



NIGERIAN WATER RESOURCES MANAGEMENT – AN OVERVIEW

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ABSTRACT

Effective management of a country's water resources contributes toward its sustainable development. The aim of this paper is to give an overview of Nigeria's surface and underground water sources alongside agencies charged with functions covering all facets in water resources development and management. Nigeria consists of three broad agro-ecological zones; the northern Sudan Savannah, the Guinea Savannah and the southern rainforest spread across eight hydrological areas for the purpose of water resources management. The Federal Ministry of Water Resources is responsible for large water resources development projects and water allocation between states; comprising of sixteen (16) parastatals and agencies made up of twelve (12) River Basin Development Authorities (RBDAs), Nigeria Hydrological Services Agency (NIHSA), Nigeria Integrated Water Resources Management Commission (NIWRMC), Gurara Water Management Authority (GWMA), and the National Water Resources Institute (NWRI). The country has four river drainage systems and 264 dams. Recent studies of Nigerian water reserves (surface and groundwater sources) indicated that there are large supplies, and the country has surface and groundwater resources potentials of 267.3BCM and 51.9BCM respectively.

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1.0 Introduction

The development of water resources is influenced by climatic, physiographic and hydrologic features, and perhaps socioeconomic factors of a region. In the instance of Nigeria, these are briefly outlined as a preface to systems studies. A brief historical and quantitative overview of water resources development including its utilization and key water issues faced by Nigeria is also presented. Furthermore, institutional regulatory and legal authorities in charge of addressing these challenges are also described.

Nigeria is located in the tropical zone of West Africa approximately between latitudes 4°N and 14°N and longitudes 2°2'E and 14°30'E (FAO, 2016). It has a total area of 923, 770 km² with a population of about 203 million (NBS, 2016). The country's north-south extent is about 1,050 km and its maximum east-west extent is about 1,150 km. Nigeria is bordered to the west by Benin, to the northwest and north by Niger, to the northeast by Chad and to the east by Cameroon, while the Atlantic Ocean forms the southern limits of Nigerian territory. Land cover ranges from thick mangrove forests and dense rain forests in the south to a near-desert condition in the northeastern corner of the country (FAO, 2016).

Three broad ecological zones are commonly distinguished in the country: i) The northern Sudan Savannah; ii) The Guinea Savannah zone or Middle Belt; and iii) The southern rainforest zone. Based on rainfall and temperature, the county is divided into eight agro-ecological zones (FAO, 2016). In Table 1, these zones are presented in a north-south succession, except the mountainous zone which is found at the border with Cameroon and the plateau zone in the center of the country. The peculiar and variable nature of Nigeria in location and climate has given rise to certain water resources issues in the country. These issues

range from precipitation to management of these resources. The annual precipitation ranges from 400mm in North Eastern part to about 2000mm in the South Eastern part of the Country (Ishaku and Majid, 2010; FAO, 2016). These variations give rise to certain issues like scarcity induced drought to Flooding respectively. Legal frameworks to facilitate the management of these water resources over the years have proven to be ineffective.

Table 1: Agro-ecological zones in Nigeria

Zone Description	Percentage of country area	Annual rainfall (mm)	Monthly Temperature °C	
			Minimum	Maximum
Semi-arid	4	400-600	13	40
Dry sub-humid	27	600-1000	12	45
Sub-humid	26	1000-1300	14	37
Humid	21	1100-1400	18	37
Very humid	14	1120-2000	21	37
Ultra humid (flood)	2	>2000	23	33
Mountainous	4	1400-2000	5	32
Plateau	2	1400-1500	14	36

(After FAO, 2016)

Nigeria is divided into eight hydrological areas for the purpose of water resources management, considering hydrological and topographical conditions presented in Figure 1.



RBDAs – River Basin Development Authorities

Figure 1: Hydrological Map of Nigeria (JICA, 2014)

Hydrological Area	Area (10 ³ km ³)	Mainly related RBDAs	Mainly related states
HA-1 Niger North	135.1	Sokoto-Rima	Katsina, Zamfara, Sokoto, Kebbi
HA-2 Niger Central	154.6	Upper Niger, Lower Niger	Niger, Kwara, Kaduna, Kogi, FCT
HA-3 Upper Benue	156.5	Upper Benue	Adamawa, Taraba, Gombe, Bauchi
HA-4 Lower Benue	74.5	Lower Benue	Plateau, Nasarawa, Benue, Kogi
HA-5 Niger South	53.9	Anambra-Imo, Niger Delta	Bayelsa, Delta, Edo, Kogi, Anambra, Rivers
HA-6 Western Littoral	99.3	Ogun-Osun, Benin-Owena	Lagos, Ogun, Oyo, Osun, Ondo, Edo, Ekiti
HA-7 Eastern Littoral	57.4	Cross River	Abia, Anambra, Imo, Enugu, Ebonyi, Cross River, Akwa Ibom, Rivers
HA-8 Lake Chad	178.5	Hadejia-Jama'are, Chad	Kano, Jigawa, Yobe, Borno, Bauchi, Adamawa, Plateau

2. Institutional Arrangements of Nigerian Water Resources Management

Presently, the Federal Ministry of Water Resource (FMWR) is responsible for large water resources development projects and water allocation between states (Idu, 2015). FMWR has sixteen (16) parastatals and agencies made up of twelve (12) River Basin Development Authorities (RBDAs), Nigeria Hydrological Services Agency (NIHSA), Nigeria Integrated Water Resources Management Commission (NIWRMC), Gurara Water Management Authority (GWMA), and the National Water Resources Institute (NWRI).

