PATTERN OF WATER SUPPLY IN RELATION TO DIFFERENT WATER SOURCES IN METROPOLITAN KANO

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SPS/11/MGE/00062

BEING A DISSERTATION SUBMITTED TO THE DEPARTMENT OF GEOGRAPHY, BAYERO UNIVERSITY KANO, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN GEOGRAPHY (M.Sc. GEOGRAPHY)

OCTOBER, 2016

DECLARATION

I hereby declare that this work is the product of my own research efforts, undertaken under the supervision of Malam Murtala Badamasi. And has not been presented any where. All sources have been duly acknowledged.

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Hadiza Suleiman Abubakar

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CERTIFICATION

This is to certify that the research for this dissertation and subsequent preparation of this report by Hadiza Suleiman Abubakar SPS/11/MGE/00062 was carried out under my supervision.

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APPROVAL PAGE

This dissertation has been read and found worthy of approval having met the requirement specified by the Department of Geography, Bayero University Kano, for the award of Master of Science Geography (M.SC. Geography)

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DEDICATION

I dedicate this piece of work of mine to my beloved parents; Late Alhaji Suleiman Abubakar, Hajiya Zainab Aliyu Abubakar, and also to my Children.

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ABSTRACT

The study was carried out on pattern of water supply in relation to different water sources in metropolitan Kano. It was aimed to assess the pattern of water supply in the area. Eight local government areas were found in the area but six local government areas were selected in conducting the research work. The selected local Government areas included Dala, Fagge, Kano Municipal, Gwale, Tarauni, Nassarawa. Excluding Kumbutso and Ungoggo. The research work was conducted through the following methods of data collection,(questionnaire and interview). Krecjie and morgan sampling techniques was adopted in administering the questionnaire, because it was the best sampling techniques that suited the study. The result of the findings indicated that ground water sources are now the major sources of water used in the study area, pipe borne water was generally inadequate. Dala, Kano Munincipal, Fagge and Gwale were the areas mostly affected with scarcity of pipe borne water. Other sources of water for household usage included water from vendors and water supply Tankers. Some sources of water were found in active (that is sources of water producing less or no water due to some problems). Most people in the area depend on sachet water as their source of drinking water . Finally, in order to overcome some of the problems of water supply it was recommended that there should be alternative sources of power, regular maintenance, training of manpower, and effective management of water supply systems.

CHAPTER ONE

GENERAL INTRODUCTION

1.1 INTRODUCTION

Water is an essential biological need for humans. Without an adequate supply of potable water, most living things will not survive. Water is needed for personal hygiene, sanitation, cooking, cleaning, and laundry. It is essential for agriculture, fisheries, industrial production, river navigation, maintenance of ecological assets and biodiversity, promotion of tourism, and many other social demands. If all the earth's waters were fresh waters, there would be no need to secure water for human and nature needs for long time (Santoshi et. al., 2007). This is not the case in the real world, where 97 per cent of the water is in the oceans which is salty. Of the remaining 3 per cent, about 77 per cent is stored in ice caps and glaciers, 22.4 percent is in the groundwater and soil moisture, 0.35 percent in lakes and marshes, 0.04 percent in the atmosphere, and barely 0.01 percent in the streams. Even rivers provide 80 per cent of peoples freshwater needs, which carry only 0.000003 percent of all the water on earth (Elhance, 1999). Over the years, rising population, increasing industrialization and expanding agriculture have pushed up the demand for fresh water, hence efforts have being made to collect surface water by building dams and reservoirs. Due to shortage of the surface water, groundwater has been embarked upon in developing countries creating ground water structures such as wells, tube wells and boreholes to tap the groundwater (Lennitech, 2012).

The shortage of portable water is a vital problem in the 21st century. For hundred years the water consumption has increased faster than the population. By 2025, the demand may increased by 65%.Today 1.4 billion human beings do not have access to portable

water. Based on United Nation and UNESCO figures, this number could increase to 2.5 billion in 2025 which is a third of the whole world population. African water Association [AFWA], (2005). In recent report, the United Nation emphasize that too many people access to safe clean water is not yet attained, partly because of the failure to improve the quality and reliability of the service delivery in the water sector (United Nation, 2003). This problem is more enormous in the developing countries and has since resulted in massive poverty, hunger and diseases. The problems associated with the lack of adequate water in the country (Nigeria) threatens to place the health of about forty million people at risk. According to the World Bank (1990), it would cost in excess of US Dollar ten million a year to correct such problem if ground and surface water goes unchecked. The people most affected tend to be the urban and landless poor. In the long run, the present level of environmental degradation could create health problems from water born diseases for most of these populations.

Nigeria being a country in sub-Saharan Africa is recorded to have access to poor access to water supply and sanitation facilities by its citizens. Nigerian cities and environment in particular are fraught with inexorable rise of squatter settlements, breakdown of waste disposal arrangement, air and water pollution, inadequate water and sanitation services. Many problems of mortality, morbidity and poverty have been reported in the supplies as well as poor sanitation coverage and deteriorating environmental quality. In spite of the considerable investment of governments in Nigeria over the years, a large population still does not have access to water in adequate quality and quantity. It is estimated that 48% of the inhabitants of urban and semi urban areas of Nigeria and 39% of rural areas have access to potable water supply. In spite of these low figures, the average delivery to the

urban population is only 32 liters per capita per day (1pcd) and that for rural areas is 101 liters per capita per day (FGN, 2000). The scenario is critical when moving toward the northern part of the country because most of the landscape is that of the basement complex. Hence, this study intends to examine this problem in Kano.

1.2 STATEMENT OF RESEARCH PROBLEM

Linkages between water supply and sanitation and a cluster of key sectors, including health, education, agriculture, and environment are intuitively obvious, and documented with varying precision in different developing countries. Some of the data and project experience in Nigeria in these sectors in the recent years suggest clear linkages between poor water supply and sanitation standards which also led to decline in indicators such as health, education and productivity. Specifically, these include low enrolment in schools, particularly of girls who must spend time collecting water, higher crime against women due to lack of toilet privacy which also lead to environmental nuisance through submissive odour , as well as the more obvious impacts of disease, higher infant mortality, high absenteeism in schools and at work, and lower productivity. Thus by directly impacting key indicators in the health, education, agriculture/food security, and environment sectors, water supply has a profound impact on quality of life and is a major determinant of productivity and poverty levels. In this sense, water supply is the single sector investment with high and most diverse multi-sector returns positively or otherwise. Many other diseases endemic throughout the country are generally associated with unsatisfactory drinking water supplies, poor sanitation conditions and inadequate health education programs. These include diarrhoea, dysentery, gastro-enteritis, infectious hepatitis, hookworm, guinea worm, and other parasitic infections. Health implications of

water supply deficiencies in Nigeria are enormous. As the percent of people with access to safe water in the country is low and the country is relatively densely populated, the direct health repercussions, the situation impose, especially on children, is often underestimated. Improving water supply infrastructure will help improve the social well-being of the population directly. It has been shown, for example, that better access to potable water can relieve about the same total burden of disease (measured in daily-adjusted life years) as do improvements in public health care. Unlike literacy rates which usually take longer to become visible and materialize, increasing safe water provision, if done by using the right approach and taking into account affordability and sustainability into action, has proven to impact poverty rapidly and directly in many developed countries. In addition, water supply is an input in many aspect of human development. Studies have proven that the costs of water supply deficiencies in many cities in Nigeria are large. As water is usually considered as an infrastructure service, which its final consumption product and service is targeted to meet the basic needs of households, the costs of water supply deficiencies in public policy is often overlooked, underestimated, or totally unaccounted for. The heavy incidence of water supply failures among developing communities has an implication for the growth of the future generation most especially in communities such as the Kano metropolis. This research work therefore aimed at finding out the situation of water scarcity and sources in the study area.

1.3 AIM AND OBJECTIVES

The aim of this research is to assess the pattern of water supply in relation to different water sources in Kano Metropolis through the following objectives

1. To identify the sources of water supply for house hold usage in Kano metropolis.

2. To assess the nature of water supply in the study area.

3. To assess the quality of drinking water.

4. To identify the challenges of various sources of water supply in the area.

1.4 RESEARCH QUESTIONS

1. What are the sources of water supply in Kano metropolis?

2. What is the pattern of water supply in the study area?

3. How adequate is the supply of water in the study area?

4. What are the challenges of various sources of water supply?

1.5 JUSTIFICATION OF THE STUDY

The research work which is on sources of water supply in the study area is to explore issues pertaining water. As water is essential to all life on earth, yet nearly 800 million people lack dependable access to clean water and about 2.5 million people lack access to modern sanitation, putting them at risk of diseases. Despite the studies conducted on issues related to water supply to people in Kano metropolis, there is still the need to address some other issues pertaining to water supply in the study area. This necessitated the study to identify alternative sources of water supply in order to meet up with the challenges. Generally, the research intends to provide a basis for policy intervention by stakeholders with a view to make sustainable water supply in the study area. While issues of water supply are often looked at in isolation. It is directly tied to issues of food security, global health and climate change.

1.6 THE STUDY AREA

1.6.1 Extent and Location

The area for the study is Kano metropolitan area. The area encompasses eight (8) local government area. Kano metropolis is located in north western Nigeria, which served as provincial and State capital during the pre-colonial, colonial and post- colonial eras. Ancient Kano is the area enclosed by the city wall and it comprises three Local Government Areas (LGAs) namely: Kano Municipal, Dala, and Gwale LGA areas and some parts of Fagge. While the present Kano comprises Kano municipal, Dala, Gwale, Ungogo, Kumbotso, Fagge, Nasarawa and Tarauni, all in the south eastern, north eastern and south western parts and occupies an area of about 683Km^2, with an aerial distance of 19Km from east to west and about 15Km from north to south respectively. On the world map, it is located around latitude 12º 25″ to 12º.40” North and longitude 8º 35″ to 8º 35”East of the Greenwich Meridian.

