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Geostrategic Plan for Mitigation of Flood Disaster in Nigeria

Olomoda I. A.

Niger Basin Authority, Niamey, Niger Republic.
E-mail: olomoda_ibraheem@yahoo.com

Abstract

Nigeria is geographically located downstream river Niger and Benue that takes their sources from Guinea and Cameroun respectively. Both rivers discharge into the country by forming a confluence at Lokoja. The Niger basin has a total active catchment area of about 1.5 million km² and usually subdivided into the Upper Niger, Inland Delta, Middle Niger and the Lower Niger basins. Nigeria is located in the latter covering about 30% of the Niger basin total catchment area. There are two types of floods in the Niger basin; the first is known as the White floods which usually occur during the rainy season with a peak flood flow occurring between July and September and the second is the Black flood emanating from Guinea with maximum flood flows occurring between December and January. Consequently Nigeria with over 80% of the population of the Niger basin that represents about 60% of the country's population and located downstream has been continually inundated by the persistent floods from both the Niger and the Benue with many loss of lives and properties. However, the Niger Basin Authority (NBA) in Niamey, created by its 9 member countries including Nigeria, established a satellite controlled Data Collection Platform (DCP) located along the river Niger and the Benue catchment areas in the country. The DCP collects flow data at every station every 1 hour of a day and transmit every 3 hours through the EUMETSAT satellite. Flood flows can therefore be monitored and downloaded from these hydrological network stations as well as disseminated through the Internet. This paper therefore, takes critical analyses on the use of the satellite controlled DCP to mitigate the impact of the persistent flood disaster that is causing loss of lives and properties in the country.

Key words: River Niger, River Benue, White and Black Floods, Confluence, downstream, inundation, Data Collect Platforms, Satellite, Monitoring, Dissemination, Internet.

Introduction

River Niger is 4,200 km long, making it the third longest river in Africa and the 14th longest in the world. Its basin area of about 1.5 x 10^6 km² makes it the world's ninth largest river basin. This geographical basin covers wide range of tropical forests, woody savannahs, permanent wetlands and vast desert zones. The river Niger is the source of water for over 100 million people of the basin and a major source of hydropower generation and food crop production in the West African sub-region. The intensive fishing and navigation in the river improves the socio-economic development of the people. It also provides habitats for over 130 aquatic species, including fish varieties, hippopotami, crocodiles, sea-cows and birds, while its unique vegetal cover, lakes and reservoirs, create a humid zone for the habitats in the Niger basin. The Niger basin covers 9 Countries of West and part of Central Africa in the following proportions; Benin (2%), Burkina (4%), Cameroun (4%) ,Chad (1%), Cote D'Ivoire (1%), Guinea (6%), Mali (25%), Niger (21%) and Nigeria (32%) as shown in Figure 1. These countries constituted the Niger Basin Authority (NBA) member States. The NBA's primary objective is the promotion of cooperation among the member countries and ensuring integrated development of the basin in all fields notably; energy, water resources, agriculture, transportation, communications and industry. Other objectives are: to harmonize and coordinate national policies on resources in the Basin; to carry out the development of the basin by preparing and executing an integrated development plan; and to design, realize, exploit and maintain common work projects. The NBA has carried several integrated water resources developmental projects for the enhancement of sustainable development of the Niger basin. Among these project is the Niger-HYCOS project, which is also a component of the World Hydrological Cycle Observing System (WHYCOS) of the World Meteorological Organization (WMO). The Niger-HYCOS project aims at setting up an information system on water resources, collect adequate and reliable hydrological data, and reinforce regional cooperation among the NBA member countries. It also reinforces the technical and institutional capacities of National Hydrological Services (NHS) of the NBA member Countries, manages the hydrological observation networks, provides the storage of hydrological data in its databank, established the hydrological databank for the member countries, produces a Monthly Bulletin and Hydrological Year books, as well as special technical information to users and update of the website, in addition to monitoring of flood flows in the Niger basin.

