Nigerian Journal of Water Resources. Vol. 4, No.1, December 2018.

ANALYSIS OF WATER INFRASTRUCTURE AND THEIR DISTRIBUTION IN JOS METROPOLIS, NIGERIA

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ABSTRACT

This study has identified the various water supply projects, their locations and capacities in Jos metropolis. It utilized both primary and secondary data sources. The data for the study bother on types, number, capacity, location of dams, reservoirs, surface tanks, underground pipe and water treatment plants which were obtained through the author's personal observations and reconnaissance. Secondary data on the other hand dwelt on information from Plateau State Water Board on dams and other water supply projects and their coordinates. In this study frequency tables and maps were used in presenting the results. The study found that the water supply projects were executed in different locations within Jos metropolis, some of which are dams, water treatment plants, underground reservoirs, overhead tanks and underground pipeline network. It concluded that these water supply projects and services should be extended to unserved locations within Jos metropolis to enable the Plateau State Water Board become sustainable to deliver enormous benefits to government, target water users and also recover her costs.

KEYWORDS: *Dams, Geographic Distribution, Jos Metropolis, Project Execution, Water Supply, Water Supply Projects*

INTRODUCTION

Water plays a crucial role in the economic development of Africa and other countries of the world, and in sustaining natural ecosystems. The various uses of water impinge upon its availability in terms of quantity, quality and time for various economic, social and environmental needs. Water is vital for human life and for the survival of ecosystems, and is, therefore, an essential commodity (African Development Bank, AfDB, 2000). Water supply projects have the potential to produce significant socio-economic benefits of a public good nature, such as improvements in health, and related positive externalities which are not taken into account in the production decisions of private agents. According to Aswathanaraya (2001) the reasons for building dams and reservoirs include some of the following: providing water for drinking purposes (potable water), industry (utility water) and agriculture (irrigation); flood control, power production; inland water transport and recreation. Dams and reservoirs are useful to man and the economy but at the same time impose costs/losses as the process of their construction, their continuous existence and operations perturbs the natural environment and adversely affects the geographical, climatic and social conditions (Fahim, 1981). According to NWSP (2004) Dams are important structures

for storing water for regulating flows and containing floods which main objectives of ensuring the availability of surface water for its different socio-economic uses through design, construction and operation of financially viable storage devices without compromising environmental requirements and to also ensure proper harnessing and utilization of the vast water resources of the nation. They are important economic factors that provide water for economic activities and for avoiding the destruction of economic means, life and property through floods. However, establishment of dams and reservoirs in a watercourse automatically introduces the element of risk in possible loss of life and property to the people living downstream due to possibility of dam failure (Cessti, and Malik, 2012).

Over the past 30 years, activities in the water sector have helped African countries achieve sectoral objectives such as: providing safe drinking water and sanitation services to rural and urban populations; expanding irrigated areas to increase food production; increasing energy supply through hydropower development; supporting families through the development of fisheries and fish farming; and more recently, protecting the environment through conservation programs, and the promotion of tourism. Sectoral policies were developed to guide the implementation of projects (AfDB 2000 & Nwankwoala, 2011).

African countries and their major cities are experiencing water stress or water scarcity and the figure of victims of scarcity is expected to increase to twenty-five by year 2025, partly due to the high population growth rate experienced by African countries. The current shortage of water supply in Plateau State, particularly within Jos and Bukuru areas became a matter of public concern to the government of Plateau State (Plateau State Water Board 2007/2009) and this has made the government to engage in massive rehabilitation of existing dams and the building of new ones to curb the trend (AfDB ,2013). Furthermore, with the existence of so many dams and abandoned mine ponds with very high capacities of water storage coupled with the fact that the Jos Plateau serves as a source and the hydrological head for many rivers such as the Hadeija, Gongola, Kaduna among others. Despite that these rivers serve as sources of water supply to other cities for multiple uses, the Jos Plateau which is the source appears to have less capacity to cater for the residents of Jos metropolis where these rivers originated from. So worrisome is the fact that many ponds which are scattered all over Jos South and Jos North carrying water all the year round are yet to be harnessed to satisfy the requirements for domestic, agriculture (irrigation), hydro-electricity generation and other purposes are still untapped. As Water Aid (undated) notes that currently, water provision in the state is poor, while 85% of the residents surveyed in the state capital, Jos, reported having connection to the water supply, the supply is extremely irregular, resulting to most people resorting to unclean water sources or trek long distances to source for water and wasting precious man hour in the process.