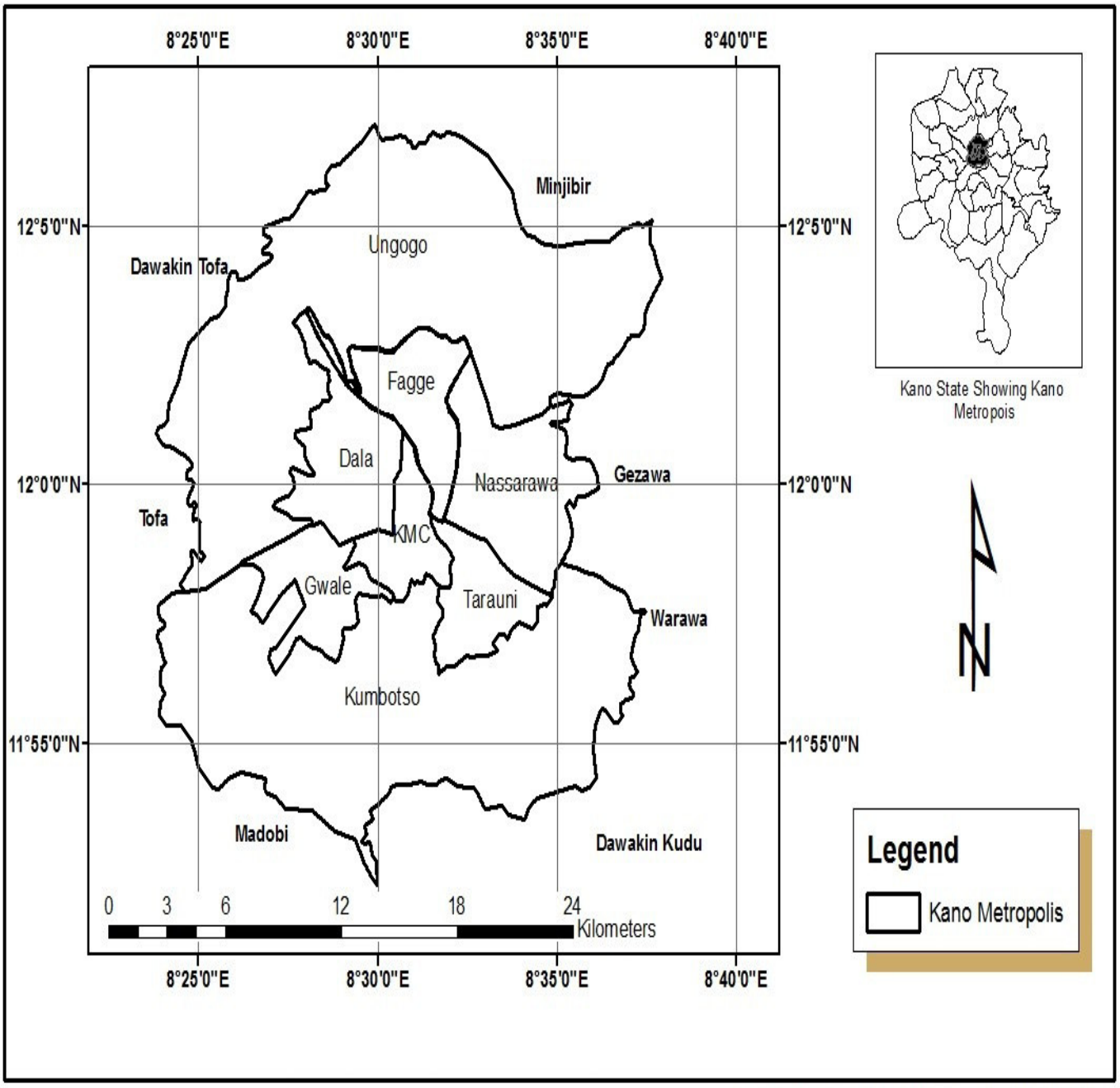

Figure1.1: Metropolitan Kano

1.6.2 Climate

Generally, the areas fall within the tropical “wet and dry” season which is categorized under Aw in Koppen’s classification. Consequently, a low mean rainfall of 880mm is a typical occurrence. In drought years it could be lower than 450mm as in the case of 1972/73 drought. Between 1997 to 1999, heavy down pour were recorded. In 1998 alone, over 100mm of rainfall was first experienced in the Arial metrological records and is called the flood year. According to Maryam et al, (2014)four distinct seasons are experienced, which are the dry and cool, dry and hot, wet and warm, and dry and warm seasons.

The Inter-tropical front (ITD) starts its southward movement in February and between March and May it has no considerable influence in the state and the weather is hot and dry during rani season. The mean temperature is 28 to 30^0c while this is the season when the "false" start of the rain is recorded in May. A few rainfalls are recorded in May and rain days are separated by days of dry spell and less than 1% of the annual rainfall is recorded in May. The ITD has by now made considerable advance northward and there is widespread rainfall in the state. Rainfall occurs mainly in the evenings for periods of one to three hours and considerable heavy rainfall (high intensity) is recorded in the first forty minutes of rainfall occurrences. Over 90% of the annual rainfall is recorded in this season. This is the humid period when surface runoff is available for stream flow and soil moisture in sufficient for plant growth. Damina is the crop growing season when grains and legume are grown. Temperature drops to an average of 24^0-29^0c while evaporation is lower because of the higher relative humidity of the moist south westerly’s air. This is why the runoff-coefficient is highest during this season.(Adnan Abdulhamid,2010)

1.6.3 Relief/ Geology

The area form part of the high plains of the Hausa land. And it is generally plain with elevation not higher than 600 meters above mean sea level (MSL). The general relief of the area is between 472 meters in south extreme to 557 meters in the east and northeastern side. The area is characterized by basement complex of undifferentiated and granitic materials. The materials consist of metamorphic and igneous rock types of Precambrian origin, aged between 580 and above million years. Geological reports from boreholes and VES data revealed that the thickness of the water bearing strata not exceeding 40 meters except for Airport where soft overburn layers reached up to 76 meters (Szentes, 1974). To large extent useful information about the cross section of the overburn layers of sedimentary regolith is shown in deep gully erosion. At Gama and Kura Goje of North and Eastern Gwagwarwa , Getsi River at confluence of Jakara, gully head has a depth of about 8.50m these revealed sandy and clayey rich materials. No underlying rock materials were exposed, which indicated that more soft materials were presented underneath. Region geology has also indicated that in North and North-eastern part of the study area, metamorphic rocks formed most of its geological landforms, while in the southern part, the older granite form its geology. Although this distinction is theoretical and no theory can sufficiently explain the whole range of geological process involved in any land formation (El-Nggar, 1992).

1.6.4 Drainage and Hydrology

The metropolitan Kano being situated on the basement complex zone of Kano region which is a zone of high surface water discharge and retention, this feature makes it possible for the accumulation of surface water especially in ponds and rivers around the area. The Jakara River which dissects the ancient city which collects water from minor streams and channels, when this

water is collected into the Jakara River the water then moves north-wards and discharge into the Jakara reservoir in Minjibir. Most of the domestic waste effluents collected from the ancient city are discharged into the Jakara River. Most of the houses close to the ancient city wall discharge their effluent into the ponds beside the wall.

The hydrology and drainage of Kano metropolis unit is the reincarnation of the larger system of Kano region, relief, climate and human activities influence them. The gently sloping terrain made the natural hydrology predominantly surface one, dominated by ponds and streams. The surface drainage is principally a disappearing flow type made up of individual streams that drain along the slope gradient to Jakara reservoir (northeast wards) and river Kano (southeast wards).

The microclimate of the metropolis also controls the amount of water available both on the surface and sub-surface at any given time of the year. Thus, water is available in the sub-surface in all the seasons and only wet season on the surface except in few ponds and reservoirs, even though, the water level falls drastically through seepage from the far bordering zone of surface water discharge and retention to the west and south.The disparity in overland flow throughout the metropolis is compared in Shaw (1989), where the run off decrease when one moves from the centre of the Kano city to semi-urban and to non urban areas and infiltrate capacity increase. The basic difference is based in the idea that, there is reduction in the base flow component since there is less percolation and recharge to groundwater.

Environmental profile of metropolitan Kano reported in 1997 that the total catchment of Jakara and Challawa from impervious settlement of Kano as related to the total catchment of the rivers.

1.6.5 Soils

The soil are generally matured on the plain but seriously altered due to human activities. The influence of topography, wind drift material (from desert) and climate are what shaped the aggregate of the soil. The matured soil are said to be latosols of ferruginous type (Olofin, 1987:6). The soil is however, well drained, brown to reddish in color. Along the floodable area of river channels hydromorphic soils are found. These are dark in colour and have a high content of clay. The soil have marked differentiation of horizons, frequently has a leach "A" horizon and always contain a textual or structural "B" horizon.

The study area lies within the Sudan Savanna zone and form part of the human settlement in which vegetation is seriously depleted through the construction process. Very few natural vegetation species are often found and these do not exceed 20 meters in height. Grasses are hardly found, except in scanty patches. These hardly reach 1 meter in height at maturity and tend to dry up in the dry season. Cultural vegetation has replaced the natural vegetation in the area, where exotic species are predominant.

1.6.6 Population

Based on the 1991 Census, the population of Kano metropolis was about 2,374,221 with a density of about 6,476.2 persons per Km^2 (Ismail, 2009). By the year 2004 the estimated population has risen to about 3 million (NPC projection 2004) with a density of 4,392.4 persons per square Km. By the year 2006, the population has reached 9,383,682. Even though the population is not evenly distributed, the settlement pattern has been characterized by two categories based on population density. The first category is the high to medium density settlements which include the old city and the peripheral areas respectively, while the second

category is the low density settlements of Nassarawa, Tarauni and Hotoro Government Reserve Areas (GRA); Kabuga, Kundila, Ja'oji, Darmanawa, and Mariri housing estates among others. The old city, which is the most densely populated area in the metropolis, has a unique cultural setup that reflects the people's religious belief (Islam). Most buildings are made up of mud and clay, closely packed and surrounded with walls (Ismail, 2009). The cosmopolitan nature of the city has also resulted in the growth of the population of other tribal groups such as Yoruba, Igbo, Kanuri, Edo, Tuareg, Lebanese, Middle class live in medium density areas while the two income group live in high density areas within the old city and in the metropolitan fringes as well as in pocket areas alongside the medium density settlements. The predominant occupations of the people are agriculture, trading and commerce. The populace also provide labour force to over 360 heavy and light industrial establishments within the metropolis. (Kano State Water Board 2006.)

1.6.7 Water Supply System

A water supply system delivers water from its source to the consumer homes, business or industrial water users. The source of a water supply may be either groundwater or surface water. Surface water may be natural lakes, rivers or reservoirs formed by impounding water behind dams. Water is usually transported from its source through a transmission system consisting of open channels (canals) or large pipes (called conduits) to a water treatment plant. After treatment, the water usually is pumped into transmission lines which are connected to a distribution grid system. From the grid system, the water is delivered to individual service lines which serve private homes, business, factories and industries. Ground water may not have transmission lines, but often are disinfected with chlorine and pumped directly to service storage and distribution systems.

Storage facilities may consist of large reservoirs behind dams (impoundments) or service storage reservoirs located at a water treatment plant and/or at various places in distribution system. Storage facilities for treated water at water treatment plants are called clear wells. Operational service storage tanks in distribution system may be pressure tanks, elevated tanks, ground-level tanks or reservoirs or underground facilities.

Surface water requires treatment to remove suspended and dissolved materials and also to kill or inactivate disease-causing organism. Groundwater may require treatment for removal of excessive hardness, taste and odor-causing substances, dissolving gases and impurities such as iron and manganese. Water treatment plants provide the necessary treatment to make the water treatment plants safe and suitable for drinking purposes. All waters regardless of the source or treatment received, should be disinfected to prevent the spread of disease-causing organisms. Chlorination is the most common means of disinfection used today to protect the public's health.

1.6.8 Kano State Water Supply System

Kano State, Nigeria second most populous state and one of the most vibrant industrial and commercial centres were created May, 1967. Provision of portable water in the state is the combined responsibility of the state and local governments. After the creation of the state in 1986, the water division of the then State Ministry of Works was responsible for the development of water resources.

Three earth dams (Tiga, Karaye and Birnin/kudu) were constructed through direct labour. In 1974, the state government created an agency called Water Resources and Engineering Construction Agency (WRECA) to ensure portable drinking and irrigation water to all nooks and corners of the state. Dam of different capacities were constructed all over the state to provide

water supply for irrigation and for recreational purposes. With the completion of almost all the planned dams and the need to ensure more efficient operations and maintenance of water supply, WRECA was splitted into three separated establishments namely:

1. The Ministry of Water Resources which formulates policies.

2. The State water Board responsible for operation and maintenance of the existing water treatment plants.

3. The new WRECA which is now fully a commercial outfit.

In 1993, the state government decided to separate the urban and semi-urban water supply from the rural water supply. The water board therefore covers water supply in urban and semi-urban centers. There are seventeen water supply regional schemes under the Board and each one serves at last two local governments (the headquarters and the major towns). The rural water supply is currently handled by the State Rural Water Supply and Sanitation Agency (RUWASA).