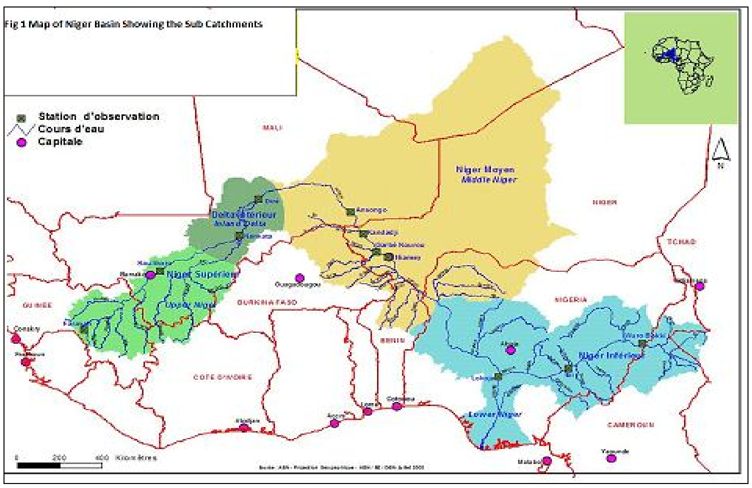


Figure 1: Niger River basin and member contries of NBA

Flood Occurrence in Niger Basin

The Niger basin is usually subdivided into the Upper Niger, Inland Delta, Middle Niger and the Lower Niger basins. Nigeria is located in the Lower Niger basin, where it receives the flood flows from the upstream countries from Guinea, Mali, Niger and Burkina Faso along the West, and from Cameroun and Tchad along the East from the Benue River. River Niger and Benue forms a confluence at Lokoja before flowing southward into the Atlantic Ocean in the Niger Delta of Nigeria. There are two types of floods in the Niger basin known as the White and Black floods.

The White and Black Floods

The White floods usually occur during the rainy season, with a peak flood flow occurring between August and September and mostly from Niger and Burkina Faso in the Western flank, as well as from tributaries and releases from major dams in Nigeria. Another major White Flood is that coming through the river Benue mostly from Cameroun and upstream dams.

The Black floods on the other hand, emanate from flood flow during the wet season in Guinea which flow through Mali, Niger and Benin before arriving Nigeria, having its maximum flood flow occurrence between December and January.

In recent years particularly in 2009/2010 and 2012/2013 hydrological years, the Niger River has continued to experience unprecedented flood flows at the upstream, which, coupled with the existing flow in Nigeria downstream, has become catastrophic thereby inundating towns and villages in the country with many loss of lives and properties.

Figure 2 is the comparative hydrograph of Niger River in Niamey, Niger Republic. This shows that the average daily flow of 2,480 m^3/s recorded in Niamey in August 22, 2012 was the highest ever since the Niamey station was established in 1929. This recorded peak flow of 2480 m^3/s has a return period of 125 years.

The floods from the Niger and Benue joined at Lokoja to create the highest flood ever in the history of Niger River. As shown in Figure 3, the comparative hydrographs of Niger River at Lokoja, as at 28th of September 2012, when writing this paper, indicated that the daily flood flow recorded was 31,274 m^3/s, which has never been recorded. Statistically, this flow has a return period of 500 years. This flood flow is still increasing as shown in Figure 3.

