SCIENTIFIC ACTIVITIES FOR

THE AFRICAN NETWORKS OF CENTRES OF EXCELLENCE

(ACE WATER 2)

(WEFE ASSESSMENT IN THE NIGER-DELTA BASIN, SOUTHERN NIGERIA)

INCEPTION REPORT

PREPARED BY

PROF J. O. EHIOROBO

(Expert consultant)

AND

PROF O. C. IZINYON

UNIVERSITY OF BENIN,

FACULTY OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING.

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1.0 INTRODUCTION

In the framework of phase II of the NEPAD Centres of Excellence in the water sector, the University of Benin Centre of Excellence in Water Science and Technology plans to carry out a comprehensive assessment of the NEXUS of four key sectors of Water, Energy, Food and Ecosystem (WEFE).

2.0 THE STUDY AREA

In the Niger Delta Basin of Nigeria, the catchments of interest are the Benin Owena River Basin and the Niger Delta River Basin. These basins consist of a network of meandering rivers and creeks with Mangrove Swamp and Rain Forest vegetation. The lower Basin of the river Niger flows and discharges through a massive delta known as the Niger Delta into the Gulf of Guinea in the Atlantic Ocean. The extent of the basin covers 42,874 square kilometres and is situated strategically on both sides of the Niger River.

The catchment extent is bounded to the North by Niger state, North West by Edo and Kogi states, South by Rivers and Delta states, and East by Anambra state. It is characterized by wide extreme floodplain formed by rivers Niger, Benue and Anambra (see Figure 1). The study will be confined to downstream of Niger River from the confluence between River Niger and River Benue from Kogi state to Delta state.

The National Water Resources Institute (NWRI) in Nigeria will be working on the upstream section of the Niger River from the country boundary to the confluence at Kogi state. Output hydrological results from their analysis especially for the Water sub-component of the NEXUS would be used as an input for the downstream section starting from the River Niger and River Benue confluence to the Niger Delta exit to the Atlantic Ocean which we will be considering. The major area of collaboration between our team and the National water resource institute is in the area of data sharing for analysis.

The major agencies for data collection in Nigeria are The Nigerian Meteorological Agency (NIMET) and The Nigeria Hydrological Agency (NIHSA), whose head offices are both located in Abuja the federal capital of Nigeria as well as River Basin Development Authorities located in different state capitals. Data collected by our team and the National water resources institute Kaduna will be shared and compared before being used for analysis. Results will be compared for completeness and reliability by the two teams from Nigeria. We intend to share our methodologies and result with the National Water Resource Institute Kaduna.

The area of collaboration with AGRHYMET will be to exploit the possibility of filling gaps in data available from local agencies in Nigeria including NIMET and NIHSA. The possibility of acquiring satellite data, and ground observation survey data in respect of hydrology, meteorology and Agriculture will be exploited for possible Drought and Flood modelling, water resources in agriculture and livestock breeding etc.

We intend to collaborate with AGRHYMET and other western African Centers of Excellence (COE) in the development of regional models for hydro-meteorological and crop yield forecasting and water availability for water supply, irrigation and power generation