1.6.9 Water Resources Potential

1. **Ground Water**

The ground water resources potential relates to underlying geology, Greater Kano is underlain mainly by granite rocks. Although these rocks were weathered to some depth, or fractured, do hold some water and hundreds of bore-holes have been drilled over the years in Kano state to tap such aquifers, the output from the bore-holes are however, low within the range of 100,000 liters/day, this is adequate for domestic use, rural settlements and very low water consuming industries.

A survey conducted by Messrs Parkman revealed that the potential source of ground water that may contribute significantly to the demand of Kano state are recent alluvial deposits along the channels and floodplain, of the major rivers (Kano and Challawa).

This source of groundwater has been exploited for a long time for the water supply of Kano state. Presently, only about 10% of the water supply to the state is derived from alluvial aquifers

2. Water Resources in Kano

The Primary river within the project area is Challawa River with its tributaries; River Kongor, River Dmjatau, River Didiri, River Damuni and River Dudurun Gaya. The Challawa River runs behind Wudil, approaching it from the north, meanders and passes behind Garin Dau and continues in a south westerly direction. River Kongor passes through Tudun Gunsau in the south and tunrs north east through Gwarai before passing close to Gatchi at a place where it crosses the Wudil-Gaya road perpendicularly before emptying into Challawa river. River Dmjatau passes some kilometers behind Utai and runs on a northerly courses crossing the Wudil-Gaya road perpendicularly at a location in between Gatchi and Rege before emptying into Challawa River.

River Didiri Aarawa is a tributary of River Dmjata and originates about Amarawa following an east-west course before emptying into River Dmjatau. River Danladi has origins at locations about Yankau, Danruwatau Malamawa, Kasai and Wudilawa. It collects about Wudilawa and empties into River Dmjata close by River Damuni originates about Kausani and runs Northwest to empty into Challawa River. River Dudurun Gaya lies some 7.8km south east of Gaya only the Challawa River has some limited data for assessment of potential of surface water resources. The most recent extensive study of the Kano/Challawa River system was that undertaken by Parkman in 1999 which concluded that the potentials for surface water within the project area remain the

Kano/Challawa River system. Using scant available hydrological data, they estimated the 95% reliable annual yield of this river system to be 944mm^3 (2,586 MLD). It was also noted that the then current releases from the reservoirs were more than their long-term sustainable yield .

The feasibility studies concluded that the Kano/Challawa River system is adequate to provide for the water needs of Greater Kano up to 2025, though this may come under increasing pressure from competing uses.

Since part of Greater Kano form an axis of coverage from the Wudil Treatment Plant there is available potential for utilization of surface water as source for the Wudil Treatment Plant.

3. Groundwater Resources in Kano

There are two potential groundwater resources in Kano. These are:

1. Groundwater derived from the rocks of basement complex and
2. Groundwater derived from alluvial deposits along the channels and floodplains of River Kano and River Challawa.

4. Surface water

Surface water must provide all or nearly all what is required. It is also clear that the greater part of the supply must come from the regulated catchments of the Kano and Challawa rivers including tributaries such as Watari River. Water consumption is based on domestic and those of socio-economic and institutional needs. Future water demand is based on projections of population of the state. The following per capital consumptions are adopted:

- Urban area with population above 20,000 = 120 L/C/day
- Semi-urban area with population below 20,000 = 80L/C/day

An additional 20% is assumed for other uses (commercial, industrial etc) the unaccounted for water has been estimated at 25% (leakages).

The first conventional water treatment plant using tube-wells as raw water source was built in 1932 at Challawa with a maximum capacity of 18MLD. With time, this volume became inadequate. A second water works with a capacity of 180MLD was completed and commissioned in 1974. This uses both surface ad tube-wells as raw water source. In 1991 another water works with a capacity of 90MLD was commissioned.

Presently according to Magaji Hussaini (2004), apart from the above three water works, about seventeen regional schemes were constructed across the state and about fifteen dams of different capacities were also constructed at different locations in the state.

Knowledge on the sources of water in Kano is required for adequate planning . For instance,

It is estimated that about 35,000 boreholes per annum need to be drilled in sub-saharan Africa e.g. Nigeria to meet the Millennium Development Goals (MDGs) for water supply. For full coverage by 2050, inclusive of the demand for industrial supply and irrigation about 50,000 boreholes per annum are required. This poses a great challenge to the drilling sector in Africa and there is urgent need for reliable and cost effective drilling services. At the 5th Forum of the Rural Water Supply Network (RWSN) in December, 2006 in Accra, it was agreed that in order to meet the MDGs for water supply and sanitation, drillers association must be formed in each African country (Dotin Adekile, 2008).

The seasonality and annual variability of the water regime necessitated the development of water resources by way of dam construction to harness surface water. The dam structure needs to be managed in order for the water reservoir life span to be achieved. For example, the Bagauda dam

was designed to store about 22.14 million of water for irrigation, domestic supply, fisheries and recreation. Nigeria's surface water resources is estimated to be about 267 billion m^3/annum while it is Ground water resource is estimated at about 52 billion m^3.

Rainfall is another source of water which supplies water for mostly domestic use. The average rainfall for the country varies between 250mm per year in the north (occurring mostly around April and September) and could be as high as 400mm per year in the south (occurring mostly around March through October) depending on location (Dotin Adekile, 2008).

Rainwater harvesting provide water at or near the point where water is needed or used. The system can be both owner and utility operated and managed. It has few negative environmental impact compared to other water resources development technologies. It is relatively clean and is usually acceptable for many purposes with little or even no treatment. The physical and chemical properties of rain water are usually superior to sources of ground water that may have been subjected to contamination. (Olugboye, 1995).

It involves the collection and storage of rainwater in surface and subsurface for future use. The in site storage includes roof water collection, collection in ponds and collection in other artificial storage structures. Rain water is generally of good quality and has been helpful augmenting other sources. This is usually practiced on an individual or family basis.

CHAPTER TWO

THEORITICAL FRAMEWORK AND LITERATURE REVIEW

2.1 INTRODUCTION

Groundwater accounts for over 95 percent of the earth's useable fresh water resources. In general, it is widely distributed, dependable, inexpensive and usually required little pre-treatment. Over half the population depends on ground water. Nigeria has abundant groundwater resources which have been developed through shallow-dug wells and boreholes. Since 1980, there has been an astronomical increase in the number of wells and boreholes constructed in Nigeria. These have been controlled to a certain level by government at all levels, private companies, international organizations such as UNICEF, UNDP, EU, communities and individuals.

Occurrence of groundwater varies with the geological nature of an area. In the basement complex terrain, groundwater occurs in the weathered regolith and in fractures of the fresh rocks. The use of surface geophysical techniques coupled with down the hole hammer have revolutionalized groundwater development in the basement complex areas. Many communities now obtain water from boreholes either with hand pumps or motorized pumps.

Well fields have been developed in many communities within the basement complex areas. In the sedimentary areas of Nigeria most aquifers consist of sands and gravels. Limestone (carbonate) aquifers do occur and are developed in some areas while groundwater occurs in most parts of the sedimentary basins some communities still lack suitable groundwater. The area are underlain by clays; they can only get water supply through surface water sources. These areas occupy much less than 5 percent of the country.

Static water levels in water wells range between zeros in parts of coastal alluvium to 200 mat adepth of aboutetres in some sedimentary areas (FGN, 2000:2). It is further established that in crystalline rock areas found in many parts of the north, well yields are unpredictable, where sufficient depth of weathering exists the area may be suitable for operation. Wells dominate the ground water hydrology of the area just at some 2.5 to 5m deep before reaching the water table .Water table is very shallow and in most cases at a depth of about 20m below the ground surface and average values of transitivity and co efficient of permeability for the basement complex as observed from many boreholes log are 0.5134m^3\hr(12.32m^3\day) and 0.0138m\hr(0.33m^3\day)respectively (Mohammed 1984).

2.2 THEORETICAL FRAME WORK

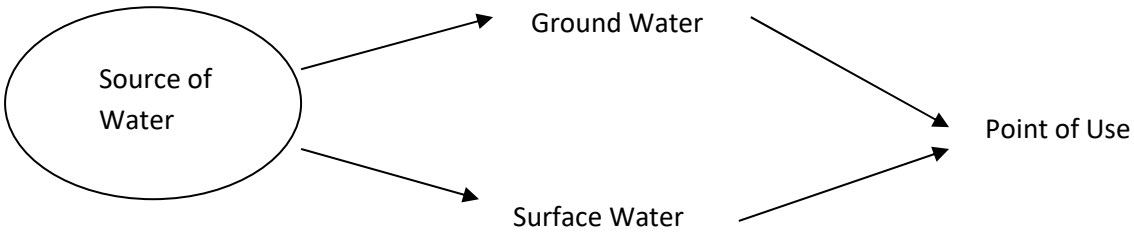

Figure :Idealized water sources in Kano

Source: Authors Conception, 2016.

Water is fundamental for sustainable development. It affects sanitation, health, poverty alleviation, disaster reduction and ecosystem conservation. It cuts across all eight Millennium Development Goals. In particular MDG 7 and it is target to reduce by half the proportion of the 2.6 billion people without access to safe drinking water and basic sanitation by 2015. In addition, the ever growing vulnerability that is induced by global and local changes such as population

change and variability in socio-economic issues and environmental degradation can result in increasing both the frequency and severity of extreme events, including drought and floods.

Recently, in its report, the United Nations emphasized that the world is facing a serious water crisis and that water access and service delivery in the developing world need to be improved dramatically and urgently especially if we are to make gains in the fight against poverty, hunger and diseases (United Nation, 2003)

Nigeria's National Water Supply and Sanitation Policy, approved in 2000, encourage private sector participation and envisages institutional and policy reforms at the state levels. However, little has happen in both respects. As of 2007, only four of the 37 states- Lagos, Cross Rivers, Kaduna and Ogun State began to introduced Public-Private partnership in the form of service contracts, a form of Public Private Partnership where the responsibility of the private sector is limited to operating infrastructure without performance incentive. While the government has a decentralization policy, little actual decentralization has happened. The capacity of local governments plan and carry out investments, or to operate and maintain systems, remains low despite efforts at capacity development. Furthermore, the national policy focuses on water supply and neglects sanitation.

Nigeria's surface water resources is estimated to be about 267 billion m^3/annum while it's ground water resource is estimated at about 52 billion m^3 ground water potential. While only 15% of the surface water has been utilized (Garba, 2009) statistics on the actual amount of the ground water utilization is, however, not available. What is most commonly known is that ground water resources (which come in the form of boreholes and hand dug wells) have become the most important sources of public and private water in urban and rural areas which attract wide and minimally regulated exploitation (Apkpabio, 2012: 4).

2.2.1 Effects of waste Deposits on water sources and its consequences

Pollution results from the release by man of substances likely to affect human health or damage ecological ecosystems in general. The contamination of water by the discharge of untreated sewage into surface or ground water is among the most serious form of pollution, especially in the urban centers and is mostly responsible for various types of water borne diseases such as dysentery, cholera, typhoid. Today, less than half of population in developing countries have no access to safe and drinking water.

