AWARE platform was considered an appropriate tool that can bridge this gap of synergy and integration of institutions and resources in Nigeria. IWMI, promotes disaster risk management options using innovative tools and technologies in Africa and Asia. IWMI has developed flood forecasting tools and drought early warning systems, employing advanced remote sensing technologies in developing countries (e.g., South Asia Drought Monitoring System [SADMS]², Early Warning, Early Action, Early Finance [AWARE], etc.).

Table 2: Stakeholder observation on available tools, challenges and building sustainable FEWS in Nigeria

<i>What systems and tools do we have for flood management in Nigeria?</i>	<i>The Key Challenges and gaps in flood management and disaster preparedness in Nigeria</i>	<i>How can the challenges and gaps be addressed?</i>	<i>How can we build an inclusive and sustainable FEWS for Nigeria?</i>
<ul style="list-style-type: none"> • NIHSA – Global Flood Prediction Partnership, SWAT, HEC, WEAP • European Union Open HEC Model, NiMET SCP, Model from Swedish Meteorological Agency, • NiMET Seasonal Climate Predictions – of weather, rainfall, flood and drought, • High Impact Rainfall Predictions – focusing on flash floods (3 times weekly) • NSRDA – Satellite data, Grade 3 platform although with little on flood. Readiness to partner with other stakeholders. 	<ul style="list-style-type: none"> • Poor uptake of the prediction by the public and SEMA (State Emergency Management Agencies) • Sometimes people refuse to obey the early warning because of the historical attraction to the ancestral lands • Wrong perception about disaster management – it is often seen from the perspective of relief distribution which has 	<ul style="list-style-type: none"> • Need to create a national platform that brings all the stakeholders together. • Closer engagement with stakeholders and users of products and predictions • Engage Indigenous and Local Knowledge holders – they have their way of relating and passing weather information across the community. 	<ul style="list-style-type: none"> • Strengthening the Presidential Committee on Flood Prevention in Nigeria • Ensuring that all stakeholders subscribe to the national report produced and submitted to the President. • Develop a governance structure based on Anticipatory Policy Action Plan which must be owned by the government and policy authorities. • The voice of the people should be captured in the FEWS.

² <https://dmsdemo.iwmi.org/home>

<ul style="list-style-type: none"> • National Geospatial Infrastructure with geospatial data available for all the stakeholders • NEMA is transitioning from relief management to support structural measures. Collaborating with other stakeholders to address flood issues beyond relief materials distribution • AWARE Platform – that works with stakeholders by collating local/national available data together. An interface that integrates credible data to arrive at actionable decisions and enable coordination. 	<p>implications for proactive actions to address the causes</p> <ul style="list-style-type: none"> • Weak political commitment to go the extra mile to address the issue – from structural systems, • Bureaucracy of government agencies and users of products. • Corruption across national systems/structures – people want to take advantage of the system • Poor funding of research and development • Fragmentation of mandates and poor integration of the agencies • • 		<ul style="list-style-type: none"> • Enhance accountability, political stability, control of corruption, government effectiveness and commitment to the action plan • Appropriation and funding for flood early warning, early actions, and related activities in Nigeria
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Box 1

Outcome of Engagements 1

Floods in Nigeria have become perennial. Partly due to the impact of the climate change and because of human’s wrong attitudes to the environment. The devastation, and setbacks that floods bring to the achievement of sustainable developmental goals in Nigeria are colossal and should not be allowed to continue. A renewed determination is expected of government, institutions, people and communities to address the menace of floods in Nigeria and the starting point is the collaboration among the stakeholders to develop Flood Early Warning Systems for the country. Partnering with the International Water Management Institute on the implementation of the AWARE platform is a major opportunity that should be explored.

AVAILABLE CAPACITIES AND ASSETS

The institutions have significant capacities and assets to undertake data gathering, analysis, predictions and modelling scenarios. Table 3 contains the details of Assets, the type of data the institutions can generate, their strength in predictions of weather and extreme events as well as modelling of scenarios. These in-country capacities also include a significant number of professionals who ensure the quality of operations and delivery of mandates.