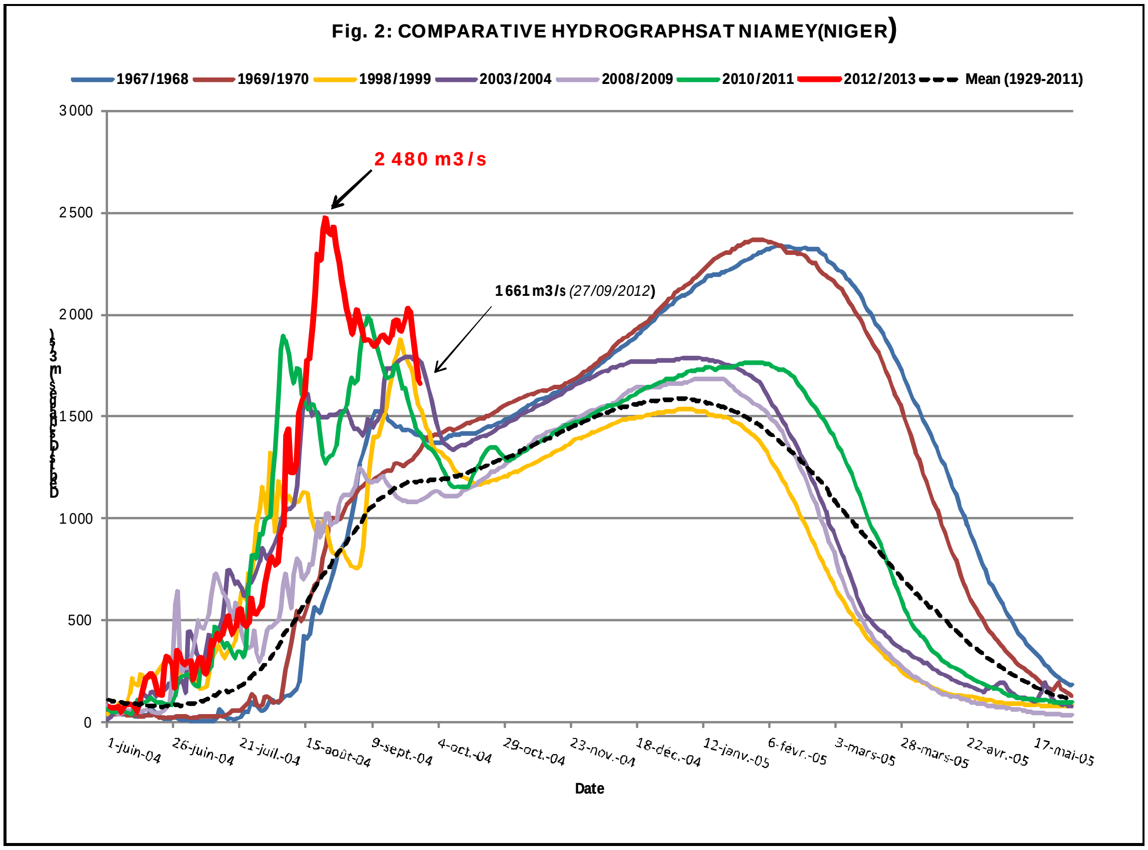


Figure 2: Comparative hydrographs at Niamey, Niger

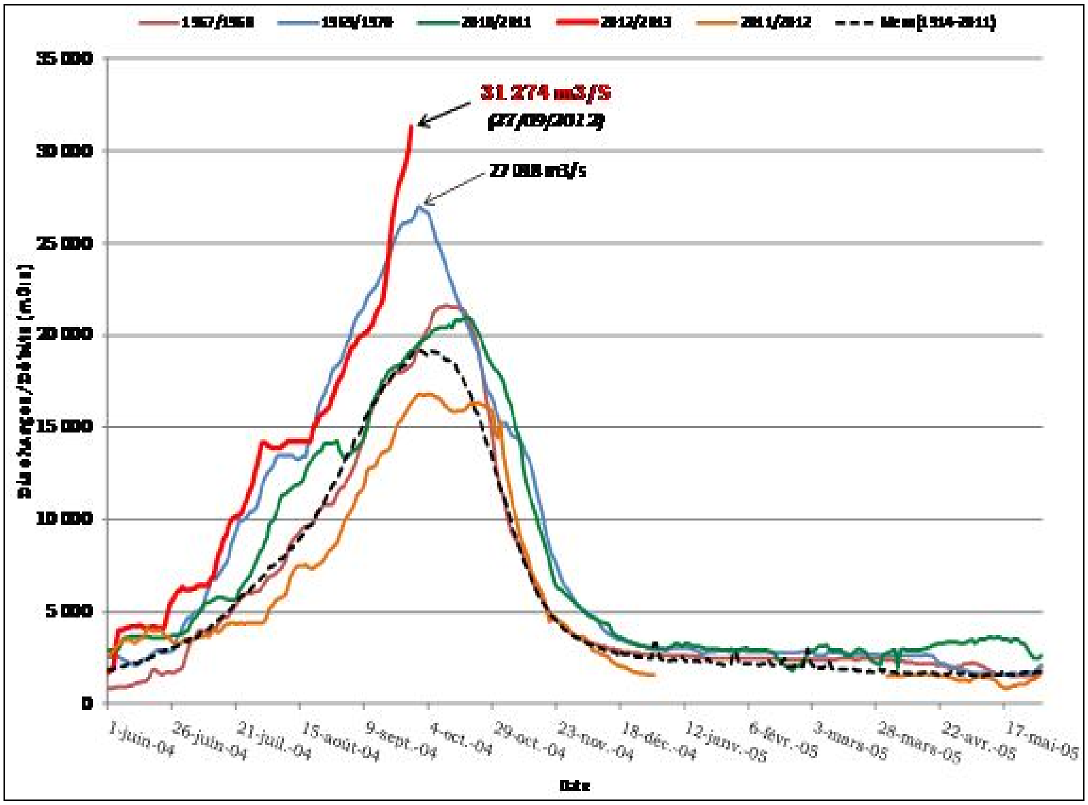


Figure 3: Comparative hydrogaphs at Lokoja, Nigeria

Establishment of Data Collection Platform

In the past, hydrological data is collected using manual gauging as shown in Figure 4. To improve the data collection system in Niger basin, the UNDP, OPEC, EU (EEC) and the NBA member countries funded the establishment of 65 ARGOS Satellites controlled hydrological Data Collection Platforms (DCP) stations as shown in Fig 5, along the Niger River, with WMO as the supervising agent under the framework of HYDRONIGER project between 1984 and 2000. Figure 5 is an example of a DCP. Out of the 65 DCP stations, 18 were located in Nigeria within the Niger River catchment areas at Lokoja, Jiderebode, Kainji dam, Wuro Boki, Kiri dam, Downstream Jebba dam, Makurdi, Umaisha, Wuya and Onitsha, to name but a few. The remaining 47 were established within the catchment areas of Niger River in the other NBA member countries. As result of the lack of spare parts, some ARGOS DCP were used to repair others to make them functional.

