SPATIAL IMPACT ANALYSIS OF COMMUNITY WATER BOREHOLES IN BIDA METROPOLIS, NIGERIA

BY

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MSUD/CHSUD/2018/7998

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ABSTRACT

The problems of urbanization as heighten concerns for water supply in urban centres in relation to demand and available quantity for supply from the local water board. In the light of this, water boreholes are seen as suitable alternative for the provision of community water supply. This has led to multiplicity of water boreholes utilities of different uses in Bida Metropolis, Niger State. This study aimed at analysing the spatial impact of community water boreholes in Bida metropolis. The spatial data of the utilities were collected using hand-held GPS tool and questionnaire was also administered to the users of the utilities. The data assembled was analysed using Statistical Package for Social Science (SPSS) and Geographical Information System Application ArcGIS 10.1 software. A total of 135 community water boreholes utilities were identified within the 14 political wards of Bida. 112 (82.96%) of the Community Water Boreholes were functioning while 23 (17.04%) were not functional, 115 are motorised and 20 are manual and the Average Neighbour Analysis shows that the utilities are dispersedly distributed and also the study further revealed that the utilities lack proper maintenance and mostly are located with influence of community decision or choice not to planning regulations. The study therefore recommended that provision of community water boreholes should be based on the planning regulation by determining the most suitable site for the location of the utility through planning survey and procedures in order to allow for efficient and effective service and a maintenance department be set up to monitor the condition of these utilities and implement proper maintenance pattern for the utilities and also employed the use of standard materials during installation for long time span and sustainability.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

The significance of water to man's existence cannot be overstated (WBCSD, 2005), because all of man's actions in life include the usage of water in some way. It is believed to be a source of life, social, and economic need, without which no economic endeavour can be undertaken (World Bank, 2002). According to Neon and Kanaroglow (1999), water is the most basic of all natural resources, and it lies at the heart of all of man's most valuable operations. Water is extremely important, and despite the fact that the earth's surface contains 75% water, known as biodiversity, the need for portable water has increased. One of the primary difficulties that has developed throughout time, according to the World Bank (2002), is the availability of portable water. Around 12 percent of the global population devours 86 percent of available water, meanwhile one out six of the global population (around 1.1 billion individuals) lacks access to suitable water supplies (World Bank, 2002). Climate and population growth are decreasing portable raw water while worldwide demand for portable water rises. As a result, there is a strong desire to improve small-scale water projects at the community or household level can provide portable water (World Bank 2002). Boreholes (whether automated or human drills) are excellent for these developments for the reason that the quality of their source (underground water), proximity availability, low land need, and simplicity of accessibility and management, among other aspects, to meet the challenges created by water crises. In a civilization, these facilities can be drilled for either private or public use.

Various administrations in Nigeria, from Military to Civilian regime, at all levels (municipal, state, and federal), had made desperate exertions to provide portable water to its peoples (Okeola and Sule, 2010). This progress toward increasing portable water supply, when it is available, is unreliable, and the apparent challenges in managing water utilities in the nation make such utilities unsustainable. The water-board is the primary source of residential water; however, it is either not operating or is not providing at the rate of its installed capacity. Other alternatives to the water-board include well water, streams and rivers, boreholes (both manual and motorized), and so on. Rainwater is another supply, but it is seasonal, especially in the north, where the average yearly monthly rainfall is between five and six months Notwithstanding these choices, the ratio of water supply to demand is considerably low, particularly in the country's non-state urban capitals, such as Bida, a municipal area in Niger State.

1.2 Statement of the Research Problem

The utilization of a network of pipes to individual households is the most common form of urban water delivery globally. Increased population and industrialisation have put a strain on water as a global resource. Bida, an old Nupe kingdom town and one of Niger

State's largest towns, is now seeing a growth in both populace and housing units. Citizens of the city have seen it as a necessity to build their own homes in order to have personal space with their families, resulting in an increase in the number of residential properties in Bida, and the planning insinuation is that basic infrastructure, utilities, facilities, and services demand will increase, particularly water utility, as it is established to be one of the most indispensable and important necessities for all, where regrettably, due to various excessive stress and strain, as well as a failure of government dedication to the improvement and maintenance of the local water board and pipe-borne services due to a lack of government involvement in Bida town have worn out, necessitating the installation of alternate means such as boreholes. Boreholes, ranging from private to community water boreholes, are becoming more common in Bida as a source of residential water supply. However, despite their availability, the community suffers from a severe lack of water.

As a result, the research believes it is critical to analyse the geographical distribution of these community utilities (boreholes), identify areas of water supply deficit, and suggest a model for successful borehole management and long-term water supply in the municipality.

1.3 Aim and Objectives

The study is aimed at analysing the spatial impact of the community boreholes and their efficiency and effectiveness as alternative source of water supply for domestic use in

Bida Metropolis.

The objectives of the research are to;

1. Identify the location of Community Water Boreholes in Bida Metropolis.
2. Determine spatial distribution pattern of the Water Boreholes in the Metropolis.
3. Examine the efficiency and effectiveness of these boreholes.
4. Propose an effective management Strategy of the boreholes facility in the Metropolis.

1.4 Research Question

(a) How are the Community Water Boreholes located in the study area?

(b) What is the Spatial Distribution Pattern of the boreholes in the study area?

(c) How efficient is the Water Boreholes in the Metropolis?

(d) How effective is the Management Strategy?

1.5 Scope of the Study

The research was based on the geographical distribution of Community Water Boreholes, as well as the planning ramifications of current utility placement arrangements in the study region in respect to development guidelines (the highest possible walkable distance to gain contact the boreholes and the volume of water per head each borehole serves.) This is expected to offer context for their site planning and analysis.

1.6 Justification of the Study

The research is imperative to the research region (Bida) since it will expose the distribution pattern and placement of society boreholes by using Geographical Information Science (GIS) techniques to build a geospatial map (point-map) which will demonstrate the general trend of utility placement, regardless of whether uneven or even, and the effectiveness in terms of water supply volume from the services. It correspondingly suggests a planning strategy that would provide long-term water supply options in the study zone.

1.7 Study Area

1.7.1 Historical background

Bida is one of Nupe land's primeval cities, is recognized for various historical and cultural activities that stretch back many centuries. It is positioned in the state's southern region and acts as the administrative centre for the Bida Local Government Area in Niger State and perhaps even the Nupe Kingdom. It is the second biggest city within the State and is residence to the mansion of the thirteenth Estu Nupe, "HRH Alhaji Yahaya Abubakar," who holds the title of "Estu Nupe."

Traditional crafts like as glass, bronze art crafts, and brass goods are well-known in the area. Bida's Durbar celebration is also well-known. The people's economic activities include farming, commerce, brass and aluminium production, and the town is regarded as a historical location with excellent artists. The people are recognized for their hospitality, which allows them to welcome individuals from various ethnic and religious backgrounds. As a result, the town is home to a large number of Yoruba's, Hausas, Igbos, Igalas, and other ethnic groups. The historic town of Bida has an Emir ship ruling system, and the town's chief is known as Estu Nupe (King of Nupe).

1.7.2 Location of Bida

Bida is situated on the Nupe sandstone formation's longitude 90061N and latitude 60001 E, which comprises of plains with iron stone topped hills. The availability of fadama is an essential aspect of the local landscape. The town is drained by two large streams, the Chicen and Mussa, as well as the Landzu, which runs through the center of town. The streams are significant because they provide superb irrigation options for the residents. As a result, they have economic as well as social significance. The settlement is located southwest of Minna, Niger State's capital. It is roughly 189 kilometers from the Federal Capital Territory (FCT) Abuja in the North-Eastern direction. (Bida Master

Plan 1980-2000).