1.1 AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to determine the spatial distribution of water supply projects in Jos metropolis. This aim has been achieved through the following objectives:

1.2 OBJECTIVE OF THE STUDY

1. To identify and analyze the geographical locations and capacities of different water supply projects in Jos metropolis.

METHODOLOGY

This study utilized both primary and secondary data. Data on water supply projects like dams, pipelines, reservoirs, treatment plants, their capacities, year of construction and their locations were obtained from Plateau State Water Board data base, Federal Ministry of Water Resources' reports and this was complemented by questionnaire administration and interviews of stakeholders from Plateau State Water Board, Jos. Maps obtained from GIS LAB, physical visits to the major water supply projects such as Dams, reservoirs, surface tanks, treatment plants and the underground transmission lines with their coordinates would also be taken. Data generated from the field have been presented in tables, figures and maps.

THE STUDY AREA

3.1 Location, Position and Size

Jos metropolis is located between latitudes 90 54' N and 100 10' N and longitudes 80 48' E and 90 30' E. The study area comprises Jos South and Jos North local government areas with their headquarters in Bukuru and Jos respectively. The area is situated within the northern senatorial zone of Plateau state, and is bounded by Barkin-Ladi and Jos East to the east, Riyom to the south and Bassa local government areas to the west (see Figure 1). The areal extent of Jos metropolis from north to south is 104km while from east to west is about 80km on an elevation of 1,250m above sea level with Shere hills having the highest peak of 1,777m above sea level with an area of 1002.19 Km2 (Mohammed, Gajere, Adigun & Folayan, 2010).