The NiMET and NIHSA have extensive networks of meteorological and hydrometry stations where information is captured and delivered to their various databases and centres across the country. The NEMA and Federal Ministry of Humanitarian and Disaster Management have the administrative capacity to mobilize finance and other resources for the immediate succor of victims. Over the years, these capacities have been demonstrated, although, experts believe that there are still lapses in the response time, scope and modalities to reach the actual vulnerable people.

Table 3: Capacities and Assets existing within institutions towards FEWS in Nigeria

	Nigeria Hydrological Services	Nigerian Meteorological Agency	Federal Ministry of Environment – Flood Early Warning and Erosion Control Department	Nigerian Space Research Development Agency	National Emergency Mgt. Agency
Assets	NIHSA has 279 Hydrometric River Gauging Stations across the country and working towards meeting the World Meteorological Organization’s minimum network density of 482.	<ul style="list-style-type: none"> ▪ 54 Synoptic Stations (22 Airports; 4 major Airports (Abuja, Kano, PHC and Ikeja) ▪ 113 higher institutions/research institutes ▪ 1 Central Forecast Office (CFO) ▪ 8 Upper-Air stations ▪ 6 RADAR stations ▪ 43 TAHMO NiMET AWS ▪ 33 WAGTECH AWS ▪ 14 BARANI AWS ▪ Calibration Lab (Hqtrs.) ▪ Air quality stations ▪ 3 AgroMet stations ▪ 12 Marine stations ▪ NEWMAP AWS stations ▪ TRIMIMG AWS Stations. ▪ 	<ul style="list-style-type: none"> ▪ Community-based FEWS (CBFEWS) ▪ Pilot programmes – 17communities in 17 states ▪ Truncated trapezoidal monument 5nos (NWRI) ▪ Web-based FEWS <ul style="list-style-type: none"> ○ Central hub ○ Online data ○ Modeling ○ ArcGis ○ Forecast data – 302 communities with a 5-day lead time ▪ Automated FEWS <ul style="list-style-type: none"> ○ Central hub –download ○ Outstation- equipment and sensors ○ Real-time data ○ Live feeds of rivers water level ○ River flood forecasting 	<ul style="list-style-type: none"> ▪ Satellite data ▪ NigeriaSAT-1 ▪ NigeriaSAT- 2 ▪ NigeriaSAT-X ▪ NigeriaEdu SAT 	Active administrative structure across the states
Data	Available hydrological data include – Stage, discharge, sediment yield, surface water quality and river profile, groundwater level/aquifer fluctuations, aquifer characteristics and groundwater quality across Nigeria	NiMET conducts Seasonal Climate Predictions (SCP). The SCP is published in different formats – Brochures, Pamphlets, and Journals, on the NiMET websites, and via NiMET App and social media handles. Regular stakeholder meetings are held with the state authorities, NGOs, CBOs etc. to break down the predictions to the public for necessary actions.	<ul style="list-style-type: none"> ▪ Flood Risk and Vulnerability Studies and Mapping of Nigeria ▪ Produced Flood Vulnerability Maps for the twelve River Basins in the country. ▪ Floodable areas/settlements at risk in the country were identified. ▪ Suitable locations within hydrological areas nationwide where observation stations for the Flood Early Warning Systems can be sited were identified. 	<ul style="list-style-type: none"> ▪ Remote sensing data on land, air and water resources and their associated problems ▪ Satellite meteorology to study atmospheric and weather sciences using satellite data to facilitate the effective management of our environment. 	<p>Work in partnership with Federal and state agencies</p> <p>Social Registers of Vulnerable Groups</p> <p>Demographic and disaggregated data on disaster incidences in Nigeria</p>
Predictions	Conduct flood forecasting to give early warnings to mitigate the likelihood of risks and threats by disasters, which are often compounded by the socio-economic	The hydrometeorology unit of NiMET provides critical advisories to various sectors, including Marine and Maritime, Water Resources, Disaster Management, Oil and Gas, Building and Construction, Agriculture, and Environment in Nigeria	Flood predictions and issuing early warning alerts. E.g. a 5-DAY FLOOD EARLY WARNING FLOOD PREDICTION		

	vulnerability of the population exposed to the hazards.				
Modelling	Flood forecasting models/tools are:				

ENABLING LAWS AND POLICIES

There is no principal legislation whether at the national or state levels dealing primarily with flood disasters in Nigeria (Adebayo, 2014). But there are relevant laws governing the management of natural resources in Nigeria. The management of floods is part of the laws establishing these institutions listed in Table 3. The laws establishing NEMA and NESREA specifically address the issues of flooding in Nigeria.