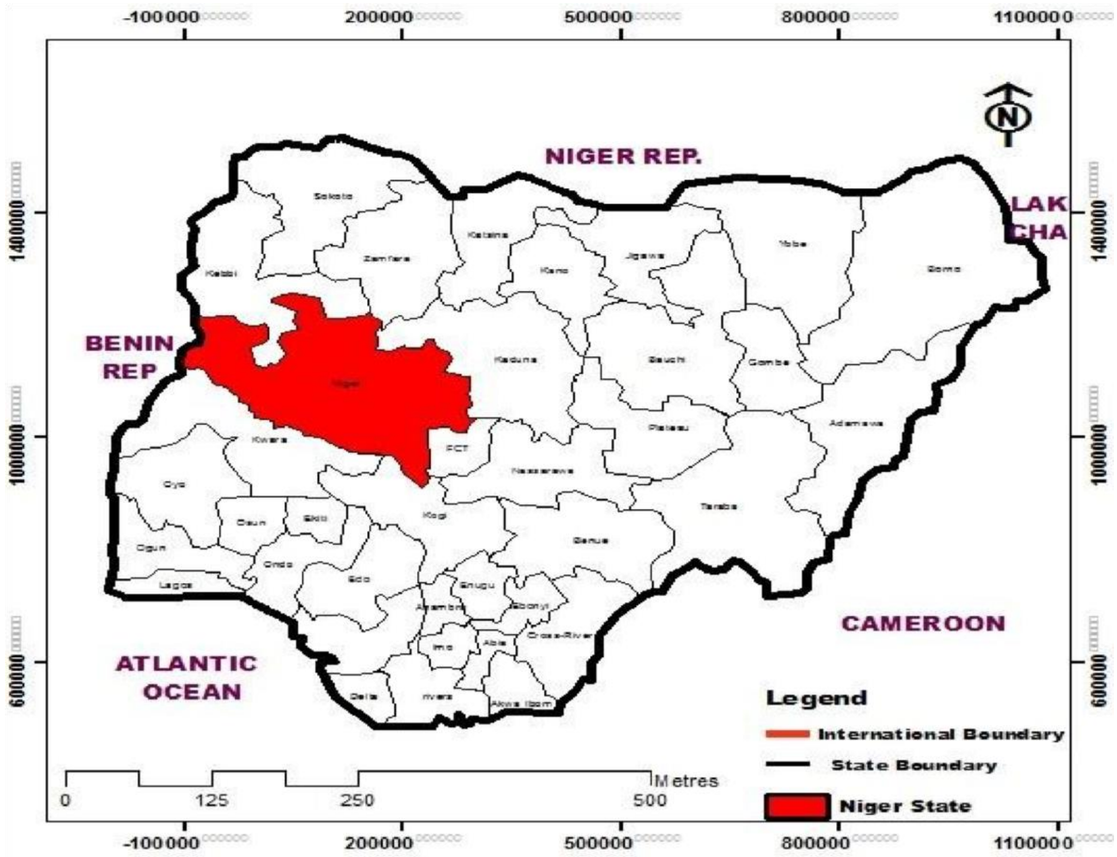

Figure1. 1: Location map of Niger state in the context of Nigeria
Source: Urban and Regional Planning, Department Archive (Modified by author, 2021)

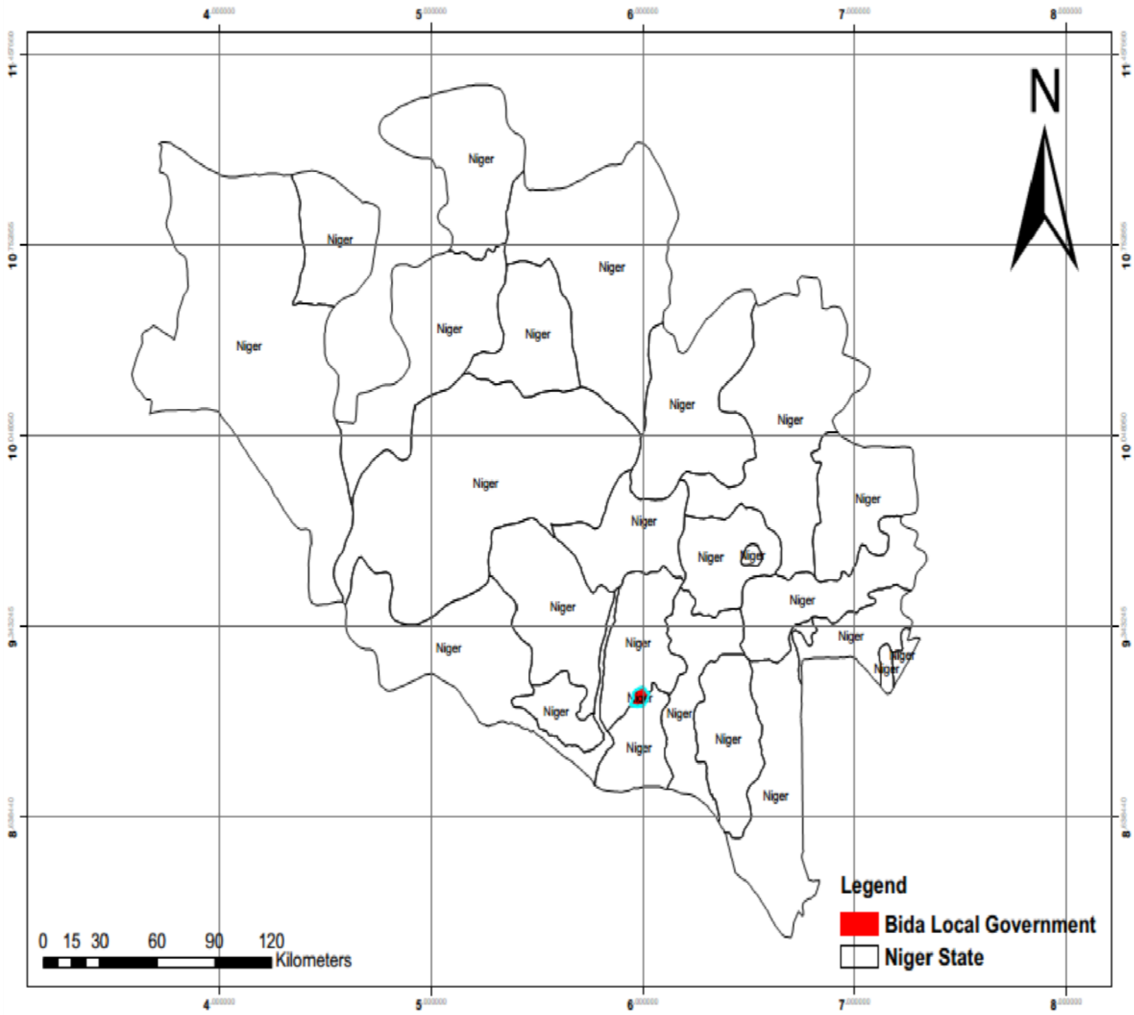

Figure1. 2: Bida in the context of Niger State.
Source: Urban and Regional Planning Department Archive (Modified by author, 2021)

1.7.3 Climate of Bida

Bida has a reasonable 19-year rain fall record with a mean annual rainfall of 1227mm. September has the greatest mean monthly rainfall of 248.8mm. The raining season typically begins sandwiched between the 5th and 15th of April and lasts for little over 200 days. The average monthly temperature is 31.1 degrees Celsius in March and 26.0 degrees Celsius in August (Bida Master Plan 1980-2000).

1.7.4 Population and size of Bida

Bida is an old traditional town that has progressively expanded through the years. It has traditionally drawn individuals from various areas of the state and the nation as the home of the Nupe classes of Nupe society (Bida Master Plan, 1980-2000). As per the

2006 census report, the populace of the local government Bida was 188,181 people. With a growth rate of 2.8 percent (NPC, 2006), the present population is predicted to be 241,276 people using population projection formula $P_1=P_0\ (1+r/100)^{n}$ where:

$\mathbf{P_1}$= future populace, $\mathbf{P_0}$= present populace, **r** = yearly growth rate and **n** = number of years. Being the second-largest city in Niger State, it has total land area of Bida 51sqkm landmass.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Concept of Water Supply

The problem of water supply has been compounded by rising urbanization, specifically in terms of the volume and quality of the water accessible in metropolitan areas. As a necessary consequence, despite the fact that a settlement or province tends to meet its fully functioning demand when satisfactory infrastructural facilities are prevalent in the neighbourhood, there is a concerning disparity between consumption and theoretically accessible portable water supplies, there is a concerning disparity between consumption and theoretically accessible portable water supplies. As a consequence, the community is conducive to human habitation and activities, including physical, social, and economic ones.