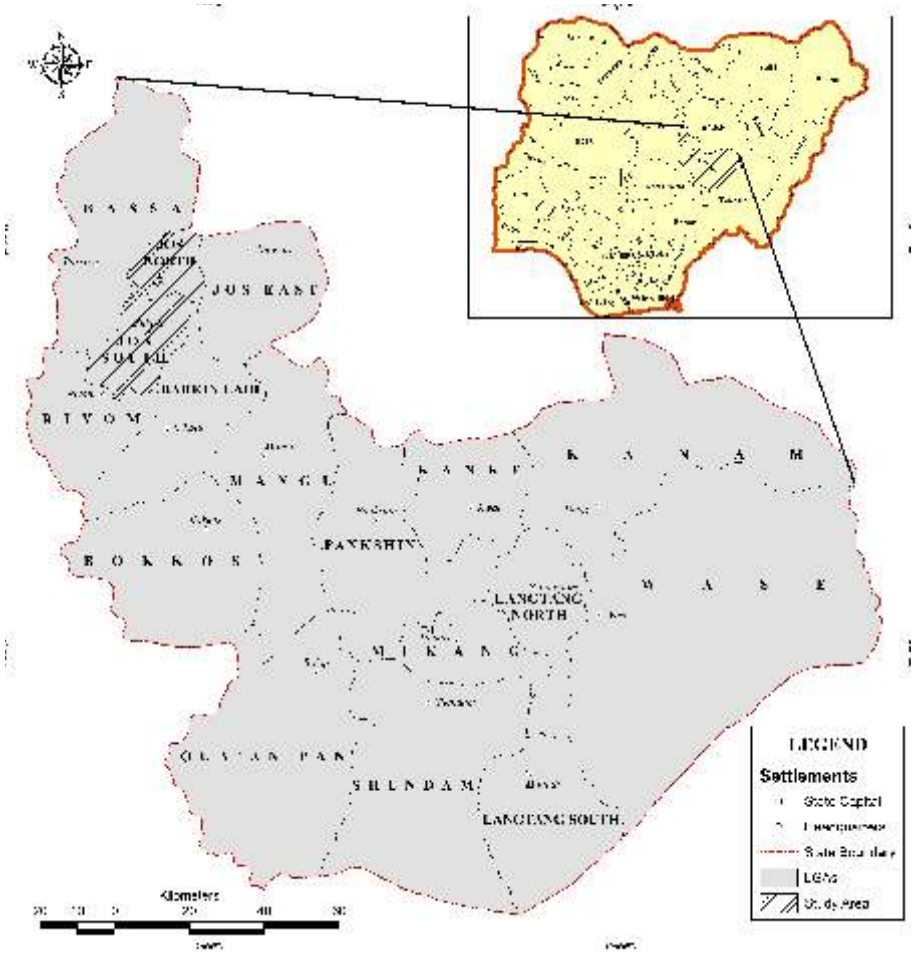

Figure 1: Plateau State showing the LGAs

Source: GIS LAB Department of Geography and Planning, University of Jos

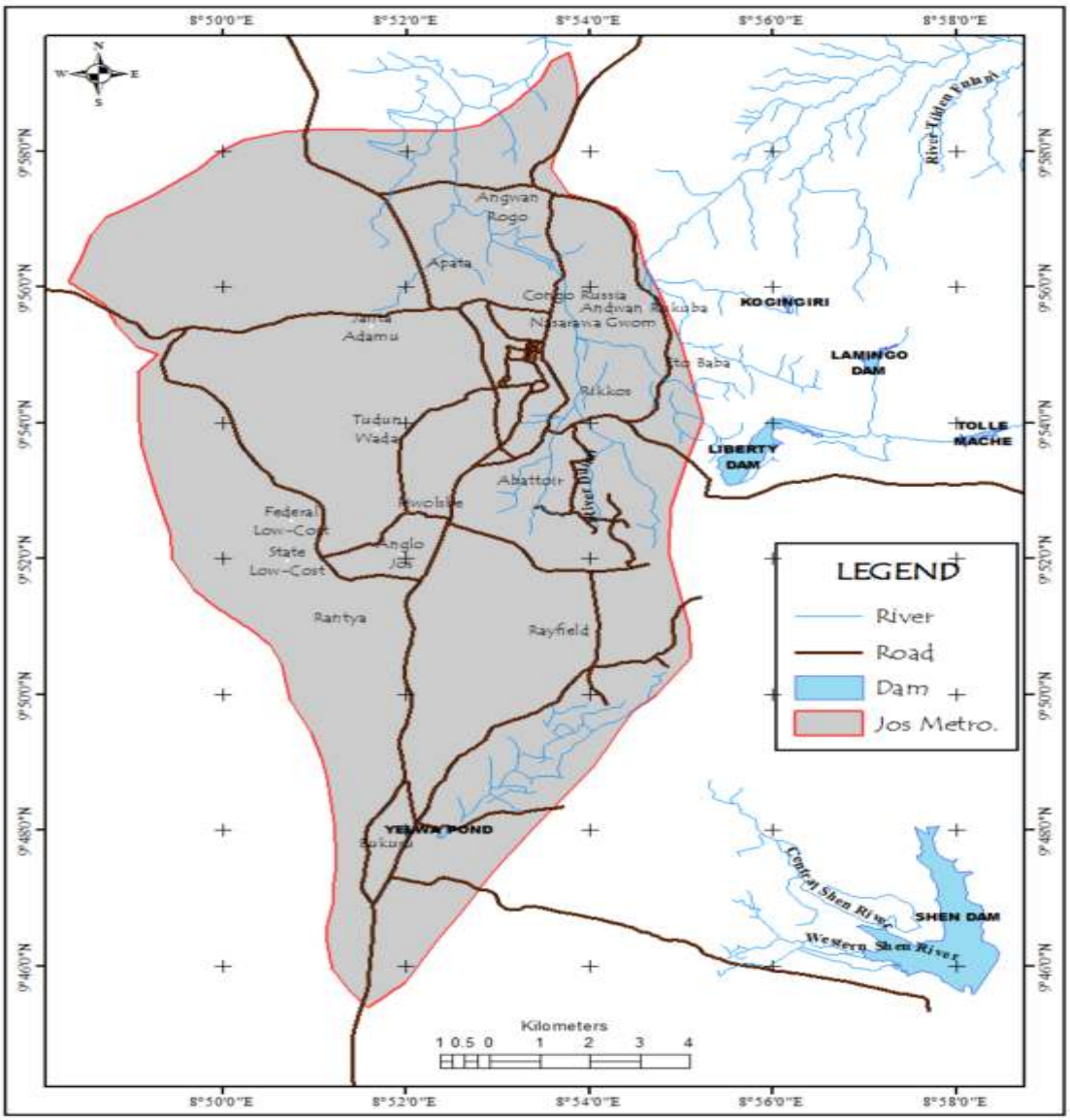

Figure 2: Jos metropolis
Source: GIS LAB Department of Geography and Planning, University of Jos

3.2 Drainage, Hydrology and Hydrogeology

Most rivers in northern Nigeria owe their origins to the Jos Plateau due to its height above other regions in the northern Nigeria and is the source of Kaduna, Gongola, Korot, Shimanker,N'gell, Kassa, Delimi, Hadeija-Jama'are, Wase and Tenti rivers. The volume of these rivers are high during the rainy season and low during dry seasons due to the nature of rainfall and other climatic elements of the area (Bingel, 1978, Jiya & Musa, 2012). The presence of these rivers, streams, dams, hand dug wells, ponds and springs constitute very good water resource base for the area. Some of the rivers that the government has dammed and is harnessing for potable water supply to the metropolis are Nupis, Shen, Gwash, Rafin-Sanyi, Agog rivers and Yelwa pond with Tolle Mache, Yakubu Gowon, Liberty (Laminga), Lamingo (Gwash),Kogin – giri and Yelwa Dams built on

them. The intensive rainfall in Jos metropolis presents great potential for rain harvesting to the quantities that will cater for households, industries and other water consuming units' need for water right to dry periods. But the technology and the awareness for the harvesting though cheap and simple is not being embraced by most water users due to long rainy season that guarantee abundant precipitation for nine months. Apart from this there are a lot of streams, ponds, mine pits, lakes and smaller rivers which compliment other major water sources in their raw forms which if developed along with dams will contribute potable water to the piped water system (Daloeng, 2006).