National Emergency Management Agency (Establishment)

The Act generally deals with natural disasters without any special provision to tackle the menace of flooding. The agency is to perform some functions among which relevant ones to flooding are: (a) educate and inform the public on disaster prevention and control measures (b) distribute emergency relief materials to victims of natural or other disasters and assist in the rehabilitation of the victims where necessary. (c) liaise with the United Nations Disaster Reduction Organisation or other international bodies for the reduction of natural and other disasters. (NEMA, 2004)

National Environmental Standards and Regulations Enforcement Agency (Establishment) Act 2007

The Agency is charged with the responsibility for the protection and development of the environment in Nigeria. The Act is not a law designed primarily to address the problem of flood disasters in Nigeria. However, the Act tersely refers to the issue of floods in sections 8 and 26. (NESREA, 2007)

The enabling laws establishing NiMET, NIHSA and NSRDA equally empower these organizations to conduct their operations in a way to provide needed frameworks, data, guidelines, flood predictions and appropriate policy directions on possible control in Nigeria.

At the Federal and States levels, there are adequate laws policies on land use, land planning, urban development, and waste management that have implications for the control of flooding in Nigeria. It was generally agreed that many of these regulations are not implemented as expected which further contributes to the problem of flooding in Nigeria.

Box 2 ***Outcomes of Engagement 2:***

To combat the menace of floods in Nigeria, experts from the FEWS workshop observed that there is need for a legislation to enforce compliance with existing environmental management laws. Strong coordination of various institutions and implementation of existing regulations and laws is crucial. People and institutions must play their roles. Also, a strong platform to create synergy among the institutions for data sharing and the establishment of an operational Flood Early Warning and Early Action System

4.0 EARLY WARNING, EARLY ACTION EARLY FINANCE: LESSONS FROM AWARE EXPERIENCE

The stakeholders in Nigeria observed that the implementation of the AWARE platform in the country will (1) ensure better coordination of relevant institutions (2) adopt a useful approach to data sharing and integrate data and uses and (3) guarantee a proactive plan of early action and early finance (Figure 3). Other benefits of AWARE were further considered as having strategic importance to FEWS implementation in Nigeria. For instance, based on nationally available data, AWARE equally can evaluate the Return Period, also known as extreme event analysis, to understand how often a specific event, like a flood, is expected to happen. This helps to plan and prepare for such events. It also provides the Drought-Standardized Precipitation Index useful inputs for flood and drought triggers for agencies to prepare timely early action plans (Figure 6).