Water is an essential natural resource that sustains all kinds of life1. Without water, life as we know it on our planet is impossible. Water demand already outstrips availability in many places of the world. As the world becomes more globalized, numerous places are likely to suffer this disproportion in the nearest or impending future. According to the WHO, 75 Litres of water is necessary daily to guard against home illnesses and 50

Litres of water is required daily for basic family sanitation. According to the World Water Forum's international consumption estimates, a person living in a city consumes an estimated water 250 Litres/day. Nevertheless, individual water usage varies greatly throughout the world. (Yaro, Kogi, Onoja, Attah, & Zubairu, 2019).

The WHO and UNICEF Joint Monitoring Program estimated that 1.1 individuals have no access to water supplies globally, according to Bates et al. They defined access to water as the ability to obtain at least 20 litres of water for every person in a day through an better-quality water source inside a one-kilometer radius. Each year, a lack of access to adequate drinking water causes around 3.3 billion instances of disease and 2 million deaths. According to the UN, two-thirds of the global population will face water scarcity by 2025. And as per the UN World Water Assessment Program, 7 billion individuals in 60 nations may be faced with shortage of water by 2050 (Yaro, Kogi,

Onoja, Attah, & Zubairu, 2019).

This study focuses primarily on the spatial and temporal distribution of Community Water Boreholes as something of an alternative source of household water supply for Bida town residents, with a focus on determining the location and status of the facilities, their impact on water supply in the settlement, and the regulations that shape where they are located.

2.1.1 Importance of domestic water supply

Domestically, water is necessary for a variety of purposes, including human and animal consumption. Water is used for a variety of purposes in the home, including drinking (the most important), cooking, bathing, and washing.

Water supply for household use is a major priority for city planners, policymakers, and international development organizations since it is vital for life and in safeguarding community well-being and the level of existing of rising residents (WHO/UNICEF, 2014). The significant capital investment in infrastructure for water by the government and foreign donor organizations demonstrates the importance of household water supply, particularly drinking water. For example, in 2013, the Federal Government of Nigeria allocated #5.6 billion (USD $28.06 million) for water delivery in the Federal Capital Territory (Abuja) unaided (Budget Office of the Federation, 2013). The notion that expanding the area covered by water delivery would aid in attaining not just the socioeconomic advantages of water supply, but also national and intercontinental goals, such as the Sustainable Development Goals (SDGs), permits for such a big expenditure. Local politicians often observe it during election campaigns. They frequently list the number of villages that have been granted access to safe and clean drinking water as one of their accomplishments.

2.1.2 Rights of human to water

Water civil liberties have evolved from flexible to rigid international regulation, and it is presently measured as an "assorted, complex social right" (Meier *et* al., 2012). “The right to clean and safe drinking water is viewed as a social right that is vital to the complete gratification of good living and all human rights,” the United Nations General Assembly proclaimed in 2010. Water that is reliable and pure is often regarded as essential for living a productive and healthy life (WHO, UNICEF 2012). Preceding to the United Nation General Assembly's official proclamation of the right to safe and clean drinking water and good sanitation, many people considered access to safe and clean water and good sanitation services to be a precondition for fulfilling other civil dignity (Gleick 1998).

When contrasted to investments in other industries, the slow road to acknowledging water as a social right has stayed linked to inadequacy of legislative will and properties in this field (UNDP 2006). Also, because the poor, who are suffering so much from inadequacy in appropriate water services, has less political clout, their demands for these basic services may be disregarded far more effortlessly if the social right to water is not explicitly established. Though progress has been established, an absence of cooperative action and authority among the poor is key and one issue that has contributed to developing nations' ongoing absence of access to clean and safe water supply services in recent decades (WHO and UNICEF 2012).

768 million persons worldwide do not have access to clean and safe drinking water, with an excess of 80 percent of these individuals residing in countryside (WHO and UNICEF 2013). Water scarcity is associated to a range of illnesses, undernourishment, decreased productivity, and low educational attainment, particularly among girls and women. Household water consumption need day-to-day access to clean and safe water to gratify elementary requirements such as washing, bathing, drinking, and cooking. Water is also essential in non-urban (rural) regions for subsistence activities such as livestock keeping, agricultural irrigation, brick manufacturing, and small-scale moneymaking operations. These activities contribute to a rise in average earnings as well as improved food and health sustainability. Water is also required in peri-urban areas for a variety of source of revenue (Kurian and McCarney 2010). Already in the

1990s, urban agriculture was growing more significant as the world's population grew (Zezza and Tasciotti 2010); approximately 20 percentage of the global food was projected to be generated in cities.

The traditional understanding of water as a fundamental right in 2010 was a huge step forward towards overcoming the inaccessibility to water in emerging nations, particularly for women. Civil liberties to water were established from a slender public health perception, emphasizing the availability of clean and safe drinking water for sanitation, drinking, hygiene, and other household events. Without denying the relevance of household usage in social rights law, this viewpoint might be viewed as disregarding a number of wider socioeconomic social rights in which water plays a critical part. In overview, the right to clean and safe water is implemented through supplying water amenities and services that are specifically designed and developed for household usage. At least a volume of 20 litres per day per capita is recommended by service delivery level design criteria, ostensibly for household purposes exclusively. Even when higher service levels are provided to promote the progressive realization of this right, it is believed that such bigger quantities are solely utilized for domestic reasons.

The Universal Declaration of Human Rights (UDHR) of the United Nations (UN) engenders significant state obligations to respect, fulfil, and defend a wide variety of socioeconomic rights. The UN General Assembly affirmed the right of everyone to clean and safe drinking water and good sanitation in 2010, marking a watershed moment. Water, on the other hand, plays an essential part in the realization of other basic social rights, for example, the right to food and a livelihood, as well as the concept of the abolition of all arrangements of discernment against women. These larger rights that were related to water have been acknowledged but are yet to be implemented.

2.1.3 Need for groundwater exploitation

Boreholes and wells are groundwater types that are an essential element of water delivery systems in rural and urban regions, particularly in Africa, due to insufficient public water supply systems (William, 2014). More than billion individuals across the globe don’t have adequate access to clean, safe water, with approximately 300 million rural dwellers in Sub-Saharan Africa experiencing a deteriorating scenario. While sanitation and health improve, there is a rising demand for large amounts of water (William, 2014). Families' health and livelihoods might suffer if safe water is not available near their homes. Borehole water consumption is related with a reduced risk of diarrhoea in children when compared to surface water in Bangladesh.

Boreholes may offer safe and easy water supply since it is evenly distributed, cheap, of excellent quality, and is not impacted by seasonal fluctuations, making it sustainable.

The only practical option for meeting rural water demands is groundwater extraction. Because it is reachable from anywhere, requires less funds to build and maintain, is less vulnerable to contamination and periodic variations, and is unsurprisingly of high quality, ground water is the primary source of household water for a hefty portion of the global population, particularly in Sub-Saharan Africa.

Water resources are vital for provincial economic and social development and are viewed as a limiting influence in human progress. Groundwater is essential for the development of scorched and semi-scorched regions, and its development, especially borehole water, is viewed as extra adaptive to poverty reduction in Africa than external water. To compensate for a shortage of water locally, a higher amount of family income may need to be spent on water provided from private sources, such as tankers (William,

2014).

2.1.4 Water security

Water security mapping may aid in the identification of susceptible regions, and improvements to monitoring systems can assure the early discovery of pollution concerns. Water security efforts include efforts to reduce the time and effort essential to collect water, reduce the burden on women, improve water availability, increase the amount of water consumed per capita per day, and increase production activities such as crop washing, particularly small-scale gardening, as social conditions that could be improved by developing community water supply. Increased penetration of groundwater-based rural water supply can dramatically increase rural populations' reliance on climatic variability (William, 2014).

2.1.5 Impact of dry and wet seasons on groundwater quality

Seasonal changes affect the visual quality of the water and cause customer discomfort. Seasonal fluctuations in water quality occur as a result of changes in the area's biological activity, precipitation, and geology. Because of the limited permeability of the confining layer, artesian boreholes / rock wells created in unconsolidated sediments tend to respond slowly to rainfall, perhaps many days or weeks later. Boreholes that penetrate fractured material in a region with thin overburden respond fast to percolated rainwater. The eco-system, surrounding region features, habitation time, and geological factors all influence the physicochemical and microbiological seasonal changes of groundwater parameters (William, 2014).