The Jos Plateau is composed of the crystalline basement complex of both igneous and metamorphic origins with younger granites and basalts as the other major rock types existing in the area. According to Schoeneich (1992), the Jos Plateau is denudational in nature and came into being at about the end of tertiary period when there was tectonic uplift of a small area of about 8, 000km^2 in the central crystalline shield. The raised Plateau which was followed by volcanism went through denudational activities during the late cretaceous age especially on the ages of the Plateau forming valleys which were filled with basaltic lavas.

Mallo (2007), states that the Jos Plateau comprises of Precambrian basement complex rocks (migmatites, gneiss and older granites) the Jurassic younger granites (mostly biotite – granite) and the tertiary as well as quaternary volcanic rocks (basalt, pumive, lava flows and ash deposits). The Jos Plateau due to these geologic processes has risen to the heights of 1,600m, 1,777m and 1,300m at Ropp, Shere Hills and Dogon-Dutse respectively.

The combination of favourable climate, relief, soils, vegetation and abundance of natural scenic vistas, the city presents very great opportunities and potentialities for agriculture, mining, trade, industrial production and recreation and tourism, some of these attractions are: Shere hills, Jos Museum and Zoological Gardens, Jos Wild Life Park, Riyom Rock, Solomon Lar Amusement Park. Also, the presence of higher institutions of learning, stadia, Tertiary health institutions of learning, tertiary educational institutions, good road network, water supply infrastructure, waterfalls, mining ponds, ongoing mining activities in Jos metropolis, though environmentally destructive presents very beautiful tourist attractive sites to every visitor to Jos City.