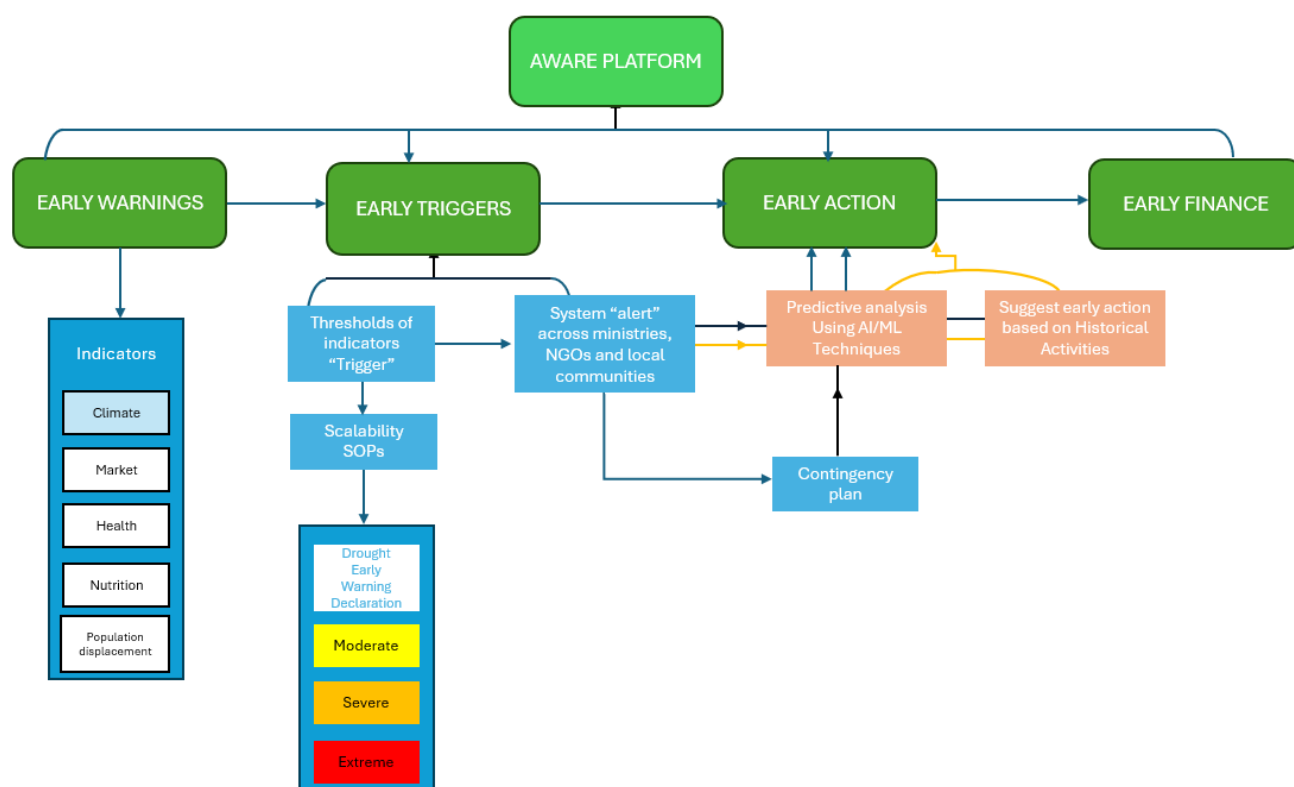


Figure 6: Framework for the operation of the AWARE Platform

EXPERIENCES FROM THE OPERATION OF THE AWARE PLATFORM

The AWARE Platform helps countries overcome the challenges of weak institutional integration, poor climate governance and inadequate responses to extreme weather events. It enables responses to extreme climate events in advance to protect people before disasters strike based on early warning to early action and finance. 'Early Warning' capability enables authorities to access indicators related to the environment, food prices, water-related diseases,

nutrition, and population displacement, so that they can anticipate and monitor the impact of climate shocks. The 'Early Action' facility summarizes actions to be taken under specific scenarios indicated by the Platform's Early Warning tools. The 'Early Finance' mechanism ensures that institutions access adequate funding at an early stages of an unfolding extreme climate event. This ensures smooth evacuations, maintains food supply, and protects lives and livelihoods (Figure 7)

The implementation of the AWARE platform in Senegal, Sri Lanka and Zambia has enabled a responsive institutional governance structure, ensuring inclusivity and resilience-building which are crucial to the implementation of sustainable FEWS. The platform is an example of an accountability framework that sets out the roles and responsibilities of key actors in ensuring the mechanism to tighten the links between early warnings and responses and how these could be sustainably established.