Acid rain is a type of water pollution that occur as a result of oxidation of sulphur dioxide and nitrogen in the air to form sulphuric acid once oxidized the sulphuric and nitric acids dissolves in the available cloud water. Rain is already naturally acidic due to small amount of dissolved carbon dioxide. Unpolluted rain has a Ph of about 5.7, while acid rain Ph varies greatly. Rain water in eastern England for example may be around Ph of 4.5.However,severe pollution events may cause rain or mist of P.H 2.0 to be formed. The effects of acid rain often depend generally on total quantity of acidity deposited. The deposition of such pollutants may take place many hundreds of kilometers from their source. Sulphurdioxide is produced by the combustion of fuels containing sulphur. It rarely occur naturally. The main combustion sources are generally Coal and oil.Some oil derived products lack sulphur (e.g petrol while some retain it e.g diesel.The extensive use of coal for domestic heating is a significant national and local source of sulphurdioxide. However,this has now declined substantially, the principal sources are now large power stations and industries that use coal or oil as energy sources. Natural gas is very low in sulphur. Much of western Europe and North America, ambient concentrations have fallen markedly in recent years(Laxen and Thompson,1987).

Atmospheric deposition (Nitrogen compound + Sulphuric compound)

Increased susceptibility to drought

Soil leaching

Acidifies water, affecting water sources

(Source; authors conception,2016)

A model of Acid rain formation

Arsenic is another natural chemical found in the rock and soil it dissolves into the well water the result is a massive on going poisoning event in which million of people suffer from Arsenic poisoning. Example of such incidences is in Bangledash and India. {US Environmental protection agency (EPA) 2005}.

The WHO estimates that 80% of ill health in the developing countries is water and sanitation related. It is also reported that only 61% of people in developing countries have access to adequate water supply while 36% had access to sanitation facilities (WHO 1998).

The potential sources of surface water pollution in Kano region are mainly from the industrial estate in the densely populated Kano and the largest irrigation project (A.I Tanko,2006)

Where proper sanitation facilities are lacking, water borne diseases which are caused by water contaminated by human, animal or chemical wastes spread rapidly. Diarrhea, the disease major

water borne is responsible for 4 billion cases every year, causing 3-4 million deaths especially in children and infants (Ishankye etal; 1997 USAID 1990). Other water borne diseases include cholera, typhoid fever, bacillary dysentery, polio-meningitis and hepatitis A & E.

Guinea Worm Disease (GWD) is another extremely painful parasitic infection spread through contaminated drinking water. It is characterized by thread-like worms slowly emerging from human body through bluster. Infection affects poor communities and remote part of Africa that not have safe water to drink. In 2008, fewer than 5000 cases of Guinea Worm Disease were reported. Most of those cases were from Sudan (78%).

Worldwide, water-borne diseases are a major cause of morbidity and mortality in humans (WHO, 1996). While water-borne pathogens infect around 250 million people per year, resulting in 10–20 million deaths (Anon, 1996), many of these infections occur in developing nations that have sanitation problems (Nsubuga et al., 2004). Lewis et al. (1980) also reiterate that diseases caused by pathogens are related to the use of contaminated groundwater hence, the greatest cause of death in developing countries. In African countries such as Nigeria, most of the rural communities are poverty-stricken, poor access to portable water supplies and rely mainly on shallow wells, rivers, streams and ponds for their daily water needs (Nevondo and Cloete, 1999). In most cases water from these sources is used directly without treatment and the water sources may be faecally contaminated (WHO, 1993).

Simple low-cost on-site sanitation methods have been developed to dispose faecal matter, mainly because of their economic advantage. However, the biggest drawback is the well-recognized potential to pollute groundwater resources (Adelodun, 2001), which conflicts with Integrated Water Resources Management principles, in particular to preserve the integrity of vital ecosystems and to maintain water quality and quantity. Given the widespread use of groundwater

for domestic purposes in rural areas, maintaining groundwater quality is a critical livelihood intervention.

Globally, the larger part of the population lives in rural areas and in Africa it is estimated that these people represent approximately 70–80% of the continent's population. In Zimbabwe for instance, according to figures derived from the Census 2002 Zimbabwe Preliminary Report (CSO, 2002), the rural population is about 70% (the derived figure is 68%), with that same percentage relying on groundwater (Chenje et al., 1998). The reliance may be higher in some districts as noted by Hoko (2005), where rural communities like Gokwe, Nkayi, Mwenezi and Lupane mainly use groundwater for domestic purposes with very little reliance on surface water. Yet there is an information gap on the levels of groundwater contamination from pit latrines (Chenje et al., 1998; Chidavaenzi et al., 2000). Therefore the quality of groundwater, which potentially can be affected by on-site

sanitation systems, must be carefully assessed in order to reduce the health and environmental risks.Groundwater pollution has been the focus of attention by many researchers in the recent times (Weissman et al., 1976: Graun, 1984; Whelan et al., 1984; Hyelni, 1994; Dillion, 1997; Pedley and Howard, 1997; Howard et al., 2002; Khazael et al., 2004; Priiss-Ustun et al., 2004; Ayanlaja et al., 2005; Pritchard et al., 2007). Leachate from pit latrine is one of the major sources of this pollution. It is partly responsible for low access to potable water and sanitation problem especially in many developing countries (WHO, 2002). Therefore, there is an urgent need to provide an improved water supply and a safe means of excreta disposal.

Pit latrine is a common method of excreta disposal in the developing world. It is popular and widely used in urban slums as well as rural areas probably because it is the simplest, cheapest and the most efficient excreta disposal that is within the reach of the poor people. Rybezynski et al (1977) affirmed that pit latrine remains to date, the most widely used technique for excreta

disposal in the developing countries, both in the urban as well as the rural areas. Ground water is often polluted because pit latrines are mostly located near water source such as shallow wells. In fact, pit latrine has been identified as a major source of contamination of wells with faecal matter (Molard et al., 1994; Howard et al., 2002; Ayanlaja et al., 2005; Pritchard et al., 2007). Bacteria, viruses and other contaminants such as nitrate infiltrate the surrounding soil through leachate from pit latrine to ground water. Dillon (1997) asserted that in the latrine pits, the liquid soaks away through the base and side of the pit. That is in the absence of a protective structure between the content in the pit and the soil.

Hence, human waste in the pit contain large numbers of enteric micro-organisms that have high concentration of nutrients and a high oxygen demand, all of which may have adverse impact on groundwater quality (Dillon, 1997). At least, an average adult excrete about 2,000,000,000 coliform bacteria in each day (Geidrich, 1966). The mass and chemical composition of feces, urine and the microbial composition of feces from adult is compose of calcium, carbon, nitrogen, organic matter, phosphorus, potassium, sodium, magnesium, chloride and sulphate (Feachem et al., 1983; Cancer, 1988).

The presence of bacteria in water indicates the preference of pathogenic organism causing water related diseases. The pathogenic organisms are the most important sources of serious illness and death especially among young children in poor countries. Water- related diseases such as cholera, bacillary dysentery, typhoid, hepatitis, diarrhea and others are all feco-oral in their transmission (Trivedi et al.,1971; Feachen, 1983; Kukkula, 1997; Nassinyama et al., 2002; Priis-Uston., 2004). Unsafe water and poor sanitation account for 3. 7% of the global diseases, and 80% of all the diseases in the developing world. Diarrhea alone accounted for the yearly death of 1.6 million people around the world (WHO, 2007). Children under 5 years are the most

vulnerable. Shallow wells are important source of water supply in the study area. The closeness of most of these pit latrines to shallow wells is capable of causing ground water pollution, consequently leading to water-borne diseases and possible outbreak of epidemics.

Table: Identified Water Pathogens and Diseases

PATHOGEN	DISEASE	EFFECT
Bacteria	Typoid	Headache severe
Salmonella typhi	Dysentery	Vomiting/ diarrhea
Shigella dysenteride	Chorela	
Vibro escherichia (ecoli)	Enteritis	
Viruses	Polio	Severe headache
Hepatitis		Fever, gentive and
Poliomyletis		enlarge liver, paralysis, body and limb can be fertile
Parasitic worms	Amoebic dysentery	Severe headache,
	giardiasis	abdominal pain, fever can be fertile if untreated
		Diarrhea and fatique
Schistosma spp	Hack infestation	Skin rash, fatique,
Anchylostomas spp		anaemia.

Source: Adapted from Jackson & Jackson, 1996 (Adakiyaoye, 2010).

2.3 Water Sustainability and Reliability

1. Adequate quantities of water are required for healthy living: for drinking, cooking and washing. The WHO recommends that the minimum daily amount per person is 27 liters per day. Because of the population growth and urbanization, the gap between per capita water supply and demand is getting bigger. Population growth also has an effect on demand of food and sewage disposal facilities. This means bigger demand of irrigation water and bigger water resources.

These days in many countries the water demand is between 20 to 40 per cent of the total runoff, even the sustainable amount would be 5 per cent. The demand nowadays in many countries is so massive that it needs investments and a large part of GNP has to be used for the water management (Vakkilainen et al 1999).

2. Kasarda and Parnell 1993 stated that in most African and Asian cities recurrent supplies of piped water seem to be the norm, because of scarcity of needed equipment, material, and skilled personnel, Power outages are also normal. This irregular electricity supply causes pumps to shut down and reduces water pressure, which creates problems by damaging the water pumps and water treatment plants. In many cities in developing countries piping systems are reasonably old, and non-effective. The loss of water by leaking is enormous. Leakage of water may make up as much as 40 to 60 per cent of the total water supply in developing cities. The personnel are inadequately trained and monitoring is non-existing.
3. Already 20 per cent of the world's population falls short of access to safe drinking water. This situation is set to worsen dramatically. If current trend holds, per capita water supplies worldwide will drop by more than a third by 2025. This means that 67 per cent of people will live in water stressed condition.
4. The problem is most acute in Africa and West Asia. In Africa, 14 countries already experience water stress or water shortage. Another 11 countries will join that list in the next 25 years (Somlyódy et al. 2001, Postel 1992). Even our planet has a great physical, chemical, and biological systems to clean waters, we humans are even more effective in dirtying it. Fast growth in population, more effective agriculture and industrial development are the main reasons for the growing amount of pollutants in the waters. Wastewater from the human settlements contains organic material and nutrients,

industrial wastewater contains heavy metals and complexes, insoluble chemical compounds, which are harmful to people, animals and plants. Fertilizers and pesticides are used in the agriculture and they are harmful for the surface and groundwater, traffic loads air, soil and water and irrigation burdens water with salt. In the developing countries these agglomerations are even worse than in developed countries because they do not have proper sanitation and the technique are often too old and non-effective (Bowman 1994).

2.3.1 Water Resource Management

Water resource management involves a sequence of activity and decision including needs assessment, problem analysis, resource allocation, planning and design, implementation, operation and maintenance all of which are inter-related in a complete way.

Water Demand Management is defined as a strategy aims at using water resources in an efficient and sustainable manner, taking into account social, economic, environmental, natural and regional conditions. It is the most economical way to increase the availability of water while limiting as much as possible heavy investments (transfer of water from far away sources for example). That strategy provides the hope that those who receive an intermittent service today and those who have no water supply service at all in their informed housing areas (peri-urban areas) will in the future have portable water insufficient quantity and quality and in a sustainable way.

Water resources development practices in the Kano region began in the late 1960s and was basically to address natural water deficiency due to climatic short fall and also the hydrological conditions.

Early attempts and strategies especially in harnessing the surface water resources included the creation of artificial ponds, use of shaduff pits, improved springs and streams intake and the construction of dams, reservoirs and irrigation canals (Olofin, 1987).

Hussaini, (2009) Assert that, the creation of the FEPA as the central co-ordinating body for all environmental matters within the country, Nigeria has evolved a mechanism that will monitor adequately and will keep records of all relevant environmental variables.