3.3 Climate

Jos metropolis experiences AW climatic type and falls within the koppens AW climatic sub-region. Generally, weather conditions are warmer during the rainy season (April-October) and much colder during the hammattan period (December-February) (Ariyo, 2000). The mean annual temperature of the city ranges between 20^0c and 26^0c. These temperature ranges are due to influences of rainfall, relief and cloud cover at different periods and seasons of the year. Relative humidity is lower during the dry season between November to March and is very high during the wet season with the peak values of between 81% and 84% in July and August (Bingel, 1978, Ariyo, 2000, Nyong, et al, 2003, Nyong, et al 2008).

Precipitation on the Jos Metropolis ranges from 70cm to 100cm during the peak period. The study area has wet and dry seasons. The wet season takes about 8 to 9 months between mid-March and end October, while the dry season takes about 3 to 4 months from mid-November to mid-March (Ariyo, 2000). The wet season is influenced by prevalence of the warm moist

maritime south westerly monsoon winds which blow from the Atlantic Ocean south westward hinterland while the dry season is linked to the dry tropical continental north easterly winds (Hammattan) a cold dry and dusty mass blowing from the Sahara Desert (Ariyo, 2000).

3.4 People and Population

Jos metropolis comprises of Jos city and Bukuru town which have fused together due to long years of urbanization and population growth. The metropolis has two local government areas – Jos South and Jos North local government areas and expanding to cover parts of Bassa, Jos East, Riyom and Barkin-Ladi by the urbanization efforts of the state government through the implementation of the Greater Jos Master Plan. Jos has a heterogeneous population with Berom, Anaguta, Afizere, with few of Jere and Buji in Bassa and Jos North Local Government Areas. The other major ethnic groups of Plateau extraction residing in the city include Ron, Mushere, Ngas, Pan, Geomai, Mwagavhul, Tarok, Irigwe, Mupun, Amo, all numbering up to fifty (50) ethnic groups (tribes). The city is cosmopolitan in nature as it has nearly all Nigerian ethnic groups residing in it, some of which include Yoruba, Igbos, Hausa-Fulani, Kanuris, Tiv, Kuteb, Jukun, Ibibio, Idoma, Igala among other ones, attracted partly from all over the world by mining activities and her status as the capital city,

The population of Jos city is put at 892, 914 based on the 2016 population projection (National Population Commission, 2006). It has a density of about 391 persons per square kilometer and is the most densely populated and urbanized place in Plateau State. Due to the presence of so many higher institutions, church institutions, commercial activities, administrative activities which have over the years mobilized and are continuously attracting labour, capital and entrepreneurship, all these have combined to make Jos to assume the status of a cosmopolitan city.

RESULTS AND DISCUSSION

4.1 Identification and Location of Water Supply Projects in Jos Metropolis

The water supply projects in Jos metropolis comprise of the six dams, four water treatment plants, eight reservoirs, a network of underground pipes of different sizes and two surface tanks. These projects were executed by Plateau State Government and are managed by the Plateau State Water Board to take water to all the households connected to the piped water network within Jos metropolis.