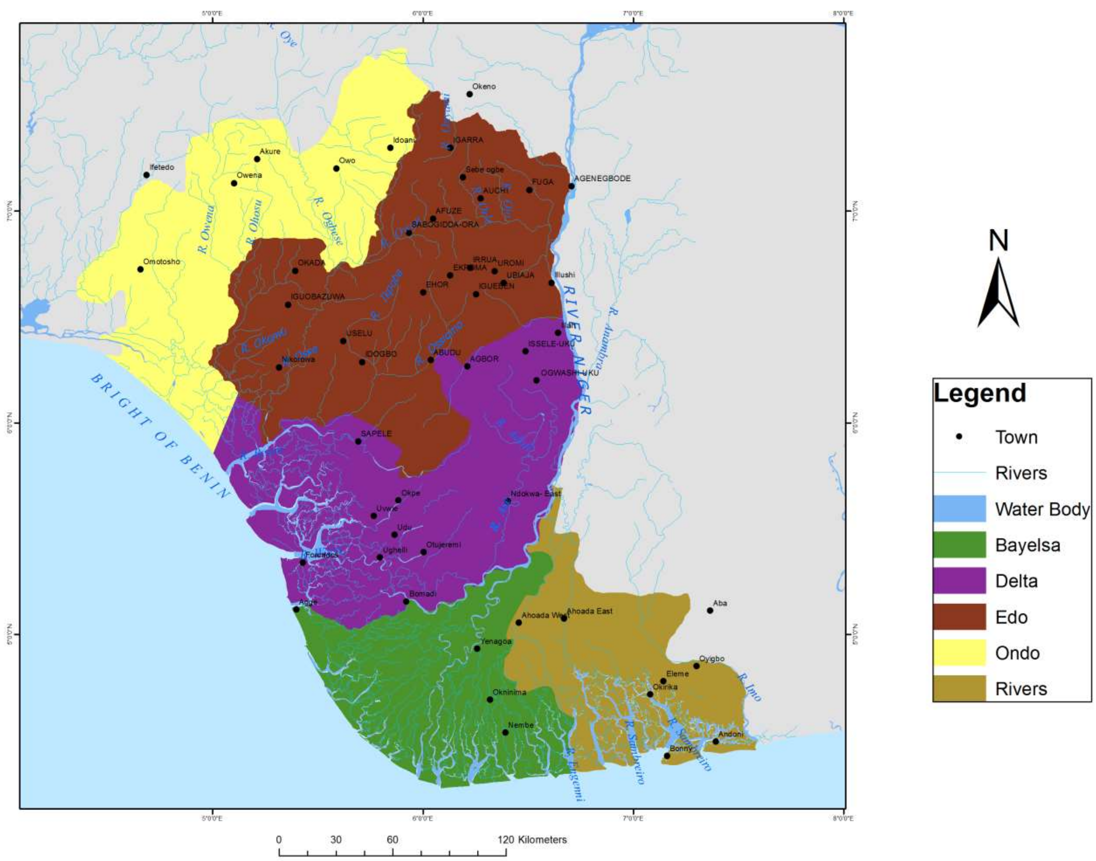

Figure 1: Overview of the study area. The floodplain ranges from less than 10meters in the south to 500m above Sea Level in the North.

2.1 Climate

The climatic condition around the area is typically humid tropical climate with high rainfall for most parts of the year and dry harmattan from November – January, which accounts for the dense mangrove and rainforest vegetation which characterize the basin. The average annual rainfall is 2000 mm, the temperature range is 22°- 27°C during the raining season and between 28°-35°C during the dry season.

2.2 Hydrology

Nigeria occupies an area of 923,800 square kilometres and 800 square kilometres coastline to the Gulf of Guinea. The surface water resources in the country are grouped into 8 hydrological areas (HAs) while the groundwater resources are also subdivided into 8 hydrological areas (HGAs). Due to financial and time constraints the study area will be limited to Niger-Delta and Benin - Owena River Basin. (see Fig1)

These two river Basins are located partly in hydrological Zones V and VI and comprise of Edo, Delta, Bayelsa, Ondo, Ekiti and Rivers states. For the area within hydrological Zone V, the geology is 90% sedimentary and 10% basement. This area is drained primarily by River Niger, Anambra, Osse, Nun and Forcados rivers. The geology of the areas within Zone VI is 60% basement and 40% sedimentary. Principal rivers within this area include Osse, Ossiomo, Oyan, and Owena. Almost all the Nigerian rivers with the exception of the Chadian system drain into the Gulf of Guinea.

River Niger and Benue have built-up the huge Niger Delta due to the combined action of sea waves and depositional action of the river emptying into the sea. Rivers systems within the proposed study area present rich runoff due to the high annual rainfall from 1500-2000 mm.

The large flood caused by high rainfall intensity often takes place and brings about flooding problem in urban areas located in the lower basin. This is particularly the case with coastal towns such as Warri, Port Harcourt, Patani, Forcados, Benin City, Yenegoa etc.

The river's mouth is clogged by transported sediment load from the upstream and a number of lagoons are formed along the coastline. It is to be noted that this is the area in Nigeria where most of the hydrocarbon exploration and exploitation activities take place and there has been a high level of pollution of both surface and ground water within the study area.

3.0 FLOODING

A network of numerous narrow streams with unstable stream ways are well developed and form extensive floodplains in the Niger Delta are prone to flooding. Sediment pollution of the water bodies due to accelerated soil erosion process is a serious and widespread problem in Nigeria. Gully erosion ravages large areas in Edo and Delta states as well as other parts of the southern Nigeria where agricultural practices leave the soil bare at the start of rainy season. Flooding occurs in two forms in the Niger Delta region, either as river flooding when the Niger river exceeds its capacity or as flash flooding in the densely populated urban areas after heavy rainstorms.