2.1.6 Public water services distribution in developing nations

Delivering communal amenities in metropolitan areas is the process of guaranteeing resource utilization, together with decisions regarding the quantity and quality of such services to end consumers, as defined by the United Nations (Werna, 2000). Treated drinking water is viewed and handled an economic product that may be traded for a non-zero amount, as well as a distinct good or social right that everybody ought to enjoy irrespective of financial means (UNDESA, 2010). (Garcia, 2005). In this regard, providing water for public use entails infrastructure funding and construction, as well as system operation, administration, and maintenance. In general, for a variety of reasons, including expensive infrastructure expenses, a yearning to circumvent restricted service and manipulative estimating, and the idea that unfettered marketplaces will undersupply essential services that offer society value, public sector conveyance is favoured over private sector conveyance (Thoenen, 2007). Water is mainly generated and distributed by government dominations, which stand in for more than 90 percent of the global water utilities, according to this (Hoedeman *et al.*, 2005). This administrative support (monopolistic) is believed to be the utmost price effective owing to the benefits of scaleeconomies and replication minimization.

In most emerging nations, hasty urbanization and growth of urban centres have restricted the communal sector's ability to deliver public utilities, prohibiting sufficient administration and methodical capability to operate and maintain urban water schemes. World leaders approved the Millennium Development Goals (MDGs) as part of an attempt to increase access to drinking water, particularly goal 10 which sought to decrease in quasi the number of persons deprived of adequate access to clean drinking water. By the conclusion of 2010, the goal had been achieved, and the United Nations

General Assembly had conceded a statement declaring water to be an universal right. The right to water is defined by the United Nations Development Programme (UNDP) as "the right of every person to appropriate, clean, safe, satisfactory, physically reachable, and cheap water for individual and household needs" (UN,2010).

2.1.7 Water resource endowments of Nigeria

Nigeria as a country has significant ground and natural surface water reserves, with surface water resources appraised to be at 226 billion cubic metres and groundwater resources estimated at 40 billion square meters (Obeta, 2018). These rich, differentiated, and distinctive surface water resources contain almost 9,670 miles of identified streams and rivers, 1,323 identified lakes, thousands of acres of marshland, and 390 flowages (Obeta, 2018). The country's stream dispersal is uneven, with the most streams and lakes in the southern areas. Floras and other resources necessary for household agriculture, trade, and consumption can be found in streams, lakes, and wetlands. Nigeria's longest and greatest surface water body is the Niger River, after which the country is called. In addition to surface water, the country has vast ground water resources that supply millions of gallons of water each day to rural residents and other consumers of over 78 million (Obeta, 2018). The majority of people in Nigeria's rural areas are reliant on wells and boreholes for their water supply. Numerous of the nation's rivers, streams, and lakes suffer waste water expulsions, posing significant public health and environmental risks (Obeta, 2018).

Sediments, nutrients, and other contaminants from both point and non-point origins, airborne contaminants, polluted deposits, and habitat or physical degradation are all wreaking havoc on Nigeria's rivers, streams, and lakes (Obeta, 2018). Many rivers collect enormous volumes of solid wastes and untreated seepages, both of which include chemicals that are harmful to people and aquatic life. Few institutional activities exist in the region to detect and analyse water quality status, as well as design and implement programs to improve surface water quality (Obeta, 2018).

2.1.8 Water supply in Nigeria

Although Nigeria is recognized for its rich water resources, access to drinking water is an issue in many regions of the nation. Water supply services have traditionally been regarded the responsibility of the Federal, State, and Local Governments in Nigeria. Water supplies and management have consumed a significant number of public expenditures since 1999. However, there is still a scarcity of drinkable water and many people do not have access to proper sanitation. Complications resulting from unclean water and poor sanitation account for more than half of all fatalities in the country's hospitals. The Federal Government has sought to construct water infrastructure such as dams during the previous eight years, but these were mostly for agricultural reasons, with little attention devoted to water for residential consumption. Because of a shortage of money, the government claims it cannot handle water supply on its own and has delegated its statutory duty to shady water providers that are unaware of or unconcerned about safe water requirements (Yaro, Kogi, Onoja, Attah, & Zubairu, 2019).

Several Nigerian administrations, at the federal, state, and municipal stages, have undertaken desperate attempts to offer citizens with a portable and sufficient water source. Where water delivery systems do exist, they are inconsistent and unsustainable due to apparent management challenges. In light of this, the World Bank (2002) identified access to clean water as one of the most pressing challenges of our day. Approximately 12% of the population of the world chomps up 86 percent of the freshwater resources, whereas 1.1 billion persons (one out of six of the global populace) lack adequate access to safe drinking water. Changes in climate are becoming more important as the worldwide need for clean water rises and contamination are plummeting potable freshwater.

As a consequence, there is a rising attention in expanding safe and clean water availability using small scale water initiatives at the domestic level (such as the construction of individual water boreholes) to alleviate the difficulties created by the water demand and supply crisis. With the approval of the National Water Supply and Sanitation Policy in January 2000, the national government acknowledged water supply services to be the domain of the Local, State, and Federal governments. Nevertheless, the public sector has only been able to fulfil a tiny fraction of the water demand from residential and business customers. There is a serious shortage of services (FMWR,

2000).

2.1.9 Quality and quantity dimensions of water delivery system

Basic water services are supplied through networks that are geographically dispersed within metropolitan centres and are produced jointly or separately. As a result, it is necessary to assess equally the amount and superiority of services delivered. The dimension of quantity of water supply denotes to coverage, or the fraction of the populace with access to portable or drinkable water. Though the concept or characterisation of drinking water approachability differs from nation to nation and from international organizations to local authorities, it is subjective (it fluctuates).

“Access to safe drinking water” is defined by the World Health Organization (WHO, 2011) as “having an enhanced supply of water inside 1 kilometre of a residence or inside a walkable distance of not more than 30 minutes.” Pipe-borne residential connections, boreholes, protected springs or wells, and neatly collected rainfall are among the improved water sources (WHO/UNICEF, 2014).

2.2 Concept of Water Borehole

A water well is a shaft, hole, or diggings dug into the earth for the resolve of collecting ground water. Following the excavation of the hole or shaft, water may naturally flow to the surface. The most common type of well is a vertical shaft, although they can also be horizontal or at an angle. Other than collecting ground water, certain wells are used for subsurface exploration, surface drainage, non-natural recharge, and trash disposal. Any borehole's (well's) placement is mostly determined by the underlying goal, which is an important factor. Qualified expert drillers should conduct the hydrogeological evaluation. The appropriateness, availability of adequate ground water, and suitable quality are all determined by a variety of circumstances. These elements include understanding of the groundwater system, prior experience in similar locations, and a wide range of data such as local vegetation, land surface topography, rock fracture

(depending on position), and geophysical dimensions, amongst others.

The primary objective of water borehole design and construction is to fashion a well that is architecturally solid, long lasting, and competent, with adequate space for pumps and other abstraction equipment. It will guarantee that groundwater flows easily and without silt from the aquifer into the well at the appropriate quality and volume, while also avoiding material deterioration and bacterial growth.

2.2.1 Water borehole facilities and environmental effect

Rainfall water is absorbed primarily into the earth and also serves as a source of plant nutrients. The rest flows downward via pores and crevices in the rock up until it spreads a thick layer, where it is not used by plants. The water held beneath the earth in the apertures and crevices overhead the strong rock blockade is known as aquifer water, and it is this water that we get when we drill wells. Geo-drilling activities that remove water in its natural state produce an imbalance in the earth's crust, which can result in coastal erosion. This is one of the most significant environmental consequences of having a large number of drilling facilities. As more water is taken from the region, the earth begins to sink and form a cone. Elevation changes, impairment to constructions such as canals, roads, storm drains, railways, sanitary sewers, bridges, and levees, as well as structural impairment to private and public buildings and wells, are all possible consequences of land subsidence. Subsidence, on the other hand, is most frequently associated with a rise in the risk of floods.

2.2.2 Borehole water availability and accessibility

Despite the fact that water covers about 70 percent of the ground's surface, only about 3 percent of all water on the globe is fresh water, and fewer than 1 percent of the global fresh water is available for human consumption (William, 2014). Water scarcity and access concerns have an influence on household and productive lives in communities. Nearness to water resources intensifies per capita consumption and inspires the use of water for vegetable and fruit growing. As a result, there is a need to improve source reliability by expanding water coverage and prioritizing sensitive locations (William, 2014).