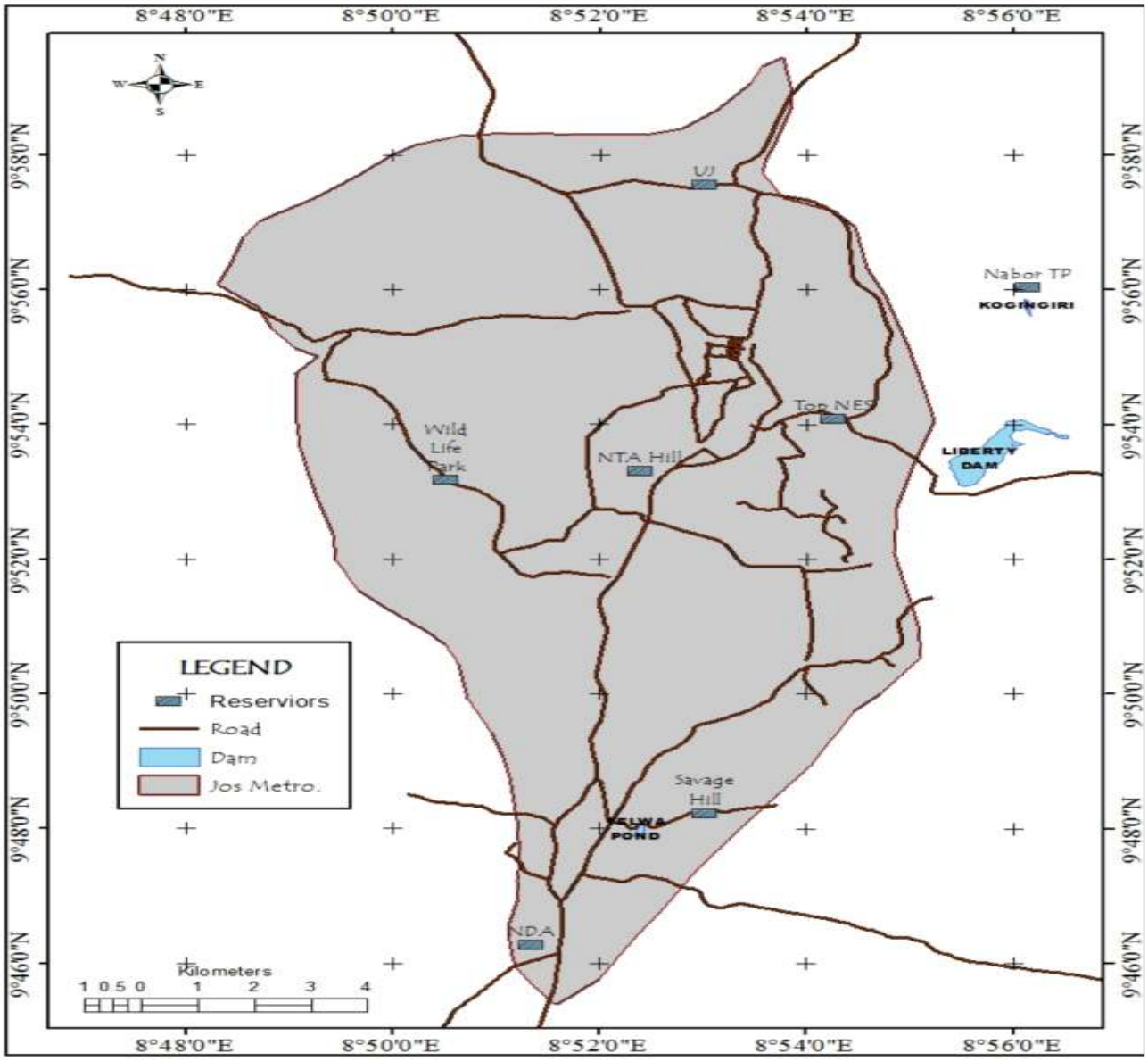

Figure 3: Jos Metropolis Showing Locations of Dams
Source: GIS LAB Department of Geography and Planning, University of Jos

Dams that supply potable water to residents of Jos metropolis are located mainly within Jos North, Jos South and parts of neighboring Barkin Ladi Local Government Area. These dams and their rivers are shown in Table 1 and Figure 3, the dams were built (constructed) on Rivers Rafin-Sanye, Nupis, Agog , Gwash, Shen River and Yelwa pond for mainly water supply purposes. Plateau State Water Board maintains a number of dams numbering six in Jos metropolis which supply raw water to treatment plants for processing.

These dams as shown in Table 1 include Kogingiri, Laminga (Liberty) Lamingo (Gwash), Tolle mache, Yakubu Gowon and Yelwa/ Bukuru dams. These dams were constructed at different times and at different sizes with a combined daily capacity of 117,000m^3 to provide potable water for the teeming urban population in Jos metropolis. Out of the 23 dams in plateau state, six are located in Jos metropolis and were built by Plateau State and colonial governments mainly to provide potable water for the teeming population of the

city. The remaining dams located outside Jos metropolis were built by NESCO, River Basin Development Authority and the Ministry of Agriculture for hydroelectricity generation, irrigation and water supply (FMWR, 2012). The three international rivers, the Niger, Benue and cross River and their tributaries draining the whole country provide ample sites for the construction of dams for all purposes (FMWR, 1991).