3.1 River Flooding in the Niger Delta Region

The Niger Delta region located within this study area is an extensive plain crisscrossed by a maze of meandering rivers and creeks. When the Niger and its tributaries are in flood the river banks are eroded. The flooding last for up to 3 to 5 months in the year with level differences between low and high flood flows being 6-10 meters.

3.2 Flash Floods in Urban Areas

In Southern Nigeria, the high local rainfall intensities and long duration in the rainy season or wet season often generate the rainfall runoff volume in excess of local drainage capacity. With residential and industrial areas expanding over the floodplains, local inhabitants suffer damage of their properties and disruption of public transportation and utilities.

3.3 Consequent land degradation problems

The problems of land degradation can be tackled by integrated watershed management. Land degradation is the loss of the ability under a particular form of land use to withstand or recover from the shock or stress by itself without external assistance. This may involve the degradation of soil, vegetation and water resources which are closely interrelated. Land degradation is an important environmental problem facing most part of southern Nigeria. Considering its economic significance, the area of land involved and the number of people affected are being studied by our team. Important effects of land degradation include:

- Irreversible loss of some production land leading to increased land pressure
- Depleted water and wood supplies
- Soil fertility loss and yield decline
- Weakening food security
- Increased food, fuel and phosphate fertilizer imports

High river water turbidity values well above permissible levels have been reported in many parts of Nigeria. Sediment pollution of water creates several problems such as early silting up of reservoirs and consequent reduction in their lifespan, low water levels in rivers and reservoirs which adversely affect fish population, water treatment costs, reduced navigability and increased flooding.

Several reservoirs which were built for domestic water supply have been virtually silted up and eutrophicated. Reservoir siltation often results in accelerated weed infestation. Weeds also waste water because of high transpiration and mitigation against algae productivity and thereby reducing fish production. The delivery of a large amount of sediment into rivers results in the formation of bars of sand and change of river bed configuration and river regime as a whole.

Table 1: Degradation type and immediate causes

Degradation Type	Immediate Causes
Flood/ Siltation	Destruction of catchment vegetation, urban drainage, inadequate coastal protection
Land Degradation including degradation of savannah woodland	Clearing for agriculture, over-exploitation for timber and firewood and bush burning
Wetland Degradation	Clearing and draining for agriculture, dam construction
Coastal erosion	Vegetation destruction, inadequate coastal erosion protection
Declining soil fertility	Shortened bush fallow, inadequate supply of farmyard manure and inorganic fertilizers, impoverished soils, intensive cultivation
Sheet erosion	Inadequate on-farm conservation, overexposure of cultivated soil to rain splash, intensive cultivation leading to soil capping and compact due to organic matter loss, overgrazing, destruction of tree cover

4.0 DAMS AND RESERVOIRS

4.1 General Features

Rivers in Nigeria have a large runoff fluctuation presenting a rich runoff in wet season/year and poor in dry season/year. Under this situation, the effective surface water available for irrigation, water supply, hydropower, etc. could not be achieved without reservoir dams to store the rich runoff in the wet period and utilizing it during the dry period. It is for the above reasons that dams and reservoirs have been constructed and operated by different agencies in Nigeria as given below:

a. River Basin Development Authorities: mainly for large dams for irrigation, water supply and hydropower development.
b. Ministry of Agriculture: Mainly for small dams for irrigation.
c. State Water Agencies (SWA): mainly for small dams for water supply of which some have irrigation function.
d. Electricity Agency: For large-scale hydropower

Dam Classification: Dams in Nigeria are classified into large dams with a height of more than 15m, medium dams between 8 to 15m and small dams less than 8m.

4.2 Reservoir operation

Reservoir operation is carried out so as to store wet season inflow appearing April to October and to use it for water demand during a long dry season period. Some reservoir water in the previous year is carried over to meet the water demand of the following year which may face dry condition presenting less inflow to the reservoir.