The globe is experiencing a water demand and supply crisis, and it is unavoidable that there is insufficient clean and safe water to satisfy the demands of today's population. Despite several years of water development programs, access to appropriate quantities of excellent quality drinking water remains limited in many African rural and peri-urban areas. Climate change affects the hydrological cycle in a variety of ways, including evaporation, precipitation, runoff, groundwater recharge, and seasonal rainfall patterns. Due to limited and depleted water resources, global per capita water consumption is falling as the world's population rises. As a result of the crisis, users congregate near restricted water sources, increasing pollution and the spread of water-borne illnesses (William, 2014).

2.2.3 Comparison of performance of public and private boreholes

For ecologically sustainable growth, a reliable water supply is essential. Despite the installation of countless boreholes in developing nations and the engagement of several organizations in water supply development, only approximately 25-35 percentage of the rural populace and 40-45 percentage of the urban populace have access to potable drinking water. Aside from the inadequate coverage, there are issues with weak feasibility studies and a lack of a proper maintenance culture. For example, due to the shallow nature of the boreholes resulting from poor feasibility assessments, most of the boreholes dug in Rivers State ceased production after a short period of operation. In addition, numerous boreholes were dug and handed over to communities or water boards without enough replacement parts, community maintenance team training, or adequate money.

The engagement of private organizations in the management and maintenance of water delivery systems has recently attracted a lot of attention. With the ultimate goal of attaining economic efficiency, privatization entails redefining the role of the state by disengaging it from those tasks that are best performed by the private sector. Privatization may be described as the systematic transfer of suitable tasks, activities, or property from the public to the private sector, where market processes can better control services, production, and consumption. As more responsibilities are moved to the private sector during privatization, the state's role or degree of engagement in the economy is diminished (Ajileye, 2002).

Braadbaart (2000) examined a large body of research on ownership effects in the water sector and concluded that ownership effects are neither independent nor overwhelming. Privatizations of water utilities can sometimes, but not always, result in increased efficiency. Braadbaart (2000) claims that our understanding of how privatization impacts water utilities is still lacking. “Economists think that privatization produces efficiency and other benefits because of the mix of ownership effects and competition.” The impacts of ownership are assessed using efficiency metrics like operational cost and cost. It's tough to quantify the impacts of ownership. The treatment group of private utilities should, ideally, be compared to a control group of government-managed utilities operating in similar conditions. Despite this, in industrialized nations, certain ownership impacts of water facilities have been studied. Because of the differences in market structures, laws, and macroeconomic conditions in emerging nations, a comparable research is required.

2.2.4 Mapping spatial distribution of water utilities using GIS software

Because data gathering is the most important step in any digital mapping or GIS project, Anwuri *et el.* (2015) utilised the Google Earth website to excerpt a high-resolution satellite picture of their research region. A portable Garmin GPS MAP 76c receiver was used to determine the coordinates of the utilities and a Canon A420 power shot digital photographic camera was used to capture photographs of the region during the site visit.

In their study "Mapping the Spatial Distribution of Water Boreholes Facilities in River State Using GIS (7606)," Anwuri *et al.* 2015, using buffer analysis, we evaluated the influence of the water borehole facility in the study region in relation to the human populace and category of human habitation. The boreholes in the closest neighbourhood were 7 meters apart, with the possibility of less in some locations, according to the buffer study. Planning supervisory procedures and controls should be followed in the procedure of placing the amenities, according to Anwuri *et al.* (2015). In their study, Anwuri *et al.* (2015) neglected to include the present state of the water borehole amenities and the effectiveness of water delivery in the studied region.

In their study "Mapping the Spatial Distribution of Millennium Development Goals (MDGs) Health Care Facilities in Kaduna North and South Local Governments, Kaduna State, Nigeria," GIS technology is used by Abbas *et al.* (2014) to augment data for communal health facility planning, decision-making, and mapping. The primary data was a topographical map of their research territories from the archive GIS laboratories at Ahmadu Bello University Zaria's Department of Geography, and the secondary data was

GPS-based geographic data from the field for the MDGs healthcare institutions. The data was analysed with the use of the Ilwis 3.2a GIS program, and the results were displayed in the form of tables and maps. According to Abbas et al., the bulk of healthcare facilities in the study region were not evenly dispersed, limiting other portions of the population convenient access. Another finding was that failing (malfunctioning) health-care facilities, notably boreholes, were causing problems. As a result, some areas were overserved while others were neglected (underserved).

Ibrahim, Mohammed, Garba, and Badaru (2014) discovered that the site location (Minna) has been challenged with the delinquent of populace upsurge from different parts of the region in exploration of better opportunities, resulting in insufficient water supply to the general public by unadventurous means in their study of substitute water sources for household use in Minna City, Niger State. Individual efforts have been made to find alternate sources of water to satisfy their daily water demands as a result of the situation.

Three alternate sources of water supply where discovered, this comprises boreholes, well water, and water from merchants. Just boreholes were chosen by the government out of these three options. While the other two depict a single household's struggle to meet its domestic water needs (Ibrahim *et al.,* 2014).

Data was analysed using the statistical program for social science (SPSS) and questionnaires addressed to the general population in order to collect data, as well as straight consultations with spokespersons of the Niger State Water Board. “The Ministry of Water Resources ought to develop and enforce private water delivery rules, particularly with regard to well water, as this is a key source of water in the study area” Ibrahim *et al.* (2014) stated. This will help to ensure that the well water supply is portable. However, it is important to highlight that borehole water is more sanitary than well water. In light of the above proposal, Ikusemoran and Ibrahim (2012) propose that the government supply portable water, form a water quality control board, and employ GIS tools to create databases and analyse water quality for easier monitoring and management. After their work "Analysis of water quality of commercial boreholes along River Yedzeram, Mubi, Nigeria," they received the recommendation.

Only eight of the twenty-two boreholes are of high quality, according to Ikusemoran & Ibrahim (2012), with the rest being either terrible or not bad portable questions. This was accomplished by analysing water samples obtained from twenty-two boreholes along the major river, the Yedzeram.

2.3 Theoretical Framework

In order to enhance efficiency and meet sufficient service delivery goals, several theories have emerged to regulate the geographical distribution of infrastructure, facilities, utilities, and other services in every city. As a result, the focus of this part will be on the many philosophies offered to assist as a chaperon for the dispersal of any infrastructure inside a geographic region or country.

2.3.1 Central place theory

The Central Place Theory aims to explain the geographical layout, number, and size of settlements in the United States. After examining settlement trends in southern Germany, a German geographer named "Walter Christaller" proposed the idea in 1933. Christaller noted that settlements of a particular size were generally equidistant on the flat landscape of southern Germany. He discovered that by studying and specifying the purposes of the settlement structure as well as the size of the hinterland, he could use geometric forms to describe the pattern of settlement sites.

The idea is based on two fundamental concepts: the threshold and the range of services and goods.

Threshold

In a community or urban centre, the minimum population necessary to bring about the availability of particular goods or services.

Range of Good or Services

The greatest distance that individuals will go to get or acquire specific products and services.

2.3.2 Relevance of the central place theory to the study

The theory is relevant to the research because of its explicit statement of a minimum populace prerequisite for the regulatory framework of any elementary infrastructural programs and amenities inside a geographical area; this demographic prerequisite for a specific infrastructural facility or service would then guarantee that it is appropriately accessible and affordable to the people it serves; additionally, it stipulates the nature and type of infrastructural facility or service.

CHAPTER THREE

3.0 MATERIAL AND METHOD

3.1 Introduction

This section explains/describes the research method /methodology that was used in the data collection, analysis, and exhibition processes to ensure the research work's success.

3.2 Research Design

A research design is a master plan that postulates the techniques and processes for data collection as well as data analysis. Given the sort of data needed for an understanding of this size and the nature of the populace, a systematic random sample approach was used to gather all data required via questionnaire administration, reconnaissance surveys, and field surveys of the study region. The types of data to be collected include the geographic coordinates of the community boreholes, the total count of boreholes in the study region, the category of utilities (boreholes) locally available (whether hand pump or motorized), the effectiveness of water supply, the maintenance and management structure of the boreholes in Bida, the average distance journeyed to access these utilities, and the status of the boreholes in Bida are all factors to consider. As a result, the research design is experimental.