Table 1: Location of dams and their rivers

NAME OF DAM	LONGITUDE	LATITUDE	RIVER	LOCATION
Yakubu Gowon	8.97324	9.76574	Shen/Yingi	Ratt B/ladi
Laminga (Liberty)	8.92374	9.8919	Rafin-Sanye	Jos North
Yelwa	8.8727	9.8	Yelwa pond	Bukuru
Lamingo (Gwash)	8.95011	9.89514	Rafin-Sanye	Jos North
Tollemache	8.96783	9.89574	Nupis	Jos North
Kogingiri	8.936189	9.929282	Agog	Jos North

Source: Field Survey, 2016

4.2 Surface and Underground Pipe Network

This consist of a network of pipes that convey raw water from dams to the treatment plants and those which convey treated water to households and water storage tanks and reservoirs for use in households and industries. The pipes used in conveying water to households are made up of transmission and distribution mains and are mostly made of asbestos cement and aged between 10-70 years (see Table 2). Due to combination of factors of age and type of pipes, they are not able to withstand high water pressure resulting to burst and leaks leading to high level Non Revenue Water of 58%. This major infrastructure of Plateau State Water Board is in dire need of replacement and rehabilitation to enable them perform optimally in delivering exceptional services to the consumers. In the same Table 2 it is evident that some of the pipes have spent seventy (70) years, some Twenty-three (23) years, while others Twenty (20) and Thirty (30) years. This according to PSWB (2009) is responsible for frequent bursts and leaks which result to a lot of wastage (Non Revenue Water of 58%) and low revenue of Plateau State Water Board. These pipes would need to be replaced with quality PVC pipes (PSWB, 2009).

Table 2: Length and Age of Pipelines

Scheme	Age	Length(km) Transmission mains	Length(km) distribution mains
Old filter house	70	13	60
Laminga Treatment	30	28	110
YGD Ratt	20	-	260
Yelwa / Bukuru	23	-	48
Kogingiri			
Lamingo	1	1	

Source: PSWB 2009 and Field Survey, 2016

4.3 Water Treatment Plants

Each of the six dams in Jos metropolis has a treatment plant with varied production capacities except for Lamingo and Kogingiri dams which were built to provide support to Laminga and Tolle mache dams, see Table 3 for details of the treatment plants, their location and capacities. Raw water from the six dams is being transported and treated in the plants and is eventually distributed to households and other water subscribers in Jos metropolis through both gravity and electric power.

Table 3: Treatment Plants, their Capacities and Locations

Name of Treatment Plant	Year of construction	Built capacity	Production capacity	Location	Source of Water	Areas served
Yakubu Gowon Dam	1981	90, 000 m^3/day	9000(10%)	Ratt, Barkin Ladi LGA	Shen Yingi Rivers	Jos / Bukuru and Environs, Western Jos
Laminga Dam	1975	18,000 m^3/day	17820(99%)	Laminga, Jos North LGA	Rafin sanyi/ Gwash Rivers	Eastern/ central Jos
Yelwa Treatment plant	1976	4500 m^3/day	2700(60%)	Behind Yelwa Club Bukuru	Yelwa club Pond/Dorowa	Central Bukuru and southern Bukuru
Nabor Gwong Treatment plant Total	2014	5000m^3/day 117,000m^3/day	4950(99%)	Nabor Gwong Jos North	Shere hills Runoffs	Ungwar Rogo Northern Jos and Etto Baba Area

Source: Field survey, 2016

Nearly all the dams, treatment plants and reservoirs in Jos metropolis operate below their built capacities. The Yakubu Gowon Dam (Y G D) has capacity of 90,000M^3 per day but currently is operating just above 9000m^3 with 81,000^3 unutilised capacity (shortfall). Kogingiri receives support from Lamingo (Gwash) dam and has a capacity to produce up to 4500m^3 in a day but produce about 3100m^3 with a shortfall of about 1400m^3 daily, Laminga (Liberty) dam which has the capacity to produce 18,000m^3 per day and exceptionally contribute as high as 99% in a day, Yelwa pond has similar trend and produce only 2700m^3 a day as against 4500m^3 and in all the total quantum of water produced and transported to the reservoirs in a day is 117000m^3. But SUWASA (2015) put the percentage of Non Revenue Water at 58% which means that 67,860m^3 water produced by the Plateau State Water Board is either lost through bursts and leaks, illegal connection and or undistributed water due to low coverage.