The first two RBDAs - Chad Basin Development Authority (CBDA) and Sokoto-Rima River Basin Development Authority (SRRBDA) were created in 1973, through the Decree Nos. 32 and 33 of 1976. In 1976, based on the Decree No. 25 of 1976, nine (9) additional RBDAs were established, and as a result, the number of RBDAs becomes 11. In 1984, with separation of Niger River Basin Development Authority into two RBDAs – such as Upper Niger River Basin Development Authority (UNRBDA) and Lower Niger River Basin Development Authority (LNRBDA), the number of RBDA became 12 and these RBDAs long continue with the operation to date (JICA, 2014). The twelve (12) RBDAs are listed in Table 2.

Table 2: List of River Basin Development Authorities in Nigeria

S/N	RBDA	Area of Operation	Office
1	Anambra-Imo River Basin Development Authority (AIRBDA)	Abia, Anambra, Ebonyi, Enugu and Imo States	Oweri
2	Benin Owena River Basin Development Authority (BORBDA)	The regions of River Benin and Owena and a senatorial district in Delta State	Benin-City
3	Chad Basin Development Authority (CBDA)	Borno, Yobe State and northern part of Adamawa State	Maiduguri
4	Cross River Basin Development Authority (CRBDA)	Akwa Ibom and Cross River States	Calabar
5	Hadejia Jama' are River Basin Development Authority (HJRBDA)	Kano, Jigawa States and north and central parts of Bauchi State	Kano
6	Lower Benue River Basin Development Authority (LBRBDA)	The catchment states of Benue, Plateau, Nassarawa States and Kogi State East of the River Niger	Makurdi
7	Lower Niger River Basin Development Authority (LNRBDA)	Entire geographical boundaries of Kwara State and a part of Kogi State, west of the River Niger	Ilorin
8	Niger Delta Basin Development Authority (NDBDA)	Delta and Bayelsa States	Port Harcourt
9	Ogun-Osun River Basin Development Authority (OORBDA)	Lagos, Ogun, Oyo and Osun States	Abeokuta
10	Sokoto-Rima River Basin Development Authority (SRRBDA)	Katsina, Zamfara, Sokoto and Kebbi States	Sokoto
11	Upper Benue River Basin Development Authority (UBRBDA)	Gombe, Taraba, two senatorial districts of Adamawa State and one senatorial district of Bauchi State	Yola
12	Upper Niger River Basin Development Authority (UNRBDA)	Niger, Kaduna States and the FCT	Minna

(JICA, 2014)

The main responsibilities of the River Basin authorities include;

- a. To enhance the development of both surface and underground water resources with particular regard to construction and maintenance of infrastructure;
- b. Management of irrigation schemes which would be handed over to farmers gradually;
- c. Supplying water from storage schemes for a fee with approval from the Minister of Water Resources;
- d. Keeping up-to-date comprehensive water resources records and requirements in the authority's area of operation.

3. Water Resources of Nigeria

In a system known as the hydrologic cycle, water is continually circulates between oceans, landmasses and atmosphere. This movement is driven by a combination of the sun's energy, geological/geographical processes and gravity. Most estimates place seawater in the oceans at 94 – 97% of all water on the planet. The remaining 3 – 6% contains all freshwater resources. Around half of this is frozen in snow, glaciers and icecaps, half is underground as groundwater, and the remaining 0.1% is surface water found in rivers, lakes, reservoirs and atmosphere (Leap, 1999). In general, water resources may be presented as:

1. Surface sources: streams and rivers, lakes, springs, and drainage areas that discharges water toward reservoirs.
2. Groundwater sources: aquifers.

Nigeria is endowed with surface and groundwater resources, yet the country is faced with freshwater scarcity, severe water pollution, growing domestic and industrial water demand, and requirement for food security. The characteristics of the surface and groundwater resources of the country are summarized in Sections 3.1 and 3.2 respectively.

3.1 Surface Water Sources

Nigeria's drainage system is somewhat considered as a close network of streams and rivers which take their source from the Precambrian Basement Complex and flow over the sediments in their lower reaches (Oteze, 1981). Interestingly, the country's four major drainage systems as reported by Spon, (1997) is presented in Table 3.