3.2.1 Source of data

The data needed for this research project were gathered from two key sources which are: primary and secondary data sources.

3.3 Sample Frame and Sample Size

3.3.1 Sampling frame

The research area's sample frame is the number of households, which was estimated to be 34,532 in 2006 (NPC 2006) with a 2.8 percent annual growth rate. The current number of households was determined using the population projection formula $P_1 = P_0 (1+r)^n$ equation (i) where: $\mathbf{P_1}$= future population, $\mathbf{P_0}$= present population, **r** = annual growth rate and **n** = number of years.

$\mathbf{P_1}$=? $\mathbf{P_0}$=34,532, **r** =2.8%% and **n** =14 (from 2006-2020).

$\mathbf{P_1}$=34,532(1+2.8%/100)^{14}

=34,532(1+0.028)^{14}

=34,532(1.028)^{14}

=34,532 × 1.472= 50,830households

Bida's current household population is estimated to be 50,830 (distributed across fourteen electoral wards), representing a growth of 16,298 homes over the last 14 years.

3.3.2 Sample size

The anticipated household number in Bida is 50,830, and the formula was used to calculate the sample size for the study from the sample frame is Sample size$= \frac{N}{1+N(e)^2}$ espoused from Abraham *et al.,* (2001) Where N = Total number households (50,830) e = degree of freedom for social science 5% (0.05)

Consequently, the sample size of the study is roughly 400 households.

3.4 Procedure for Data Collection

3.4.1 Primary data

The following approaches will be used to acquire data from primary sources:

i. **Reconnaissance survey:** This entails a preliminary assessment of the study region's key Community Water Borehole locations in order to get familiar with their placement inside the place of interest. This is critical since it provides information on the current position and status of these utilities, as well as the kind or category of borehole in use, whether hand-pumped or motor-powered.

ii. **Field survey:** This entails visiting the site to accumulate information includes by means of a handheld Garmin GPS MAP to take coordinates of utilities (boreholes) wherever they are discovered, as well as taking measurements of the service area of the physical construction correlated with facilities and photographic observation to aid in understanding the location, design, and physical features of the areas under review.

iii. **Questionnaire Administration:** Questionnaire was designed and sent to users of these kind of utilities where they are found or placed in order to obtain their feedback on the utilities, including the ease of accessing boreholes and the length of time they are accessible for usage.

iv. **Personal interview:** Inhabitants in the research region who live near Community Water Boreholes will be interviewed to learn more about the impact of utilities in their neighbourhood, alongside the policies that interpret the placement of utilities.

3.4.2 Secondary data

This was used to complement the main data obtained but entails extracting material from relevant literatures such as dissertations, theses, textbooks, journals, satellite images, government/private institutions, and so on. The internet will provide a wealth of knowledge.

3.5 Method of Data Analysis

The data gathered during the field work was submitted to descriptive numerical examination using SPSS (Statistical Package for Social Science), as well as the usage of GIS package (ArcGIS 10.1) to georeferenced and digitize satellite pictures and generate a point/dot map representing the geographical position of borehole utilities in the research region.

3.5.1 Method of data presentation

Data presentation is a need in study projects to help in the adequate interpretation of the data gathered. In light of the foregoing, the subsequent approaches were used to show the data that has been gathered.

i. Tabular form for displaying frequency, rate of answer from the disseminated questionnaire, and calculated values amongst data.

ii. Graphic format, which included the usage of charts (bar, histogram, and pie) to represent the results of data analysis.

iii. Maps: point maps were generated to depict the spatial distribution of community boreholes in the research region, including those that are motor-powered or hand-pump, operational or not, and those that were dug by hand or by engine.

CHAPTER FOUR

4.0 DATA ANALYSIS AND PRESENTATION OF RESULT

4.1 Introduction

This section delves deeper into the observation and organization of data gathered in the field throughout the field survey. The data gathered in the field revealed that there are

135 Community Water Boreholes in Bida, which are disseminated across the different Political Constituencies in the Bida Metropolis. The coordinates of the Community Water Boreholes location and their attributes were computed in Excel, and an attribute table was created, which was later imported to Google Fusion Table for further analysis and experimentation, as well as the analytic results.

4.2 Socio-Economic Characteristics of Respondent

4.2.1 Name of ward of respondents

The responses from the respondents from their respective wards are characterised in Table 4.1.

Table 4.1: Name of ward

Name of ward	Number of respondent	Percentage
Bariki	20	6.4
Cheniyan	48	15.4
Dokodza	24	7.7
Kyari	30	9.6
Landzun	13	4.2

Masaba A	18	5.8
Masaba B	27	8.7
Masaga A	18	5.8
Masaga B	39	12.5
Mayaki Ndajiya	12	3.9
Nasarafu	12	3.9
Umaru Majigi A	17	5.5
Umaru Majigi B	22	7.1
Wadata	11	3.5
Total	311	100.0

Source: Author field work, 2020.

4.2.2 Gender of respondents

Females have a higher number of respondents (52.7%) (164 out of 311 respondents), whereas men have a lower percentage (47.3%). (147 out of 311 respondents). This might be related to the fact that women are more likely to gather water for domestic purposes.

4.2.3 Age of respondents

The age range of the respondents is depicted in Figure 4.1, with the 15-30 years age cohort (Youth) being the most frequent users of these Water Boreholes with a combined percentage of 66.59 percent (48.53 percent & 18.06 percent), 24.1 percent in the group 31-45 years, and 9.35 percent in the age category above 45 years, indicating that the age demographic above youthful age makes less use of the Water Boreholes.

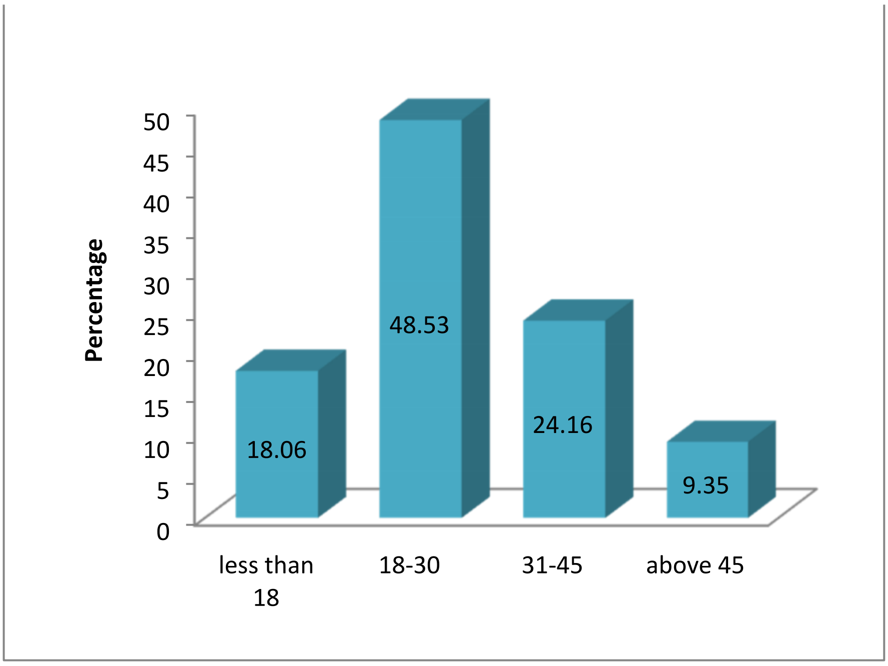

Figure 4.1: Respondent's Age
Source: Author field work, 2020.

4.2.4 Respondents' occupation

Table 4.2 shows the proportions of 311 respondents' occupations, with Civil Servant having the highest percentage (44.1%), Traders having 27%, Other kind of work having 23.5 percent, and Farmers having just 5.1 percent.

Table 4.2: Occupation

Variable	Frequency	Percentage
Farmer	16	5.1
Trader	85	27.3
Civil Servant	137	44.1
Other	73	23.5
Total	311	100.0

Source: Author field work, 2020.