Surface Water Reservoirs

Table 4 shows the different water supply reservoirs scattered in different parts of Jos metropolis. Plateau State Water Board has eight (8) water reservoirs of different capacities with a daily combined capacity of 87100m^3 as shown in Table 4 These reservoirs are constructed mostly on hilltops of relatively high altitude and receive water from the designated treatment plants which is eventually distributed into households through gravity.

Table 4: Water Supply Reservoirs

S/N	Name of Reservoir	Location	Year	Capacity	Water Source	Areas Covered	Purpose
	Savage Hill	TCNN Bukuru	1981	36,000m^3	YGD	Bukuru	Water supply
	Tudun wada	Near NTA Hill	1972	18,400m^3	YGD	Jos	Water supply
	New Eastern Side Reservoir	Rikkos	2001	12,500m^3	Laminga	Rikkos	Water supply
	NDA Camp Reservoir	Anguldi	2014	5,000m^3	YGD	Anguldi	Water supply
	Dwei Reservoir	Rayfield (Dwei Village)	2014	5,000 m^3	YGD	Rayfield	Water supply
	Old Eastern Side Reservoir	Rikkos	1981	9,200 m^3	Laminga	Lamingo	Water supply
	Nabor Gwom Reservoir	Ettobaba	2014	5,000 m^3	Lamiga	Ettobaba	Water supply
	Wildlife Park Reservoir	Federal Low Cost	2014	1,000 m^3	Yelwa	Fed Lowcost	Water Supply

Source: Field Survey, 2016

4.5 Overhead Water Tanks

Two overhead tanks were built in year 1981 and 1975 in Jos and Bukuru areas. Table 5 shows the details of the tanks constructed by the state government for water distribution easily into households through gravity. Due to long years of mismanagement, neglect and lack of attention, these overhead tanks are left in a state of disrepair and are dysfunctional and need to be brought back to use to enhance the capacity of the Plateau State Water Board to increase service coverage to unserved areas within Jos metropolis.

Table 5: Overhead Tanks and their capacities in Jos metropolis

Name of Tank	Capacity	Year of construc	Remarks	Location
Bukuru overhead Tank	10,000m^3	1981	Dysfunctional	Bukuru
Ministry of works overhead Tank	20,000 m^3	1975	Dysfunctional	Jos

Source: Field Survey, 2016

CONCLUSION

In order to identify the water supply projects in Jos Metropolis, the various water supply projects like dams reservoirs, treatment plants and overhead tanks were identified in different locations within Jos Metropolis, result of our analysis as shown in figures and maps indicated sufficiency of these water supply projects and their built capacities also show their ability to adequately cater for the rising population of households in Jos metropolis and their economic activities. Six Dams and four water treatment plants produce water which is being transmitted to the eight (8) water reservoirs of different capacities built in different residential areas within Jos metropolis to ease distribution to households. The unutilized and underutilized capacity of these water supply projects (dams) is 83030m^3 as depicted in table 1.

RECOMMENDATIONS

All the underutilized and unutilized capacities of all the water supply projects (WSPs) should be harnessed to boost water supply and cases of

burst of pipes witnessed in various parts of Jos metropolis should be promptly resolved to also enhance their capacities to provide quality and quantity of water that will satisfy the consumers and create in them the willingness to pay their bills always. The Board can go further to build more of these projects in different locations and increase their rate of households, commercial and institutional connections to unserved areas as this would boost the board's revenue base and make them become viable and profitable.

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