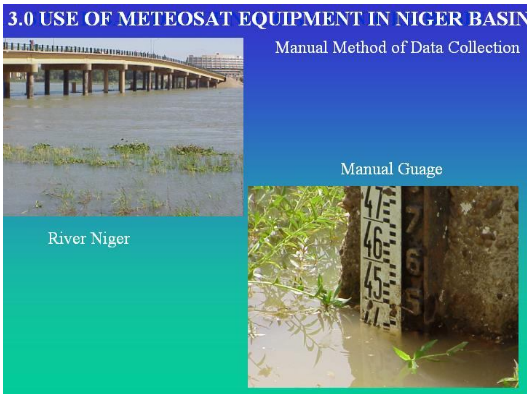


Figure 4: Manual Gauging

Figure 5: DCP Station

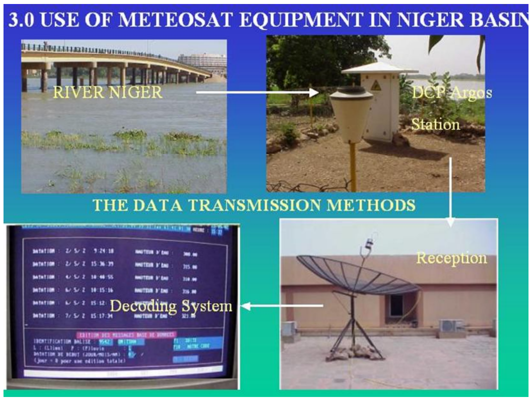
ARGOS DCP

The DCP equipment as shown in Fig 6 consists of a DCP station component that is installed along the river with a sensor for capturing the water level and sending signals into the receptor, which also sends signals through the ARGOS satellite. The signals from ARGOS satellite are relayed and received through a satellite dish which is installed at NBA. The sent information signal, which is received and converted into data by Argos Satellite Data Receiver (ASDR), is computerised in NBA as shown in Figure 6. The ASDR, therefore, converts information into water level using the computer system. One of the most important elements in the operation of DCP is the battery; once it is down, the DCP station ceases to operate. This is why solar panel is always installed with the system to recharge the batteries.

Following the lack of spare parts and access charges to the ARGOS Satellite, WMO advices all its member countries to move to METEOSAT satellite where charges are free and spare parts are available.

EUMETSAT DCP

The equipment and operation of EUMETSAT DCP is similar to that of ARGOS. The only difference is that while the ARGOS uses the ASDR, the EUMSAT send data to Damstard in Germany, where it is processed to usable data. Then it is sent to all users through the internet. Hence, data from EUMETSAT DCPs is received through the internet with all users having the user name and code for logging in and downloading. The EUMETSAT DCPs use by NBA are supplied by the SUTRON Company and it operation is shown in Figure7.



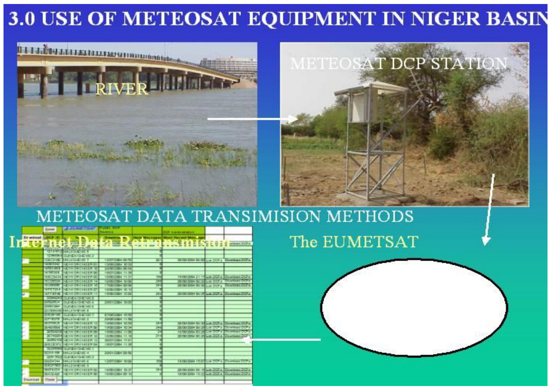


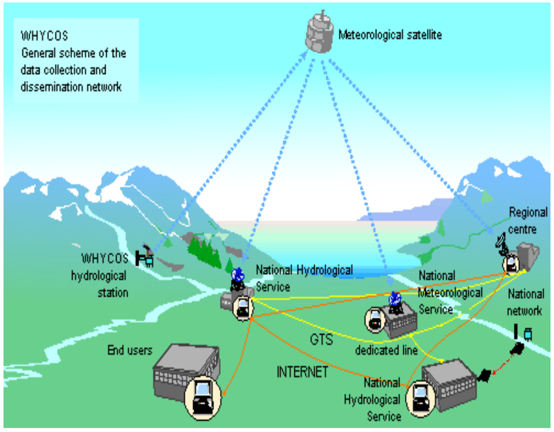
Figure 5: DCP ARGOS

Figure 6: EUMETSAT DCP

Use of DCP to Monitor and Mitigate Flood Disaster

The DCP provides real time data and information collection on the situation of a river, particularly its water level and rainfall. Information can be provided every one, two or three hours depending on the setup. The NBA DCPs are setup to collect data every one hour and transmission to the satellite is every three hours i.e. the water level situation of any river where it is located can be accessed through the internet at every hour in a day. Figures 7 and 8 show the working demonstration of the system of data collection through the satellites.

Flood flows can therefore easily be monitored, and where they are noticed to be extremely high, people downstream including government, decision makers and stakeholders can be alerted and warned on the impending danger. By this, evacuation exercise and mobilisation can be carried out for danger and flood disaster mitigated.