The new integrated water resources management concept adopted by the government will, without doubt improve all aspects of water use and conservation within the country the political will and financial resources for the implementation are sustained.

Management of water resources is aimed at making water to meet optimum long term environmentally sustainable use of society.

Sustainable use of water resource means that, even where the immediate demand for development are very high, society must find different development approaches which make sure that the use of water resource does not destroy their ability to recover. If water resources \are over used, if too much water is taken out, too much pollution put in, or if great structural change is made they may no longer be able to recover. In this way their capacity to meet human demands can be reduced or even lost. If the use of water resource remain with their capacity to recover, that level of use can probably be sustained in the long term. It is not necessary for a water resource to be left untouched to remain functional. The intension of sustainable is to balance water use with the protection of the resource in such a way that the resources are not degraded beyond recovery.

Well co-ordinated water resources studies need to be undertaken. It is necessary to quantify all aspects of demand and relate it to available resources. Where the demand exceeds the available resources, increase the supply. This will maintain a favorable balance between water demand and water supply while satisfying the various constraints of quality, technology, availability, sustainability and environmental and economic factors. Rigorous quantitative hydrological studies, geophysical investigations, assessment of equifer parameters, evaluation of well and equifer hydraulics to determine optimum yields, optimum borehole spacing, water quality testing and economic analysis to determine optimum yields are important prerequisites for scientific management of water resources. Extensive need exists for adequate and reliable data for water resources planning and management. In order to obtain such data deliberate policies need to be in place by the concerned authority to provide the necessary financial backing and a conductive atmosphere to enable water experts and operators to become responsible and to these task The management involves measures like:

- Improvement of water use effectiveness
- Rain water harvesting
- Water conservation measures, e.g. leakage detection and repair, control of free-flow, boreholes in the area.
- Improved management of the state Water Agencies Operations.
- Conjuctive surface/ground water use and management.
- Formation of the water resources development co-ordination committe .

Water utilization in the energy sector involves instream use which encompasses water used for cooling purposes in the thermo electric power stations usually returned to the influent water body. Secondary, consumptive use after utilization involves water used for drinking, sanitary

purposes, water not fit for use in any other activity prior to treatment, prevent of windblown dust, and water that is lost as vapour from cooling towers. The energy sector must compete with other water users, namely: agricultural domestic and industrial sectors for the allocation of water resources and this can have serious implication for the siting of new energy related infrastructures. (IAGS, 2004).

Energy for hydropower generation rely on the potential energy difference between the levels of water in reservoir, dams or lakes and their discharge tail water levels downstream. Hydro potential where the energy liberated from water falling through a certain height create forces used in turning turbines to generate electricity.

Energy is also use in treatment of water. Electrolysis whereby electrochemical oxidation of water takes place to produce to produce ozone whereby the water is passed between anode and cathode terminals to produce oxygen and ozone and the water is disinfected. Then the electrical discharge of corona discharge ozone generation, and then the ultraviolet radiation.

Ozone water treatment is used as pretreatment chlorination and subsequently become a primary treatment for the removal of taste and odors.

Ozone is a powerful disinfecting agent that can be used effectively in drinking water applications. The objective when using ozone is to optimize its generation and its contact with water to achieve the best water quality with the least amount of ozone. The most common method is electrical discharge ozone generation. (Mazi Alex Lemmy Ochonma).

2.4 GOVERNMENT EFFORT ON WATER SUPPLY AND SANITATION

Since the 1970s, Government had been making efforts to improve the water and environmental health sector. Quite a number of programs (such as rapid assessment programme, national water rehabilitation, river basin development authority, DFFRI, etc) were put in place to promote adequate water supply and sanitation. From available information, in 1991, the urban and peri-urban water coverage was 53% while rural water supply coverage was put 37%. The sanitation coverage for urban and peri-urban areas was 52% while that of rural areas was 30%. Only 13 States achieved 50%service level of potable water for urban population.

Various fora were organized to discuss and formulate strategies on water supply and sanitation. The initial actions were concentrated at the three levels of government. Throughout the 1990s, Nigeria participated in Africa and International Conferences towards promotion of water and environmental health 2000 initiatives. International agencies and so on, have been key actors in the water supply process particularly in the rural areas.

In 1988, the Federal Government promulgated the Federal Environmental protection Agency Decree 58, which was amended by Decree 59 in 1992. In 1989, the Federal Government, through FEPA, formulated a National Policy on Environment with the overall goal of achieving sustainable development in Science and Technology, has been updated and the contents reviewed in 1999.

The National policy provides the concepts and strategies, which will lead to the procedures and concrete actions required to create an enabling environment for sustainable development in the 21st Century.

In addition to the National Environmental policy, the Federal Government produced the Nigeria's National Agenda 21 which is the nation's action plan for addressing environmental problems and for sustainable development practices as passed by the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in June 1992.

In the agenda 21, missions and objectives for sustainability in all aspects of environment and development are stated and the programs/activities for achieving these objectives are clearly spelt out.

Government effort at ameliorating the environment problems besieging the country is commendable. The concept of the National Policy on Environment and the Agenda 21 are laudable but the Government has to go a step further by implementing the programs, as it regards water supply and sanitation, knowing fully well that the present state water supply in the country has negative health impact on the citizenry.

Dr. Rabi'u Musa Kwankwaso, inaugurated a water transition committee vested with the responsibility of studying the water supply situation in Kano state, identifying major short comings and proposing remedies for ensuring improvement in the supply situation by the year 2015. (Abdu Umar Kurmawa , 2013).

2.5 Water Improvement Program

1. **African Water Association**: This is the only continental professional association covering more than 35 countries, led by African managers of the water sanitation and environmental sector for the benefit of the population with a 25 years of experience since it is creation in 1980 has co-ordinate the search for knowledge and up- date technical, legal,

administrative and economic data gathered in the area of water supply, sanitation and environment.

- It has fostered permanent exchange of information all areas related to water supply and sanitation, particularly on research and implemented techniques;
- It has promoted contacts, exchanges and cordial relation among professionals of the sector in Africa and throughout the world; has asserted itself an unavoidable link in the implementation of national and sub-regional programs for water sources integrated management

2. The water dome: An initiative of the African Water Task Force (AWTF) established in September 2001 to increase the visibility of the African Water issues at the world summit for sustainable development as well as other large international meeting including 3rd world water forum.

Water Quality Improvement: After establishing the desalination stations of brackish water of kerkenah in 1984 and Gades in 1995. Sonede built two other desalination stations of brackish water in Zarzis in 1999 and Jerba in 2000.

3. Initiative for water provision: The African Development Bank (AFDB) launched the water provision and sanitation in African Rural Areas Initiative. This is a process which will enable three hundred million African to have access to water by 2015. This will be achieved through renewed mobilization of the international community and through increased co-ordination and efficiency of aid.

4. In 2003: A presidential Water Initiative (PWI). Water for people, water for life was launched by then President Olusegun Obasanjo administration. The initiative had ambitious target to

increase access, including a 100 percent water target in state capitals, 75 percent access in other urban areas, and 66 percent access in rural areas. Little has been done to implement the initiative and targets have not been met.

5. **MWACAFE,** Agency is created to ensure adequate water supply to people living in rural communities and small towns around Ghana The MWACAFE iron removal plant was design and developed by Mr. Worlanyo Kwadjo Siabi, (Eastern regional water and sanitation engineer of the community water and sanitation agency). The new treatment techniques is based on absorption properties of granular activated carbon, applied as filter material under limited oxygen supply (Community water anmd sanitation agency 2006

2.6 WATER, SANITATION AND ENVIRONMENTAL SERVICES: THE INSTITUTIONAL PERSPECTIVE

The institutional rationale for water supplies, sanitation and environmental quality services in Nigeria arises from the following needs: a) to protect available sources of water; b) to ensure wide urban and rural water supply and sanitation coverage; c) to respond to fill in with a wider global initiatives and goals; d) as emergency response to the water and health needs of the population; e) to regulate activities in the sector, among several others. The need to protect available sources of water guided the various versions of colonial and post-colonial policies and regulation in Nigeria over the years as detailed in the Table below.

Table 1: Relevant colonial and post-colonial regulatory instruments in the water, sanitation and environment sector

Relevant Statutes	Main Provision
The Water works Art of 1515.	Specifically to keep water from being polluted by obnoxious or harmful matters.
The mineral Art 1917.	The law vests the head of state or Nigeria with power to make regulations for the prevention or pollution of any water course
The Public Health Act of 1917.	It prohibits of water of the atmosphere by harmful human activities
The oil in Navigable water Art, 1959.	It prohibits water pollution by oil spillage.
The petroleum Act, 1969.	It covers prevention of pollutions by inland waters, rivers, lakes and water courses.
The land use Act of 1976.	Ownership of land linked to ownership of groundwater resources.
The River Basin Development (BEDA) direct/Act of 1978,1987& 2004.	To ensure a pan – Nigeria programs for comprehensive and integrated water resources development.
The environmental impact assessment (EIA) decree/Act of 1998 & 2004.	The law seeks to protect the physical and aquatic environment.
Water resources decree/Act of 1998 & 2004.	Nigeria's water resources now extensively in the control of the Federal Government of Nigeria.
The 1999 constitution.	Guarantees the right or access every citizens to water.
National policy on Environment 1989.	Protection of the environment.
National Guidelines and standards for Environmental population control (1991).	Pollution control in water resources as part of the environment.
National Effluent Limitation Regulation 1991.	Control of discharge of industrial waste and sewage into water courses.
Pollution Abatement in Industries and Facilities Generating wastes Regulation 1991.	Control of industrial pollution.
Waste Management Regulation, 1991.	Waste management.
Nigerian Industrial Standards for potable Water and natural Mineral Waste, 1992.	For public health protection.

National Environmental Standard and regulations Enforcement Agency Act 2007.	Captures a wide range of environmental protection, coordination and enforcement.
Nigerian Standard for Drinking Water Quality, 2007.	For public health protection

Policy Title	**Key Provision**
National Policy on Environment, 1989	Focuses on water quality regulation and standard as well as pollution control
National Rural Water Supply and Sanitation Policy, 2000	Focuses specifically on rural water and sanitation through community participation. The programme targets were to increase water coverage from 43% to 80% by 2010 and 100% by 2015. The sanitation coverage was to be increased from 32% to 60% by 2010 and 90% by 2015.
National Water Resource Management Policy, 2003	This recognizes water as an economic good, opted for integrated and demand-driven services.
National Water and Sanitation policy, 2004	This operated strictly in line with the demand-driven approach of the national water resources policy.
National Environmental Sanitation Policy (NESP), 2005	A bit comprehensive as it touched on a range of issues including solid waste, medical waste, excreta waste, sewage management, food sanitation and hygiene, sanitation at public places, adequate potable water supply, urban drainage management and hygiene education etc.
National Economic Empowerment and Development Strategy-NEEDS (2003-2007)	This attempted to address water and sanitation issues in clearly defined spatial units namely, urban areas, small towns, rural areas. NEEDS placed high priority on the development of safe and adequate potable water supply and sanitation services as a key instrument for fighting poverty and accelerating socio-economic development.
National Development Plan (NDP), 2007	As one of the seven point development agenda of the late Yar'adu's administration, targeted subsidies on water and sanitation facilities were planned for the poor.