4.2.5 Marital status

Figure 4.2 depicts the data gathered throughout field data assemblage and analyzed to demonstrate the proportion ratio of respondents' marital status, with married respondents accounting for 60.1 percent, single respondents for 33.7 percent, widows for 4.1 percent, and divorced respondents accounting for just 1.9 percent.

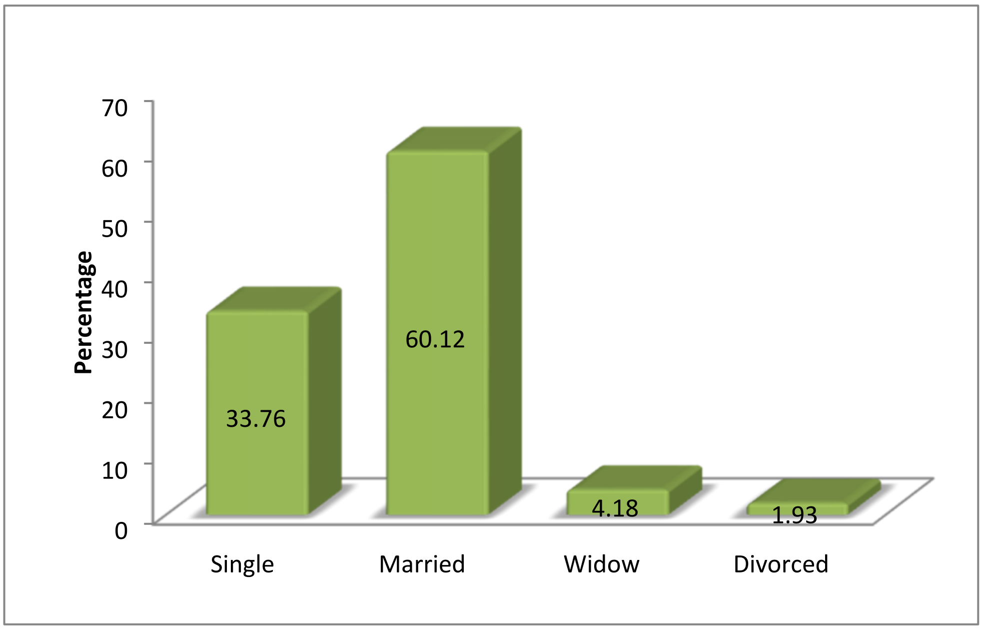

Figure 4.2: Respondents Marital Status
Source: Author field work, 2020.

4.2.6 Respondents gross income

Table 4.3 shows the respondents' income levels, with respondents with gross income less than 18000 nearly equaling respondents with gross income between 18,000 and 30,000 with 41.8 percent and 41.2 percent correspondingly, 15.4 percent of respondents falling into the group of 31,000-50,000, and 1.6 percent for higher income recipients above 50.

Table 4.3: Gross Income

Variable	Frequency	Percentage
<1800	130	41.8
1800-30000	128	41.2
31000-50000	48	15.4

>50000	5	1.6
Total	311	100.0

Source: Author field work, 2020.

4.3 Locational Analysis of Community Water Boreholes

4.3.1 Main source of water in the respondents area

According to the respondents' responses, the most common source of residential water is a borehole (52.7%), followed by well water (22.8%), water vendor (13.1%), and tap water (11.2%). As shown in figure 4.3. Based on the foregoing, it can be inferred that Water Boreholes are now the Metropolitan' primary source of domestic water supply.

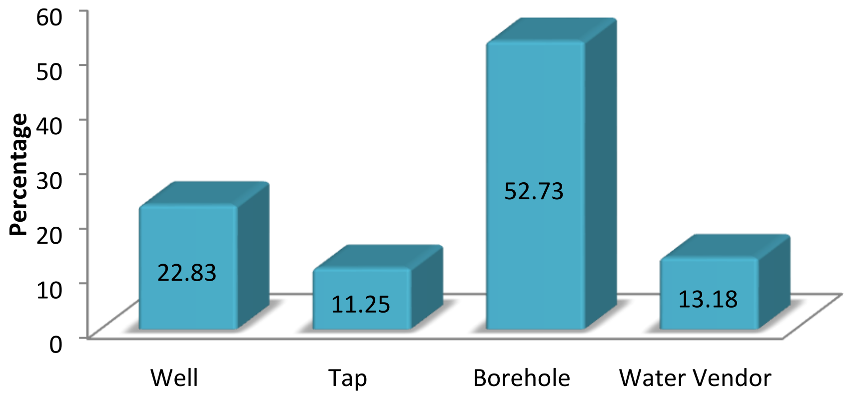

Figure 4.3: Primary Sources of Water
Source: Author field work, 2020.

4.3.2 Use of borehole by respondent

When asked if they use a borehole in their neighborhood, the majority of the respondents (88.7%) said yes, while the minority 11.3 percent said no, indicating that they do not utilize a borehole in their region.

4.3.3 Type of borehole

According to the types of community water boreholes reported by respondents, 83.6 percent of the water boreholes in the study area are motorised, while only 16.4 percent are manual boreholes.


Plate I: Motorised (Cheniyan Ward) and Non-Motorised (Masaga A Ward) Community Water Boreholes

4.3.4 Source of power use for the borehole

Figure 4.5 shows that the mainstream of respondents claim the boreholes in the study region are powered by AEDC (Abuja Electricity Supply Company), accounting for 81.0 percent, solar power accounting for just 2%, generators accounting for 0%, and boreholes not powered by AEDC accounting for 16 percent.

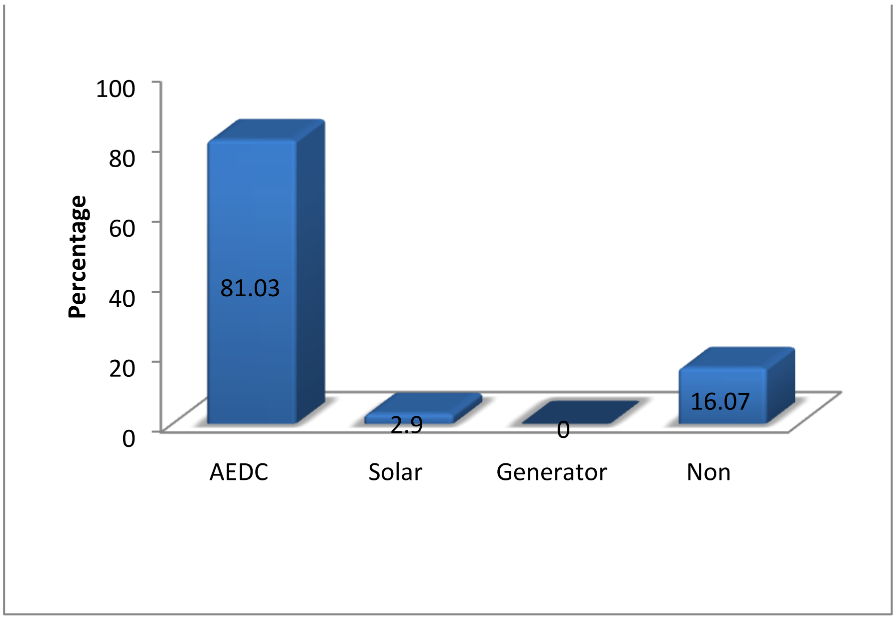

Figure 4.4: Power Source
Source: Author field work, 2020

4.3.5 Alternative power source use for the boreholes

According to the results of the questionnaire guide, the generator is the only alternative power source used in the research region to power the Boreholes utility. Despite the fact that the question number 12 in the questionnaire had four alternatives (AEDC, Solar, Generator, and None), only two of them (Generator and None) were picked in all of the responses. Generator received 59.8% of the vote, while 40.2 percent chose none.

4.4 Uses Efficiency and Effectiveness of the Water Boreholes

4.4.1 Condition of the boreholes

According to the data gathered from the field and analyzed, 227 out of 311 respondents (73%) believe their area's water boreholes are operational, whereas 84 respondents (27%) believe their area's water boreholes are not operational.

Plate II: Motorised (Umaru Majigi Ward) and Non-Motorised (Kyari Ward) Functioning Community Water Boreholes

4.4.2 Borehole Years of Existence

According to the table below, 55.9% of respondents believe the Water Boreholes were installed approximately 5-10 years ago, 20.2 percent believe about 5 years ago, 19.9 percent believe 11-15 years ago, and the least amount of respondents believe 16-20 years ago.