4.3 Existing dams and reservoirs in the study area

S/N	Name	Category and Type	Geographical Location		Hydrological zone (HA)	River	State	Reservoir capacity	Purpose and Owner
			longitude	latitude					
1	Apariko-Aisegba dam	Large (Homogeneous)	5^0 27'E	7^0 34' N	6	Apariko	Ekiti	4.7 MCM	Irrigation& Water supply (BORBDA)
2	Awara Dam	Small (Homogeneous)	5^0 40'E	7^0 30' N	6	Ashodi	Ondo	-	Water supply &Irrigation (OSWC)
3	Ayede Dam	Small (Homogeneous)	5^0 56'E	7^0 53' N	6	Ayede	Ekiti	1.5MCM	Water supply (EKWC)
4	Ikare Dam	Medium	5^0 45'E	7^0 15' N	6	Asande	Ondo	7.7 MCM	Water supply (OSWC)
5	Ikpoba Dam	Small (Earth filled)	5^0 38'E	6^0 22' N	6	Ikpoba	Edo	1.5MCM	Water supply (ESUWB)
6	Itapayi Dam	Large (Homogeneous	5^0 27'E	7^0 57' N	6	Ele	Ekiti	1.5 MCM	Water supply (EKSWC)
7	Egbe Dam	Large (Concrete)	5^0 58'E	7^0 20' N	6	Little Osse	Ekiti	2.3 MCM	Water supply (EKSWC)
8	Little Osse Dam	Large concrete (Homogeneous)	5^0 34'E	7^0 36' N	6	Little Osse	Ondo	--	Water supply (EKSWC)
9	Ojirami Dam	Large Earth fill (Homogeneous)	6^0 09'E	7^0 17' N	6	Oyanmi	Edo	4.5 MCM	Water supply (ESUWB)
10	Osse (Egbe) Dam	Large concrete/ Earth filled	5^0 34'E	7^0 36' N	6	Little Osse	Ekiti / Ondo	0.42 MCM	Water supply (ESWC)
9	Ojirami Dam	Large Earth fill (Homogeneous)	6^0 09'E	7^0 17' N	6	Oyanmi	Edo	4.5 MCM	Water supply (ESUWB)
10	Osse(Egbe) Dam	Large concrete/ Earth filled	5^0 34'E	7^0 36' N	6	Little Osse	Ekiti / Ondo	0.42 MCM	Water supply (ESWC)
11	Ogwashi-Uku Dam (Under construction)	Large	-	-	6	Ubu	Delta	18MCM	Water supply & Irrigation (BORBDA)
12	Owena Dam	Large Earth fill (Homogeneous)	5^0 01'E	7^0 11' N	6	Owena	Ondo (Idanre LGA)	36.25 MCM	Multipurpose (BORBDA)
13	Owena Multipurpose Dam	Large Earth fill (Homogeneous)	5^0 13'E	7^0 16' N	6	Owena	Ondo (Ifedore LGA)	36.25 MCM	Multipurpose (BORBDA)
14	Ukhun/Erha Dam	Small	6^0 10'E	6^0 51' N	6	Okwego	Edo	0.8MCM	Irrigation

5.0 SCIENTIFIC ACTIVITIES

Review of available information and analysis of existing studies relating to water, energy.food and ecosystem within the study area which are relevant to the study.

5.1 Main activities within the study area

Scientific activities will involve the collection and analyses of data relating to Water, Energy and Food assessment within the study area and these will include:

1) Climate database update. Climate variability/change and extreme climate events, environmental (Flooding, social and health impact analysis, food and water security.)
2) Hydrology and water demand vs. availability by sector
3) Inventory of large reservoirs and management rules for multiple uses
4) Agriculture (crops, spatial pattern, irrigation expansion) and best practices assessment using existing models
5) Analysis of WEFE Interlinks and Implications for the study area.

5.2 Scenario modelling

The fundamental problem of this study lies in the difficulty in finding the relevant data, questionable data quality and a variety of data formats. This problem will be addressed by filtering of the available data, developing or adopting an existing program that will address several aspects of water resource management including precipitation measurements, water levels and water quality monitoring, radar data for deriving Digital elevation models (DEM), historical weather data. After pre-processing the data and compiling in a database, it can be used by for decision making by stakeholders for improving water resource management and management of other climate-induced environmental hazards such as flooding, drought etc. The database can also be used for other analysis and planning purposes.

In the course of the study, it is necessary to take into cognizance that the study design will identify, examine and assess the intended and unintended consequences. Trade-offs will be made from the potential flood mitigation options from the result of the study.

ASSESSMENT OF SUCCESS OF PROJECT ACTIVITY INDICATORS

	ACTIVITY	INDICATOR
1	Acquire historical meteorological and river discharge data	The number of years consistent historical date are available within the study area and the distribution
2	River gauging and precipitation data	The indicator could be how effective the acquired data helps in predicting flood frequency for the various return period
3	Acquisition of satellite imageries for GIS mapping in the watershed	Indicators of how long-term land use and land cover has affected the natural resource allocation in the study area.
4	Integrated flood hazard modelling using process-based modelling software (SWAT and LISEM) with GIS analysis software (ArcGIS and ILWIS)	Flood hazard and risk maps prepared for better land use planning
5	Modelling and simulation of climate change induced flooding phenomenon using L-Moment Approach	Preparation of an early warning system useful for evacuation in times of extreme flooding
6	Modelling the impact of climate change on an eroding coastline	Preparation of flood and erosion hazard and risk maps
7	Competing for water use assessment and water allocation. integrated water resource management (IWRM) Decision support system will be applied for competing for water use assessment, water allocation. Dam use in hydropower production versus irrigation and water supply needs.	Availability of potable water supply improvement in electric power generation and food security