These protective regulatory instruments revolve around: a) 'right of ownership' legislation and; b) 'measures to integrate standard practices. The land use act of 1978 and the water resources decree of 1993 (updated as water resources act of 2004) in such context could best qualify as a right-base approach for protecting available water resources. Realizing that the land use act (which linked ownership of land resources to water resources) could not help achieve the aim of protecting water resources especially from powerful interest groups of resource users and corporation, the federal government of Nigeria came up with the water resources management decree of 1993 and water resources act of 2004. The law vested in the federal government the right to use and control available surface and groundwater and all water in any water-course affecting more one state, for the purpose of promoting the planning, development and regulation in the water resources sector. The water resources act becomes only enforceable where: a) conflict of interest over right of water resources poses a manifest thread to a particular water resources; b) large-scale developmental and infrastructural needs are envisaged for the wider and larger interest of the citizens and the state. Generally, access to water is a universal and constitutionally guaranteed right, providing adequate water supplies and sanitation services has always been at the core of public duty and responsibility to the population. In Nigeria such responsibility for water supply is shared between three levels of government-federal, state and local. FGN, (2000:5)

2.6.1 Federal Government level: At the federal level, water supply and sanitation provisions fall within the responsibility of the federal ministry of water resources. Other federal agencies with related responsibilities include the federal ministries of environment and the federal ministry of health is involved in responding to challenges in sanitation related diseases other sector ministries with some direct or indirect responsibilities include the federal ministries of

education, science and technology, women affairs, inter-governmental affairs, youth development and special duties. These sector ministries by their various programs are involved directly or indirectly in promoting sustainable development of water supply and sanitation services in Nigeria. For instance, the federal ministry of science and technology becomes important advisory and procurement.

Ministry when technological solutions to water supply and sanitation provisions are emphasized. The federal ministry of water resources (FMWR), initially created in 1976, is responsible for formulating and coordinating national water policies, management of water resources including allocation between states, and approving development projects. The river basin development authorities (RBDA), now12 in total, were also created in 1976 for planning and developing water resources, irrigation work and the collection of hydrological, hydro-geological and meteorological data. Their main involvement in potable water supply has been the provision of multi-purpose dams and the supply of water in bulk, some to urban water systems. The national water resources institute (NWRI) was legally established in 1985 and is responsible to the FMWR for engineering research function related to major water resources projects and training sector professionals and technicians. A utilities charges commission was established in 1992 to monitor and regulate utility tariffs, including those of state water agencies, however it appears in practice to have not been functional.

2.6.2 State Government Level: The responsibility for potable water supply was traditionally entrusted to departments of the state governments (now 36 in number). AS the importance of drinking water supply grew during the 1970s, most water departments were gradually transformed into state water agencies (SWA) to provide urban, semi-urban and, in some cases, rural water supply. Each SWA has, in general, been established under an edict to develop and

manage water supply facilities within its respective state and to meet sound financial objectives. The SWAs are responsible to their state governments. In some states, responsibilities fro roral water supply remain with or have been transferred back to a state government department; additionally, in several states (22 currently), state rural water and sanitation agencies have been set up largely to implement the **FGN/UNICEF, RWSS** program.

2.6.3 Local Government level: The local government authorities (LGAs), of which there are 774, are responsible for the provision of rural water supplies and sanitation facilities in their areas although only a few have the resources and skills to address the problems. Only few LGAS have rural water supply divisions able to construct small water systems such as open wells and small impoundments of surface water. The government of Nigeria has strengthen community participation in rural water development in 1993 reflects a priority on community ownership and management. The policy needs to be adopted, disseminated and implemented in all government donor financed programs. In some communities in rural areas, water and sanitation communities **(WASCOS)** have been formed to operate and maintain water facilities.

2.6.4 Civil Society: Civil society in the water and sanitation sector (in Nigeria) is relatively weak. NGOs lack the organizational capacity to improve their way of implementing water sanitation projects. Water aid Nigeria supports a national civil society network for water sanitation and foster better communication between communities, NGOs and local governments

2.6.5 External cooperation: Beyond mere declaratio0ns and directives, regional and international agencies and organizations have been actively involved at various scales and levels in water and sanitation programs in Nigeria. The most important external partners in Nigeria n water supply and sanitation sector are the African development bank, the European Union,

Japanese programs in Nigeria, **DFID, JICA, UNICEF, USAID,** other **NGO,** World Bank among others.

2.7 Water Demand and Population Growth

The fast growing demand for clean ,fresh water for economic development, coupled with the need to protect and enhance the environment have made many areas of the (world) vulnerable to water shortages. As with most natural resources the distribution of water resources in the APEC region are not uniformly apportioned with some economies having disproportionately large share of resources compared with others.

According to the united nations, the state of water stress is defined as less than $1700m^3$ of fresh water available per person per year which becomes acute at less than $1000m^3$\cap \yr in 2002 , Korea is the only APEC economy below the $1700m^3$ threshold. However areas of Japan, China, U.S, Australia and Southeast Asia also suffer from a degree of water stress and scarcity especially in regions of high population density. (United Nation, 2005).

In the early 70s, water demand was forecasted by bulk estimate of 1-5% in England (Kiston, 1982). In the 80s a more rational approach to demand forecasting, based on component, was adopted in the style earlier advocated by Sharp (1976), Rees (1976) and Herrington (1973). In the sense, the British water supply agencies forecasting water demands based on subsequent works (Evans, et al, 1979, Rump, 1979) have demonstrated the advantages of component analysis of water demand patterns. In the 1950's in Europe for instance, water consumption of an average family in rural areas was rarely more than 136 liters per head per day. With the introduction of baths, hot-water systems, and water borne sewerage, average consumption is now in the order of 227 1pcd, an increase of 76.5% (Willcock, 1983). In the United States of America

(USA), recent studies by Clark (1990) indicated that the average daily domestic consumption was 1 pcd for central areas, and 2501pcd for rural house-holds.

In most developing countries (especially in sub-saharan Africa), reliable water demand figures are lacking. Figures estimated by the World Health Organization (WHO) or otherwise adopted from the Europe or America standards are relied upon. However, these figures, especially in the recent years, do not represent the actual situation in the localities where they applied-since the climate, culture, and standards of living are vastly different from those of the people in the areas where the figures were originally derived. The most glaring manifestation of this is the fact that most water schemes in the developing countries become inadequate and the communities subjected to persistent shortages in supply soon after the system is completed. Likewise, existing capital and some local Government headquarters was impressive (Oteze, 1977). However, shortages still persisted. For instance, although average supply for Sokoto was 212 1pcd which was then considered very high, it was 90 1pcd for Benin City. Even then shortages did occur and not all the population in the towns had already access to the water. (Mustapha Hassan Bichi, 2010).

As the world population increases, the amount of water available per person decreases. In 2001 growth most of the increase is largely for irrigation and industrial used. It may interest you to know that 60% of world fresh water is used for irrigation, about 23% for industrially use and only 8% for household. Lagos for example is experiencing a demand on water.(Ultimate Water Technology and Environment, 1996).

Human population expansion and changes in the level of technology in the use of water for example of drilling of boreholes instead of digging traditional shallow wells , construction of

new earth dams (which previous policy indicated that it was not feasible for earth dams),the use of water pumps for irrigation in place of traditional shaduff, and creation of mega water plant across the major rivers to mention but a few, are some of the anthropogenic processes upsetting the river drainage pattern and levels of water availability for different uses in nearly all parts of the region. (Adnan Abdulhamid, 2000).

The kano region has witness substantial increase in the level of demand and consumption of water for various uses, particularly for agricultural, industrial and domestic uses over the last few decades. The development is described as silent revolution often with no planning and control on the part of government authorities.(Llamas and Martinez – santos, 2010).

2.8 QUALITY OF DRINKING WATER IN NIGERIA

Natural water (either surface or ground water always contain some naturally occurring micro organisms which derived from soil, oil, air, and water. If the water is polluted it will also contain polluting organisms from agricultural run-off, animals, birds, sewage effluents and humans which may be pathogenic. In addition surface water and to a lesser extent ground water usually contain some particles of matter derived from the surface over which they have flow intend. The particles are usually suspended in water and are responsible for the turbid and colour in most surface water.

Certain bacteria which occur naturally in human and animals intestines are known as coliforms. Their presence in water samples indicates that the water may have waste from animals or humans and therefore may also contain other organisms which are pathogenic to humans. Thus, the coliform group organisms are used as an indicator of pollution because they can be detected more readily in laboratory. (Garba A.B, 1997).

Drinking water quality involves examination of water to its suitability for drinking. It involves rapid assessment of drinking water quality, conducted in Nigeria in 2002-2004 and supported by UNICEF and WHO noted the lack of an acceptable Drinking Water Quality Standard in Nigeria which would guaranteed the quality of water supplied to its people. (NCWR, 2005), the National Council on Water Resources (NCWR) recognized the need to urgently establish such Standard. Drinking water quality standard ensures the safety of the drinking water supplies and the protection of public health. The establishment of NIGERIAN standard for Drinking water Quality (NSDQW, 2007) will ensure the protection of the consumers. It is expected that the Nigerian Standard for Drinking Water Quality will speed up the process of upgrading non-protected water system and improving the management of all drinking water systems in the country. This standard sets parameters and maximum allowable limits in drinking water in Nigeria. It includes normative reference guiding drinking water quality. In developing this standard, references were made to the Nigerian Industrial Standard for portable Water and Natural Mineral Water.

In 2005, the National Council on water Resources (NCWR) recognized the need to urgently establish acceptable Nigerian Standard for Drinking Water Quality because it was observed that the Nigerian Industrial Standard for portable developed by Standards Organisation of Nigeria and the National Guidelines and Standards for Water Quality in Nigeria developed by Federal Ministry of Environment did not receive a wide acceptance by all stake holders in the country. The standard contains mandatory limits concerning contaminants of water that are hazardous to health and give rise to consumers. The standard includes a set of procedures and good practices required to go into considered taking the mandatory limits. The selection of parameters and the

determination of maximum allowable limits have been conducted taking into consideration the WHO guideline for drinking water quality. (SON, 2007).

CHAPTER THREE

RESEARCH METHOD

3.1 INTRODUCTION

This chapter presents with the general methodology of the study, it describes the research design for the Data collection; sampling technique, data collection instrument, data collection procedure as well as method of data analysis. A total of 384 questionnaires were administered for this study.

3.2 RECONNAISSANCE SURVEY

Reconnaissance survey was conducted in order to have a clear picture of the study area. It also provides a clue and a guide on how the research work will be conducted. This was successfully achieved with the help of the research assistants. It was also through this method that sample size region was drawn in some selected wards within the study local government areas. Reconnaissance survey helped the researcher in determining the number of interviewee selected during the field work. The researcher was able to identify the kind of respondents, taking into consideration their literacy level, their convenient time as well as the number and quality of research assistants that were needed and the kind of training to be given to them.

3.3 SOURCES OF DATA

Data for this study was generated from both primary and secondary sources. Questionnaire administration and field measurement contributed the primary data while documented data was generated from the Ministry of Water Resources, National Population Commission (NPC), Kano State Water Board and from Cartographic Laboratory, Geography department, Bayero University

Kano . Therefore, formed the secondary sources of data generated for this study, relevant literatures in form of published books, journals, thesis on related topic, maps from library and internet materials were also used.

3.4 DATA COLLECTION

Collection of data is a crucial step in research processes, such data are necessary for arriving at the solutions to the problem of the study. Therefore, in order to capture the pattern of water supply in the study area, open ended questionnaire was the basic instrument used in this study.