Table 3: Major Drainage Systems of Nigeria

S/N	Drainage system	Tributaries
1	Niger River Basin	Benue, Sokoto-Rima, Kaduna, Gongola, Katsina-Ala, Donga, Tarabe, Hawal and Anambra Rivers
2	Lake Chad Inland	Kano, Hadejia, Jama'are, Misau, Komadugu-Yobe, Yedseram and Ebeji Rivers
3	Atlantic (East of the Niger)	Cross River, Imo, Qua-Iboe and Kwa Rivers
4	Atlantic (West of the Niger)	Ogun, Oshun, Owena and Benin Rivers

There are two major rivers in Nigeria, namely; Rivers Niger and Benue. Additionally, there are other rivers such as Yobe, Ngadda, Yedseram, Goa, Hadejia, Kaduna, Cross River, Imo, Sokoto, Ogun, Anambra, Ossiomo Rivers with several other streams and channels, lakes and ponds, provide a nationwide web of drainage basins (Figure 2). All rivers in the northern parts of the country drain ultimately into either the Niger or the Benue. A northwest divide separates the Niger tributaries from the south-ward flowing streams in southwestern Nigeria. These include Ogun, Oshun, Owena, Ogbese, Osse and Ossiomo Rivers. In southeastern Nigeria, the Anambra is tributary to the Niger, whereas the Imo and the Cross Rivers drain directly to the sea (Oteze, 1981).

On the other hand, the Basement Complex serves chiefly as a source for headwaters of various rivers and recharge zones for groundwater.

Groundwater in Nigeria has the advantages of being generally free from biological contamination, sediments, and of constant quality and temperature. It is thus normally satisfactory for domestic, agricultural (livestock watering and irrigation) and most industrial uses (Idu, 2015).

Nigerian groundwater can be best divided into three hydro-meteorological areas based on its availability (Idu, 2015) and presented in Table 4;

Table 4: Hydro-meteorological Areas of Nigeria’s Groundwater

	Hydro-meteorological Areas	Related River Basins	Characteristics
1	Sahel zone	Sokoto, Hadejia-Jama’are-Yobe and the South-East Chad	Low annual precipitation of 500-750mm
2	Guinea savannah zone	Kaduna, Benue (upper and lower), and the Niger (Upper and lower)	Mean annual precipitation of 1000-1250 mm
3	Tropical rain forest zone	Anambra, Cross River, Kwa-Iboe, Niger Delta and the Southwestern Coastal	Heavy precipitation from 1250mm-4000mm

There are four major aquifers in Nigeria (Adelena, 2012), these are;

1. Basement aquifers; consist of crystalline and coarse-grained rocks and argillaceous meta-sedimentary rocks. Generally, have low yields. Thickness varies from 10 to 25 m; with water table depth varying from about 5 to 15m. Boreholes tend to be drilled to depths between 10 and 70m, depending on local conditions.
2. Sedimentary aquifers generally consist of thick sequences of sediments with yields between 2 and 60l/s; water table depth between 10 and 40m; and borehole depths from 20m to 150m. Coastal sedimentary basins have borehole depths between 10m and 800m and yields between 2 and 60l/s.
3. Volcanic plateau is found around Jos plateau and Bauchi State of Nigeria. The rock types are mainly olivine basalts, coriaceous lavas and tuffs. These rocks form typically unconfined aquifers with low to moderate yields, usually below 3l/s. Aquifer thickness varies substantially. Water table depth is less than 5m. Borehole depths of 15 to 50m are common.
4. River alluvium aquifers occur along the valleys of major rivers and streams ranging from the thin discontinuous sands occurring in the smallest streams to the thick alluvial deposits of rivers Niger and Benue. They may occupy strips of country up to 15km wide on each side of the river. They are thickest (15-30m thick) along the rivers Niger and Benue and are largely unconfined with shallow water tables.

3.3 Aquifer Yield, Recharge and Groundwater Potential

The crystalline basement of Nigeria generally represents the deeper, fractured aquifer and is noted as a poor source of groundwater. Basement complex aquifers have low to moderate yields (0.83 to 3l/s). Yields between 1–2 l/s in the Nigerian basement rocks are considered good enough for the installation of motorized submersible pumps, while values of borehole yield <0.5l/s are still adequate for hand pumps (Akujieze et al., 2003). Annual exploitable groundwater resources are estimated at about 59 510 million m³, distributed as; 10, 270 million m³ in the north, 25, 480 million m³ in the Middle Belt and 23, 760 million m³ in the south (FAO, 2016).

Groundwater recharge into the Basement aquifers is mainly through direct infiltration from rainfall. Generally, Basement aquifers have low groundwater potential because groundwater occurs in thin,

localized and disconnected aquifers. Major aquifers in the coastal zone of western Nigeria have thicknesses ranging between 100 and 250m with mean groundwater storage of $2.87 \times 10^3 \text{m}^3$ (Akujieze *et al.*, 2003; Ejepu, 2020).

Studies revealed that surface and groundwater resources potential of the country were estimated at 267.3BCM and 51.9BCM respectively (National Water Policy, 2004; JICA, 2014; FAO, 2016).

4. Conclusion

Nigeria is endowed with large freshwater resources; surface and groundwater sources. The country has four river drainage systems with a lot of dams and four major aquifer formations spread over eight Hydrological areas cutting across the thirty-six states of the federation. The establishment of River Basin Development Authorities contributed to the development of water resources in the country. The country's surface waters largely drains through the Niger and Lake Chad Basin. Aquifer productivity across the Sahel, Guinea Savannah and Tropical Rain Forest zones are highly variable.

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