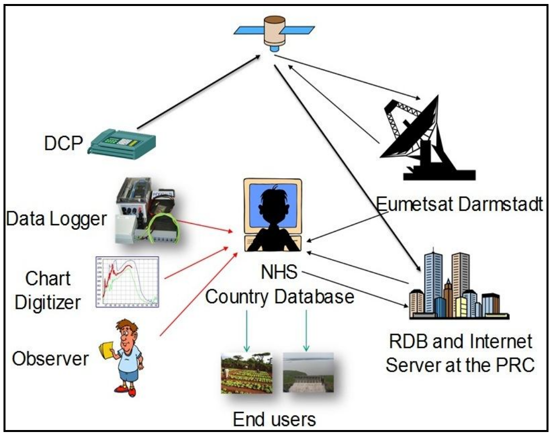


Figure 7: Satellite DCP Operation

Figure 8: Satellite DCP Operation

Flow Forecasting Model

The NBA has also developed the Flow Forecasting Model on the Niger River that uses discharge and rainfall as inputs. The model can provide ten to thirty days forecast and can be used to monitor floods in Nigeria.

Energy Water Balance for Flow Forecasting

NBA is presently establishing a Satellite_based Water Monitoring and Flow Forecasting System in Niger Basin under the framework of Satellite Hydrological Project (SHYP). SHYP is based on the use of Geostationary Meteorological Satellites (GMS) facilities and models that were developed by the EARS and the UNESCO-IHE, at Delft, in the Netherlands. It is also a data collection and analyses system based on the Energy and Water Balance Monitoring System (EWBMS) that processes hourly visual and thermal infrared imagery to daily field data of albedo, surface and air temperature, global and net radiation, actual and potential evapotranspiration, as well as precipitation. Hydrological flow data can also be modelled using the GMS with a 3 km resolution, while rainfall points data can also be obtained in near real time from the World Meteorological Organisation Global Transmission System (WMO-GTS) network. This is an effective, state of art data and information collection on hydrology, climate and environment changes, using Geostationary Meteorological Satellites (GMS). It is, therefore, good for hydrological, meteorological and agricultural data and information collection and for Floods and Drought monitoring in the basin, directly through the satellite.

Challenges Facing Hydrological Data Collection

The challenges of data collection can be outlined as follows;

- **Problems of Equipment and Spare Parts**
  Some equipment imported for installation are not usually adapted to African environment; they malfunction and become problematic to users. This kind of experience is common in areas where Donors organizations insist on equipment procurement from their country to promote their products. Equipment manufactured in cold environment most often do not last in hot weather and sometimes pack up immediately after installation. Outdated equipments can also be presented for procurement with no replaceable spare parts or with those which are no longer available on the market. These become difficult to maintain and a liability to user countries.
- **Poor Maintenance Culture**
  The problem of equipment maintenance is a major factor affecting DCP system. Most of the parts must be in workable condition and therefore require adequate maintenance.

- **Problem of Accessibility**
  Some DCP are located in remote areas that are not easily accessible. Carrying out equipment check and routine maintenance is very difficult. Remote and inaccessible areas constitute problems in the quest for adequate data and information collection.

- **Capacity Building Requirement**
  There exist the lack of trained personnel to respond to capacity in technology transfer, develop programmes and projects on climate change. There is also need for enhancement of the analytical capacity of experts, policy and decision makers as well as improvement of negotiation skills and strengthening of negotiating teams on the human resources needs of the institutions being established. Capacity building for a wide range of stakeholders from governments, non-governmental

organizations, private sector, academia, and local communities is also required for a sustainable development.

- **Inadequate Political Will**
  Inadequate political will for establishing of priorities, enforcing policy on climate change, raising public awareness, participation of key stakeholders at the sectoral level, undertaking vulnerability assessments and preparation of adaptation for planning sustainable development strategies are major setbacks for rapid sustainable development and mitigation of the impact of climate change.

- **Inadequate Financing**
  The Lack of adequate financing results in the total breakdown of equipment in most parts of African countries. The current total dependency on foreign aids and assistance for procurement of equipment and maintaining them does not enhance continuity and sustainability of data collection system.