3.4.1. Questionnaire

Questionnaire was used because of its inherent simplicity and convenience considering the large sample size. These agree with the assertion of Adamu *et. al.*, (2006) that a questionnaire serves the purposes of the researcher in that it stands as a medium of obtaining and processing information that would not have otherwise been obtained from a large sample. The questionnaire was used to seek for information on a range of factors and research variables. The first was on respondent's demographic characteristics while the second form of information collected was water scarcity related data and factors influencing choices of water supply.

3.4.2 POPULATION

The area comprises of eight local government area, that's Kano metropolis (Fagge, Dala, Gwale, Tarauni, Ungogo, Nassarawa, Kumbotso and Kano municipal) which have a total of 2,828,861 population as at the 2006 cencus recorded by the Nigerian Population Commission. Out of these eight local government areas ,six local governments were used, that is (Dala, KMC, Nassarawa, fagge, gwale and Tarauni) excluding ungogo and kumbotso. This is because only some parts of

the aforementioned two local governments falls within the metropolis. That is why they are excluded.

3.4.3 SAMPLE SIZE

Krejcie and Morgan (1960) sample size table determinant was adopted to come up with a suitable sample size that will best represent the population of the study area.

From the Krejcie and Morgan Table in Appendix 3, have a representative sample size for our population of 2,828 861(NPC 2006), Krejcie and Morgan (1960) state that for a population of 1,000,000 and above, a sample size of 384 will be a representative. So our population size is 384 as well as the number of questionnaire to be distributed (see Appendix 3)

In each of the six local government areas, seven (7) wards were randomly selected. This was reached based on the center distribution list of water supply in each of the local government for the distribution of 384 questionnaires, making a total number of 42 wards which are listed in the table. The selection of households for the distribution of questionnaire was achieved by way of administering a questionnaire to every tenth household in a ward starting with the wards head house (Mai Unguwa). Hence, the 384 questionnaire was divided equally among the 42 wards in order to have exact number of representatives. Simple random sampling technique was adopted by way of naming all the individual household interviewed in a ward on a piece of paper, these pieces were folded afterward and being put in a container which was shacked rigorously and one out of them was taking to represent the sample sites. This method was applied to the rest of the 41wards in administering the questionnaire. At the end of the day only 360 questionnaires were being retrieved.

Table 3.1 Showing the Selected Wards and the Number of Questionnaires Distributed

	Gwale	K/municipal	Tarauni	Dala	Nassarawa	Fagge	
	G/ kaya	Kurawa	Naibawa yan lemo	K /ruwa	Badawa layout	Fagged	
	Dorayi babba	Kwalli	Gyady-gyadi	Gwammaja	Kawaji	S/gari	
	Kabuga	Gandu	U/uku	Koki	Korau road	Faggec	
	Dorayi	K/ nassarawa	Yar akwa	Adakawa	Dorawa Road	Kwaciri	
	Buk old site	Zage	Kundila housing estate	Yalwa	Yankaba	Beirut road	
	Jaen	Dan agundi	Cikin Tarauni	K/mazugal	Arkan road	Unity road	
	Diso	Satatima	Darmanawa	Daganda	Amadu bello	Ibrahim taiwo road	
Total number of questionnaire administered	64	64	64	64	64	64	Total 384

Source: Authors field observation.

3.4.4 VERBAL INTERVIEW

The verbal interview was conducted with some staff of Kano state water board, the interview provide information on water sources and some relevant matters related to the objectives of the research work. The sample of questions discussed with the interviewees can be seen in appendix 2. And the responses was presented as discussion of major findings.

3.4.5 DATA ANALYSIS

The data was analysed using descriptive statistics. The information collected from the questionnaires was examined and statistical package for social sciences was used in processing the data, that is SPSS. The tables used for the analysis describes frequency and percentages. While Cross tabulation and Chi square was used in comparism.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSIONS

4.1 Introduction

This chapter presents the key findings of the research in accordance with the objectives and research questions.

4.2 Demographic Characteristics

Table 4.1: Demographic Characteristics

		Frequency	Percentage
Gender	Male	180	50
	Female	180	50
Marital Status	Divorcee	3	0.8
	Married	306	85
	Single	48	13.3
	Widow	3	0.8
Educational Status	Degree	99	27.5
	Diploma	54	15
	HIS	3	0.8
	HND	9	2.5
	Islamic Education	30	8.4
	JSSE	9	2.5
	LLB	3	0.8
	Masters	27	7.5
	NCE	15	4.2
	Nil	27	7.5
	OND	9	2.5
	Primary	6	1.7
	SSCE	66	18.4
	Students	3	0.8
	Total	**360**	**100**

Table 4.1 shows the demographic data of the respondents in the study area which include gender, that is male and female which represent 50% each followed by marital status were married people represent 85% of the respondents, then followed by educational status.

Table 4.3: Socoi-Economic Characteristics

	Occupations	**Frequency**	**Percentage**
	Barrister	3	0.8
	Business Men	63	17.5
	Carpenter	3	0.8
	Civil Servant	75	20.8
	Computer Technician	3	0.8
	Consultant	3	0.8
	Craft Men	3	0.8
	Doctors	6	1.7
	Drivers	9	2.5
	Gardener	3	0.8
	House Wives	57	15.8
	Mechanics	6	1.7
	NGO	3	0.8
	Nil	36	10
	Security	6	1.7
	Student	3	0.8
	Tailors	18	5
	Teachers	45	12.5
	TRADERS	15	4.2
	Total	**360**	**100**

From 4.2 it can be seen that the residents of the study area are engaged in various occupation, but the dominant occupation in the study are civil servants, that is 20% of the respondents, followed by business men which represents 17.5% of the respondents, then house wives which represent 15.8% and finally teachers who represents 12.5% of the respondents.

Table 4.4: Major Sources of Water in the Study Area

Sources of water	Frequency	Percentage
Borehole	156	43.3
Borehole/Pipe borne/Well	3	0.8
Pipe Borne Water	69	19.2
Water From Tankers	33	9.2
Water Vendors	48	13.3
Well	51	14.2
Total	**360**	**100**

Source: Researchers computation

From table 4.3, it can be seen that borehole is the major sources of water supply in the study area which represent 43.3% followed by water from well which represents 14.2%, then followed by pipe borne water which represents 19.2% and finally water from water vendor which represents 13.3%.

Table 4.5: Major Sources of Water Based on the Individual Local Governments

LGA	Borehole		borehole/pipe borne/well		pipe borne water		water from tankers		water vendor		well		Total	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Dala	36	60.0	0	.0	9	15.0	0	.0	3	5.0	12	20.0	60	100.0
Fagge	36	60.0	0	.0	0	.0	6	10.0	6	10.0	12	20.0	60	100.0
Gwale	12	19.0	0	.0	24	38.1	6	9.5	6	9.5	15	23.8	63	100.0
Municipal	24	42.1	3	5.3	3	5.3	0	.0	21	36.8	6	10.5	57	100.0
Nassarawa	33	55.0	0	.0	3	5.0	15	25.0	6	10.0	3	5.0	60	100.0
Tarauni	15	25.0	0	.0	30	50.0	6	10.0	6	10.0	3	5.0	60	100.0

From the table, 60% of the respondents in Dala use water from borehole, 20% use well water, 15% use pipe borne water and 5% buy water from water vendors. While in fagge, 60% of the

respondents use water from borehole, 20% use well water, 10% uses water from tankers and 10% buy their water from the water vendors.

Pearson Chi-Square Tests

		major sources of water
LGA	Chi-square	175.224
	Df	25
	P-value	.000

*. The Chi-square statistic is significant at the .05 level.

Since our chi-square value of 175 is greater than the table value, there is significant relationship between the level of water availability among the various sources of water in the study area.

Table 4.6: Most Convenient Sources of Water

	Sources of water	**Frequency**	**Percentage**
	Borehole	138	38.3
	Pipe Borne Water	219	60.8
	Water Vendors	3	0.8
	Total	**360**	**100**

Source: Researchers computation

From table 4.5, water from pipe borne are more convenient in the study area where 60.8% of the respondent access their water from, followed by borehole water with 38.3% of the respondent accessing it.

Table 4.7: Sources of Water for Consumption

		Frequency	Percentage
Sources of water	Borehole	75	20.8
	Bottled Water	6	1.7
	Wells	3	0.8
	Others	3	0.8
	Pipe Borne Water	27	7.5
	Sachet Water	237	65.8
	Sachet Water/Borehole	6	1.7
	Sachet Water/Pipe borne	3	0.8
	Total	**360**	**100**

From table 4.6 above, it can be seen that residents of the study area consume more of sachet water followed by those who consume borehole water and finally pipe borne water.

Table 4.8: Convenient Source of Water for Drinking Based on Local Government

		source of water for drinking															
		Borehole		Bottled water		Hand dug wells		Others		pipe born water		sachet water		sachet water/ borehole		sachet water/pipe born	
		N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
LGA	Dala	9	2.5	0	.0	0	.0	0	.0	0	.0	48	13.3	3	.8	0	.0
	Fagge	12	3.3	0	.0	0	.0	0	.0	0	.0	48	13.3	0	.0	0	.0
	Gwale	9	2.5	0	.0	3	.8	3	.8	18	5.0	24	6.7	3	.8	3	.8
	Municipal	6	1.7	0	.0	0	.0	0	.0	3	.8	48	13.3	0	.0	0	.0
	Nassarawa	33	9.2	3	.8	0	.0	0	.0	0	.0	24	6.7	0	.0	0	.0
	Tarauni	6	1.7	3	.8	0	.0	0	.0	6	1.7	45	12.5	0	.0	0	.0

Pearson Chi-Square Tests

		source of water for drinking
LGA	Chi-square	180.673
	Df	35
	Sig.	.000

*. The Chi-square statistic is significant at the .05 level.

Since our chi-square value of 181 is greater than the table value, there is significant relationship between level of water availability and the individual local governments in the study area.

Table 4.8: Reason for Using the Various Sources of Water

Major Sources of Water								
		Convenience		Availability		Income Level		Total	
		N	%	N	%	N	%	N	%
	Borehole	14	11.7	9	7.5	29	24.2	52	43.3
	Borehole/Pipe Borne/Well	0	.0	0	.0	1	.8	1	.8
	Pipe Borne Water	15	12.5	0	.0	8	6.7	23	19.2
	Water From Tankers	0	.0	2	1.7	9	7.5	11	9.2
	Water Vendor	0	.0	1	.8	15	12.5	16	13.3
	Well	0	.0	13	10.8	4	3.3	17	14.2

In all the local governments, people choose to use their water sources according to their income level as well as its availability.

Table 4.9: Causes of Insufficient Water Supply

Causes	Frequency	Percentage
Blockage from pipes	126	35
Can't Say	114	31.7
Distance from sources	36	10
Others	45	12.5
Population Pressure	39	10.8
Total	**360**	**100**

Some of the reasons that cause water shortage include blockages from pipe with 35%, then distance from water supply sources with 10% and population pressure with 10.8% as shown in the table above.

Table 4.10: Incidence of Contamination

	Frequency	Percentage
No	354	98.3
Yes	6	1.7
Total	360	100

Sometimes water is being contaminated especially pipe borne water because of turbidity, therefore only 1.7% was of the opinion of incidence of water contamination while the remaining 98.3% had clear water.

Table 4.11: Treatment of Water before Consumption

Treatment	Frequency	Percentage
Addition of Alum	21	5.8
Boiling	54	15
Chlorination	9	2.5
Filtration	30	8.3
Nothing	21	5.8
Others	225	62.5
Total	**360**	**100**

From table 4.10, some people tend to treat their water before consumption while some did not. According to the respondents, 62.5% use their water untreated while the remaining percent treat their water as shown in the table.