5.3 Monitoring and evaluation

Within the project implementation and outcome, there is a clear focus on the results required for this study. The Logical Framework approach will be used as the Mechanism to achieve the stated objectives since it will help in improving quality of the project design.

Monitoring and Evaluation of dams and reservoirs in the following areas

i. Provision of sufficient potable and qualitative water from the reservoir
ii. Groundwater recharge from the reservoir
iii. The effectiveness of dam and reservoir utilization for hydropower development
iv. Study of siltation in the reservoir
v. Utilization of dams in flood control regulation of river flow.

6.0 ACTIVITIES FOR PHASE II COE

1) Collection of Historical Data from relevant agencies
   - Nigerian Meteorological Agency (NIMET)
   - Nigeria Hydrological Services Agency (NIHSA)
   - River Basin Development Authority
   - Shell Petroleum Development Authority

   Data required include
   - Climatic data (Rainfall Data, Temperature, Humidity)
   - Hydrological data (River Discharge Data and reservoir operation information)
   - Topographic data (Digital elevation model (DEM))
   - Long-term land cover maps for the study area

2) Modelling/Analysis

   a. Hydrological Modelling of river flooding including flood modelling will be carried using GIS. Hydrological analysis using the Soil and water assessment tool (SWAT) (for the whole catchment) and the Limburg Soil Erosion Model (LISEM) (for selected sub-catchments). These will be required for scenario modelling with effects of land cover modification and agricultural information.

   b. Spatial Multiple Criteria Evaluation with the use of the Integrated Land and Water Information System (ILWIS). This will be used as a Decision support system tool for providing mitigation measures while taking spatial attributes into account.

   c. Groundwater quality assessment using GIS analysis: Geostatistics will be used to assess the spatial distribution of groundwater quality in selected urban areas within the study area.

   d. Competing for water use assessment and water allocation. Integrated water resource management (IWRM) decision support system will be applied for competing for water use assessment, water allocation. Dam use in hydropower production versus irrigation and water supply needs. WEAP will be used for hydrological representation, CLIMWAT and CROPWAT for computing irrigation water requirement and ARGIS for mapping support

6.1 Work plan in days

Deliverables	Duration (33 days)
a) Establishment of Project Team	
b) Inception meeting	
c) Preparation of Inception Report and submission	
d) Preparation of Project Budget	
e) Outreach to Partner about project commencement and development of a mechanism for cooperation	
f) Data collection/ Desk studies	
g) Determine baseline and target level for selected log frame indicators	
h) Modelling and analysis	
i) Project outputs and activities	
j) Project monitoring and Reporting	
k) Submission of the draft report for review	
l) Submission of final report	

Deliverables	Deadline
Establishment of Project Team	15.01.2018
Inception meeting	12.02.2018
Preparation of Inception Report and submission	09.04.2018
Preparation of Project Budget	10.04.2018
Outreach to Partner about project commencement and development of a mechanism for cooperation	30.05.2018
Data collection/ Desk studies	30.06.2018
Determine baseline and target level for selected log frame indicators	15.07.2018
Modelling and analysis	15.09.2018
Project outputs and activities	28.09.2018
Project monitoring and Reporting	15.11.2018
Submission of the draft report for review	30.12.2018
Submission of final report	28.02.2019

6.2 Outcome

- Climate Variability and extreme weather events and their impacts on the WEFE NEXUS.
- Water security
- Delta and Estuaries issues in the Niger Delta Basin-flooding, sedimentation, coastal erosion.

7.0 BUDGET

A total budgetary allocation of **€14,500** (Fourteen thousand, five hundred euros) is proposed for the assignment. The breakdown is as follows:

Activities	Percentage of total budget	The cost in euros (€)
Preparation and submission of the inception report	15%	2,175.00
Existing data collection (database)	20%	2,900.00
Data analysis and Modelling	45%	6,525.00
Preparation and submission of the draft report including spatio-temporal data and maps	10%	1,450.00
Submission and acceptance of the final report	10%	1,450.00
TOTAL	**100%**	**14,500.00**