- **Inadequate Sensitization**
  Lack of adequate sensitization is the root cause of equipment vandalisation. Equipment installed in remote areas are vandalized, and sometimes parts, such as solar panel, are easily stolen as shown in Figure 4. The lack of cooperation among stakeholders and users create rivalry, lack of understanding on the importance of data collection and exchange.

- **Lack of Synergy among Stakeholders**
  There exist inadequate cooperation among stakeholders that encourages and promote lack of synergy and duplication of functions. This consequently leads to ineffective data collection, exchange and dissemination.

Recommendations

The following are the major recommendations;

i) Policy makers, the private sectors and the stakeholders need to be sensitized to recognize the importance of data and make adequate budgetary provision.
ii) The government should enforce provision of 3 – 5% of the cost of construction of all water related projects for hydro-climatological activities and this should be reflected in their Bill of Quantities (BOQs)/Bill of Engineering Measurements and Evaluation.
iii) The government should continue to provide adequate support for the climate variability related projects, such as HYCOS Projects, to increase the network density and provide more assistance for the maintenance of the Data Collection Platforms (DCP) and other hydrological equipment to complement those supplied by the project through funding.
iv) All organizations involved in hydro-climatological data collection should strive to acquire relevant and latest database software and equipment for the collection and processing of data, while the use of locally fabricated equipment should be encouraged.

v) A policy on Hydro-climatological Data Collection, exchange and dissemination should be created and articulated in the activities of the National Hydro-climatological Services Agencies that should champion its implementation when promulgated.
vi) Equipments for Hydro-climatological data collection should be regulated and standardized to conform with the African environmental studies.
vii) The establishment of databank and the collection, sharing and dissemination of data nationally, regionally and worldwide should be instituted as a national policy.
viii) There should be encouragement and promotion of synergy among stakeholders, which will promote effective data collection, exchange and dissemination and also eliminate duplication of functions.
ix) Government should establish a tax force of experienced professionals to be charged with statutory responsibility of coordinating flood operation and hydro-climatological activities in the countries.
x) This tax force should also be involved in the NBA activities to protect the country's interest in the international institution.
xi) Capacity building of personnel at all levels should always be organized to improve the technical capacities and capabilities of personnel and relevant personnel should be the beneficiaries of such trainings.
xii) Minimum of secondary school certificate level should be the standard for data collection officers and they should be employed on permanent bases and also be given relevant practical on-the-job training.
xiii) There should be regular meetings of Heads of Ministries/Departments and Agencies for the harmonization of functions with a view of reduction of duplication of efforts and activity by the various stakeholders.

Conclusion

The geographical location of Nigeria downstream of Niger River and Benue makes her prone to incessant flood disasters. As a result, over 80% of Nigeria's populations in the Niger basin, which represent about 60% of the country's population, are perpetually facing the threat of the white and black floods from the Niger and the Benue. It is therefore high time attention is given to flood mitigation measures to minimize the incessant negative impact of flood disaster in the country by using the satellite based DCP. This will not only enhance effective data collection on the Niger River and Benue flows, but provides monitoring of floods every 3 hours of a day through the EUMETSAT satellite. Information, particularly data on the flood situation can also be collected in real time and downloaded as well as disseminated through the Internet. Other measures, such as flood forecast model and EWBMS, can also be applied towards flood mitigation in the country.

It is therefore high time the Federal Government starts paying adequate attention to these preventive measures before the adverse effect of flood disaster endanger the lives and properties of the citizens. This will also enhance socio-economic development in the country. Finally, in view of the importance and sensitivity of impact of flood disaster mitigation, a tax force is recommended to be created for the enhancement of its activities. It should also be noted that the existing DCPs in the country are facing problems of inadequate maintenance and commitments which has results on the current inadequate hydrological data that is also frustrating the use hydrological models for flood forecasting for country.

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