Table 4.12: Water Availability Since 2000

Availability	Frequency	Percentage
Can't Say	42	11.7
Great Improvement	63	17.5
Little Improvement	123	34.2
No Improvement	132	36.7
Total	**360**	**100**

From table 4.11, it can be seen that water availability since 2000 till date has seen minor improvement in the study area as only 17.5% of the respondent have seen great improvement while 34.2% of the respondents have seen little improvement and 36.7% of the respondent have seen no improvement. Hence residents of the study area tend to access their water 100% based on physical quality.

Table 4.13: Regularity of Pipe Borne Water

Regularity	Frequency	Percentage
Every Day	75	20.8
No Supply	51	14.2
Sometimes a Week	54	15
Sometimes in a Month	108	30
Some tines in a Year	72	20
Total	**360**	**100**

From table 4.12, it is seen that pipeborne water is readily available in the study area throughout the year. Only 20% of the respondents have access to water supply every day, 54% have access to water sometimes in a week while 30% of the respondents have access to pipe borne water sometimes a month and 20% of the respondents have access to pipe borne water sometimes a year, only 15% of the respondents have no access to pipe borne water throughout the year.

Table 4.14: Problem of Water Shortage

Problem of Water Shortage	**Frequency**	**Percentage**
Constraints to Domestic Activities	114	31.7
Extra Expenditures	126	35
Others	18	5
Time Factor	102	28.3
Total	360	100

From 4.13, the challenges faced by water users include constraint to domestic activities which cover 31.7% of the respondents followed by extra expenditures which include 35% of the respondents, only 28.3% of the respondents are of the view that problem of water shortage is caused by time factor i.e., time taking to access the water.

Table 4.14: Challenges Faced by Water Consumers

Challenges	Frequency	Percentage
Barriers From Water Supply Sources	144	40
High Population Growth	102	28.3
Others	24	6.7
Seasonal Variation	90	25
Total	**360**	**100**

From table 4.14, 40% of the respondents have seen to face challenges to water due to Barrier from water supply sources, while 28.3% face water challenges due to high population growth which leads to high pressure on the available sources. Only 25% sees challenges to water to be linked to seasonal variation. Below is the table showing challenges faced by water consumers based on various local governments.

		Challenges Faced By Water Consumers Base On Local Governments							
		barriers from water supply sources		high population growth		Others		seasonal variation	
		N	%	N	%	N	%	N	%
LGA	Dala	36	10.0	6	1.7	6	1.7	12	3.3
	Fagge	24	6.7	30	8.3	6	1.7	0	.0
	Gwale	21	5.8	6	1.7	6	1.7	30	8.3
	Municipal	30	8.3	15	4.2	0	.0	12	3.3
	Nassarawa	21	5.8	15	4.2	0	.0	24	6.7
	Tarauni	12	3.3	30	8.3	6	1.7	12	3.3

		challenges face by consumers of water
LGA	Chi-square	96.952
	Df	15
	Sig.	.000

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*. The Chi-square statistic is significant at the .05 level.

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Since our chi-square value of 97 is greater than the table value, there is significant relationship between challenges faced by water consumers and water availability in the study area.

4.13 DISCUSSION OF MAJOR FINDING

This section explains the general findings of the research work. It discusses the findings of each table has presented in the data and also the findings of the interview conducted in Kano State water board

Majority of the respondents as presented were married people and mostly educated. Qualification of Masters, Degree, Diploma, OND, etc.

In general the people of the area engage in different socio economic activities in order to survive. They earn their living by either businesses of different types, civil service and house wives who stays at home permanently

Ground water source it the major source of water found in the study area through the use of hand pump bore holes and open wells. This is mostly found in Dala, fagge, gwale, Municipal. The use of water from vendors is common in the area and water from pipe borne can be obtained in some areas which is mostly irregular.

In Nasarawa and Tarauni, pipe borne water was regular in some areas while in some irregular, but in general pipe borne water is more available in the area compared to the remaining four local Government mentioned earlier. Bore holes and open wells were also found, like wise water vendors. Few houses from the study revealed the supply of water from Tankers

Pipe borne water is the most convenient water for house hold usage and then bore hole. Sachet water is found to be the most available water use for drinking because it was sold at a very low price. Bore hole water and pipe borne water were also used for drinking .

Bottle water was not commonly used for drinking because of the cost involved while open wells were not mostly used for drinking because of the nature of its taste.

People used different sources of water depending on circumstances. People use a particular source of water if it was found available in the area. The monthly bill of pipe borne water was cheaper compared to buying water from vendors and tankers. Drilling of bore holes could be expensive compared to open wells.

Decline in water supply from the two major dams; chalawa gorge dams and Tiga dam usually at peak of dry seasons affect water supply output. Again, meandering of river water flow along the river bed leaves water pumps dry at their intake points consequently affecting raw-water supply output.

Break down of plants and machineries; as well as broken of transmission lines contribute to raw water supply seizure thereby affecting raw-water supply output. Many a times, the mechanical and electrical components of the raw pumps gets damage due to tear and wear of the pumping machines as such delay is created until the raw-water pumps are either repaired or replaced.

Seasonality is also a factor that contributes to low-water output. In most cases, water supply scarcity is experienced during the dry season when water flows on river beds declined and heat also contributes in the over-heating of the water supply infrastructures (raw water pumps) thereby resulting in the decline of the raw-water output.

Underground water source produced less or no water as a result of the nature of the rock found in the area and also as a result of seasonality.

The challenges faced by water consumers was due to barriers from water supply sources such as pressure from the supply source, high population increase is another challenge ,this is due to higher demand. Seasonal variation is a factor which affect water supply consumers as during rainy season there was generally increased in water table and also surface water while decrease during the dry season. Therefore, consumers experiences shortages during dry season.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

The study shows that majority of the residents in the study area rely on boreholes and wells as their sources of water supply which signifies the poor access to pipe borne water within the metropolitan areas of Kano. Due to the high turbidity nature of water in the study area and lack of access to pipe borne water, residents tends to spend much effort in order to access portable water for domestic usage through the patronage of water vendors. The study also reveals that the core Kano metropolis is faced mostly with the issue of water scarcity because almost all the water sources there are not active. Majority of the respondents tend to consume the available water sources without any prior treatment of water.

5.2 CONCLUSSION

The Availability of fresh water is of immense importance to the people of Kano metropolis, since it affects their lives in many ways. Human population expansion and changes in the level of technology in the process of using water for example drilling of boreholes instead of digging traditional wells, construction of new dams, the use of water pumps and creation of mega water plant across the major rivers within Kano are some of the process that are supposed to be embarked upon in order to minimize the level of scarcity and in a way maximize the water sources. Couple with these, there should be

Scheme for raising awareness of the residents in the study area to treat their water before consumption.

From the field work conducted, it was found out that the core Kano metropolis are being affected most by the problem of water scarcity which is being presented in both figure one and two above. This is due to the old and dilapidated nature of the water sources coupled with lack of maintenances water sources by both government officials ie Kano state water board and the individual water consumers.

Moreover, Subsequent government from 2000 to date have played significantly role in the improvement of portable water supply to various communities in the kano greater area. Many water supply sources were constructed and some rehabilitated to ensure portable water supply apart from construction of new water treatment plants at Tamburawa and watari .thus, improving water supply significantly in the kano area. Before 2002, water supply was at 300million litre per day while as at now water production capacity is at 500million litres per day but still inadequate due to higher demand and population growth.

5.3 RECOMMENDATIONS

To alleviate the above mentioned problems related with water supply situation in Kano metropolitan there are needs for stakeholders, community and individuals to work together in order to achieve the following:

1. Government should disburse enough money to water resources sector so as to improve water supply and should as well focus most with the core Kano metropolis when tackling issues of water supply and scarcity. Improving electricity supply and

providing alternative sources of power to supplement electricity in order to pump the water to the consumers coupled with Regular maintenances of existing water supply facilities.

2. Individuals and organization should be encouraged by government officials to pay their monthly water dues in time so that the water board will efficiently supply water to the state.
3. The Kano state water board and state ministry of water resources should embark on the training of man power by organizing seminar, workshop to increase their skills in water resources engineering, water resources management, hydrology and other related fields.
4. Public enlighten campaign should also be embarked in the mass media against misuse and over consumption of water, destruction of public properties and maintaining of existence water supply facilities.
5. Ward head and individuals should come together at community level to solve the issue of water scarcity by means of constructing local wells and manual boreholes without waiting for the government to ease the problem of water supply, by doing this , constraint to domestic activities would be reduced to minimal level.
6. Ward head should notify the government on the extra-expenditures being impose on individuals unwillingly on buying water from water vendors because of lack of adequate water supply which is also being billed upon every month.
7. Application of water sanitation system and security at all levels to ensure qualitative and adequate water to the people.

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APPENDIX 1 –INTERVIEW

An interview conducted with some staff of water board

(a) What are the sources of water supply In the study area

(b) What period of the year do you normally face the problem of water supply

(c) What are the causes of the insufficient water supply

(d) Is there any private partnership participation in water supply system in your study area

(e) How can we assess the quality of drinking water

(f) What are the methods used in treatment water in the area

(g) What are the daily demand of water per household

(h) Is there any incidence of contamination from your water supply system

(i) How do you manage your water

(j) From 2000 to date what can you say about water supply system in metropolitan kano?

(k) Any criteria for assessing water quality.

APPENDIX -2

INTERVIEW QUESTIONS

BAYERO UNIVERSITY KANO

DEPARTMENT OF GEOGRAPHY

INTERVIEW QUESTIONS ON PATTERN OF WATER SUPPLY IN RELATION TO DIFFERENT WATER SOURCES TO METROPOLITAN KANO

Section A: Demography of respondent

SEX

MARITAL STATUS

EDUCATIONAL QUALIFICATION

OCCUPATION

Section B: Pattern of water supply

1. What are your major souces of water supply ?

   (a)Borehole (b)Pipeborne(c)Well (d)Water tankers (e) Water vendors

2.Why do you use your source of water supply?

(a) Income(b)Geological condition of an area (c)Flexibility\Convenience (d)Others

(3)Which type of water is conveniently used among the sources?

(a)Pipeborne (b)Borehole (c)Well (d) Others

(4) What are the possible causes of insuffient supply of water

(a)Geological nature (b)Blockages from pipes (c) Construction problem (d) Others

(5) How regular is the supply of pipe borne water ?

(a) Sometimes in a week (b) Sometimes in a month (c) Sometimes in a year (d) Everyday (e) Others

(6) Any incidence of contamination from water supply sources in your community (a) High turbidity (b) Wastes deposits (c) Green algae (d) others

(7) Any report of water related diseases in your area? (a) Typhoid fever (b) Cholera (c) Guinea worm (d) Others

(8) What type of water do you use for drinking ? (a) Sachet water (b) Pipeborne (c) Borehole (d) Well (e) Others

(9) Is there any treatment before consumption (a) Filtration (b) Addition of Alum (c) Boiling (d) Others

(10) Any assistance from the community on how to assist government in boosting of water supply in the state? (a) Payment of water bills (b) Reporting to government on water supply issues (c) Construction\ Maintenance of water supply issues (d) Others

(11) What can you say about water availability since the year 2000 (a) No improvement (b) Less improvement (c) Great improvement (d) Others

(12) What criteria do you use for assessing the quality of your water ? (a)Taste (b) Colour (c)Odour (d) Others