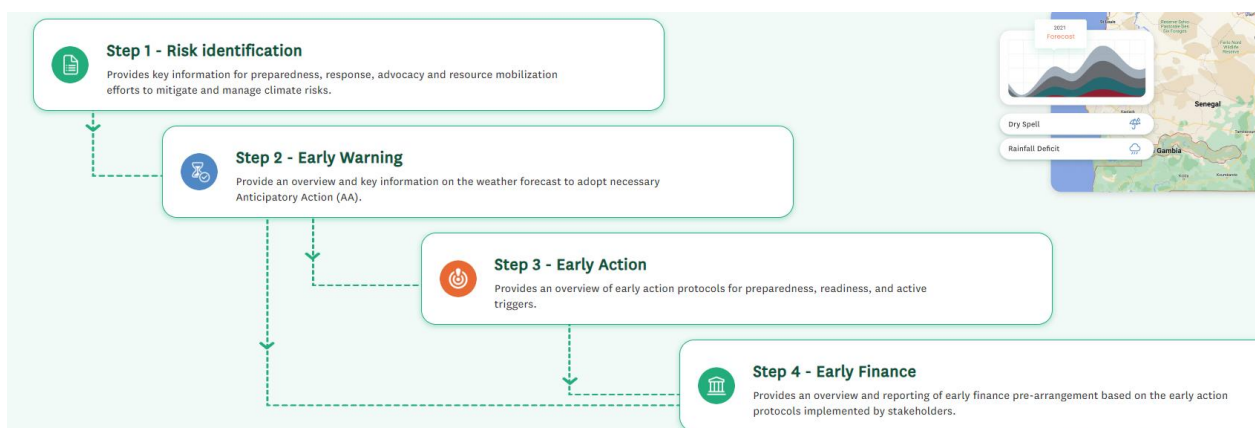


Figure 7: Steps in the operation of the AWARE

THE APPLICATION OF AWARE IN NIGERIA

The effective introduction and implementation of the AWARE Platform in Nigeria necessitates collaborative efforts and a strong partnership among stakeholders. Operationalising. AWARE in Nigeria follows five critical steps :

- Conducting AWARE Feasibility
- Consultation with Relevant Departments/Ministries
- Consultation with Relevant Departments/Ministries
- Joint Implementation of Simulation
- Capacity Building Plans

The AWARE platform uses nationally available data to promote multilevel governance for anticipatory disaster mitigation responses and proactive/informed decisions. It enables and facilitates coordination across ministries to trigger action and investment ahead of an extreme climate event, providing a better response to the needs of those affected. The AWARE platform is based on

- interconnectedness of early warning early action
- near real-time data indicators (floods, drought) for climate risk preparedness and promotion of anticipatory response mechanisms.

- collaborative platforms across multi-institutions, multi-scale and multi-sector
- promotion of inclusive governance and clear roles and responsibilities.
- ability to integrate with the existing platforms and data from national infrastructure and systems.

Onboarding all strategic partners and institutions through the Abuja workshop is the first step in the right direction. Follow-up consultations, co-designing of the AWARE platform adapting it to the Nigeria context, joint simulation and scenarios studies and capacity building of institutions and personnel across ministries, departments and agencies are the next steps.

The renewed drive indicates a new paradigm in the flood early warning system in Nigeria.

CONCLUSION

The WRDSS-FEWS workshop had a robust discussion on issues that have limited adequate and proactive responses to flood challenges in Nigeria. While flood disasters are predictable, synergy among the institutions has become imperative. The workshop strongly recommended the implementation of the AWARE platform as a tool for the integration of the institutions, data assets and other resources towards the implementation of FEWS in Nigeria. The needed multi-agency, multi-sector, and omnibus platforms for the coordination of flood control and responses can be achieved through the synergetic implementation of AWARE in Nigeria. It can move the country's flood response from reactionary to proactive management.

REFERENCES

- Adebayo W. A. (2014). Environmental Law and Flood Disaster in Nigeria. *International Journal of Education and Research* (2) 7, pp 447 – 468
- Echendu A. J., (2020). The impact of flooding on Nigeria’s sustainable Development Goals (SDGs) *Ecosystem Health and Sustainability*, 6 (1), 1791735 <https://doi.org/10.1080/20964129.2020.1791735>
- Global Partnership for Flood (GPF). (2020). Enhancing Nigerian National Flood Management using Global Flood Hazard Maps. Policy Brief. https://globalfloodpartnership.org/sites/default/files/2020-04/GFP_Policy_Brief.pdf
- NAERLS, 2023. <https://naerls.gov.ng/2023/02/naerls-presents-report-of-the-impact-of-2022-flooding-on-agriculture-to-honourable-minister-fmard/> (Accessed October 21, 2023)
- National Bureau of Statistics (NBS). (2023). Nigeria Flood Impact, Recovery and Mitigation Assessment Report 2022-2023. <https://nigerianstat.gov.ng/download/1241417>
- National Emergency Management Agency (NEMA). (2004) (Establishment etc. Act cap No LFN 2004)
- National Environmental Standards and Regulations Enforcement Agency (NESREA) Establishment Act (2007) <https://lawsfnigeria.placng.org/laws/nesrea.pdf>
- Nura U. and Alison G. (2022): Flooding in Nigeria: a review of its occurrence and impacts and approaches to modelling flood data, *International Journal of Environmental Studies*, DOI: 10.1080/00207233.2022.2081471
- UNICEF, 2022 : <https://www.unicef.org/press-releases/more-15-million-children-risk-devastating-floods-hit-nigeria#:~:text=According%20to%20UNICEF's%20Children's%20Climate,scond%20out%20of%20163%20countries>

APPENDIX 1

Institutions that participated in the Workshop

Institutions	No of Participants
Nigerian Hydrological Services Agency	6
Nigerian Meteorological Agency	3
Nigerian Space Research Agency	2
Federal Ministry of Water Resources (Irrigation and Drainage Department)	6
Federal Ministry of Environment	3
Nigeria Integrated Water Resources Management Commission	1
Federal Ministry of Agriculture and Rural Development	1
National Water Resources Institute	2
Lower Benue River Basin Development Authority	2
Nasarawa Water Resources Board, Lafia, Nasarawa State	1
Benue State Ministry of Water Resources, Makurdi Benue State	1
Universities: Nassarawa State University, Ahmadu Bello University and Benue State Univeristy	3
Non-Governmental Organizations	3
CGIAR Initiatives: <ul style="list-style-type: none"> • Transforming AgriFood Systems in West and Central Africa • Climate Resilience • Fragility Conflict and Migration 	5
Total No of Participants	40

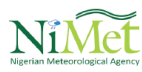


Strengthening Anticipatory Action through Flood Forecasting and Early Warning Systems to Mitigate Flood Impacts in Nigeria

Stakeholder Workshop on Water Resources Decision Support Systems and Flood Early Warning Systems (WRDSS-FEWS) for Nigeria

Casa de Lucy Hotel, Abuja, Nigeria

August 9, 2023



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AGENDA

Time	Item	Facilitator/presenters
Arrival		
9.00 - 9.05 am	Welcome remarks and agenda setting	Facilitator
9.05 - 9.10 am 9.10 - 9.15 am	Opening remarks	Engr. Clement Nze (Fellow of the Nigerian Society of Engineers), Director General, Nigeria Hydrological Services Agency IWMI Representative
9.15 - 9.30 am	Goodwill messages	
3 minutes	National Space Research and Development Agency	Director
3 minutes	Federal Ministry of Communications and Digital Economy	Director of Telcos
3 minutes	National Emergency Management Agency	Director
3 minutes	Federal Ministry of Water Resources, Department of Irrigation and Drainage	Director, Irrigation and Drainage
3 minutes	Representative of a nongovernmental organization	Working In flood risk disaster management
9.30 - 9.45 am	Status of FEWS in Nigeria: Way forward	Nigerian Meteorological Agency
9.45 - 10.00 am		Nigeria Hydrological Services Agency
10.00 - 11.00 am	Panel discussion	Nigerian Meteorological Agency International Water Management Institute (IWMI) National Space Research and Development Agency Nigeria Hydrological Services Agency National Emergency Management Agency
11.00 - 11.15 am	Tea break	
11.15 - 11.40 am	Early Warning Early Action Early Finance (AWARE) platform	Dr. Giriraj Amarnath, IWMI
11.40 am - 12.00 pm	General discussion	Questions and answers
	Breakout session	Three groups
12.00 - 2.00 pm	Communication of climate information Sustainability of FEWS Institutional support	Participants discuss these topics in at least three syndicate groups
2.00 - 3.00 pm	Lunch	
3.00 - 4.00 pm	Co-develop an implementation plan of action	Giriraj Amarnath and Moctar Dembélé, IWMI
4.00 - 4.30 pm	Closing remarks	IWMI