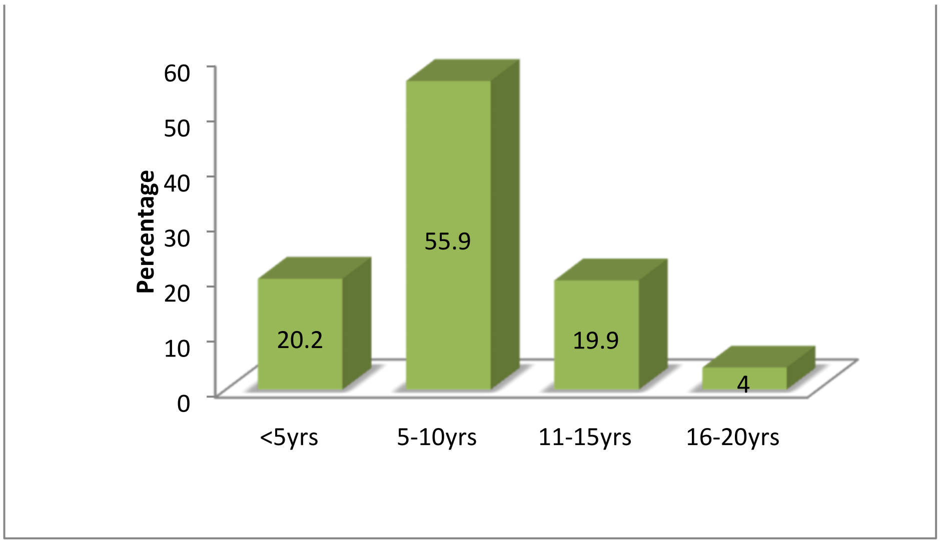

Figure 4.5: Water Borehole years of Existence
Source: Author field work, 2020.

4.4.3 Water borehole provider

Table 4.8 shows that the government is the leading provider of Community Water Boreholes in the study area, with 77.5 percent of respondents, followed by individual citizens (philanthropists) with 13.5 percent of respondents, community commitment with 4.8 percent, and non-governmental organizations (NGOs) with 4.2 percent of respondents.

Table 4.4: Water Borehole Provider

Variable	Frequency	Percentage
Government	241	77.5
Private individual	42	13.5
Community effort	15	4.8
Non-governmental organisation (NGOs)	13	4.2
Total	311	100.0

Source: Author field work, 2020.

4.4.4 Factors responsible for the sitting of the community water boreholes The results of the analysis show that community decision, which received 49.9% of this same respondent's vote, is the most important factor in determining the location or sitting of boreholes where they are found, followed by ward project, which received 35.4 percent of the vote, and donor decision, which came in third. Planning guideline is given little weight when determining the site for the position of the utilities with only

1.9% of the respondent’s mark.

Table 4.5: Factors responsible for location of the Community Water Boreholes

Variable	Frequency	Percentage
Ward project	110	35.4
Community decision	146	46.9
Planning Regulation	6	1.9
Donor's decision	49	15.8

Total	311	100.0

Source: Author field work, 2020.

4.4.5 Time the utility are accessible

According to figure 4.6, 79.4 percent of respondents say the boreholes are available between the hours of 6-9 am and 6-10 am daily, 18.3 percent say the utilities are only reachable between the hours of 6-10 am daily, 1.9 percent say other periods as may be deemed fit or available for usage, and none of these utilities are accessible 24 hours a day, i.e. throughout the day.

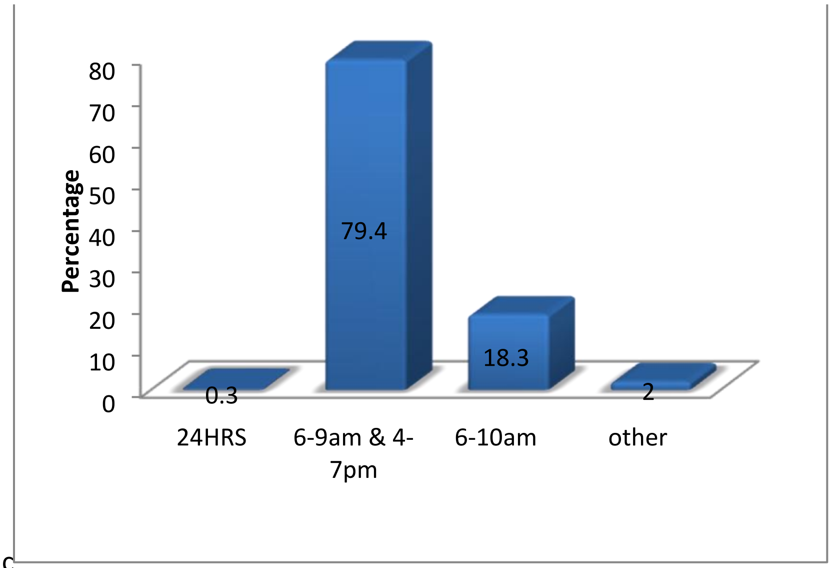

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Figure 4.6: Utility accessibility period

Source: Author field work, 2020.

4.4.6 Average distance travel to access the boreholes

The Table below shows the average distance traveled by users of these boreholes, with the highest respondent's mark being 101-150 meters. The users who travel the shortest distance are 28.3 percent of the overall figure of respondents who travel a distance of less than 50 meters on average, 21.5 percent travel a distance of 51-100 meters on average, and 1.6 percent travel a distance of less than 50 meters on average.

Table 4.6: Distance travel to access the boreholes

Variable	Frequency	Percentage
<50m	88	28.3
51-100m	67	21.5
101-150m	151	48.6
above 150m	5	1.6
Total	311	100.0

Source: Author field work, 2020.

4.4.7 Number of trip users makes to fetch water from the boreholes

The figure 4.7 shows that the most common number of journeys taken by users is three, with 51.7 percent of respondents opting for three trips, 31.8 percent opting for two trips, 13.5 percent opting for a number of trips other than three excursions, and 2.8 percent opting for travels on an infrequent basis.

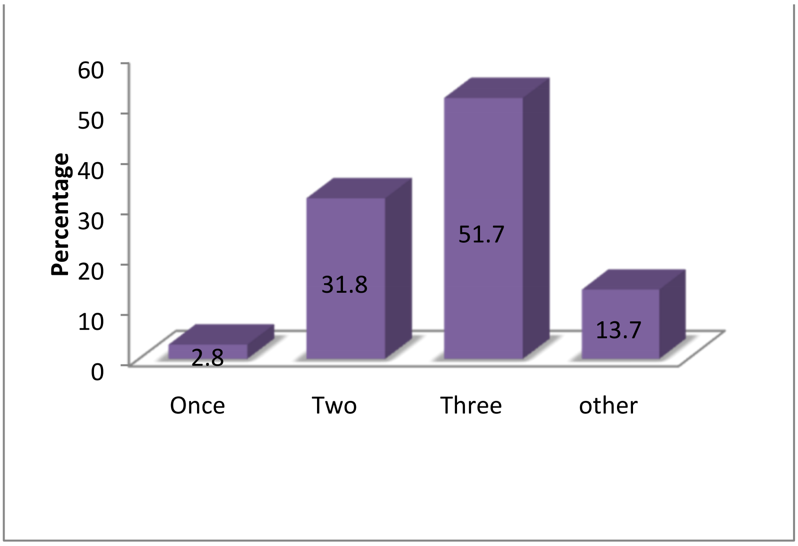


Figure 4.7: Number of trips made per users
Source: Author field work, 2020.

4.4.8 Average numbers of household each borehole serve

According to Table 4.7, the average household served by each borehole is between 4060households, with 38.7% of respondents saying fewer than 20households, 2.9 percent for 41-60households, and the least percentage age of respondents saying over

60households where the boreholes are located.

Table 4.7: Household number each boreholes serve

variable	Frequency	Percentage
<20	114	36.7
20-40	183	58.8
41-60	9	2.9
above 60	5	1.6
Total	311	100.0

Source: Author field work, 2020.

4.5 Management of the Water Boreholes

4.5.1 Maintenance pattern of the community water boreholes

The respondents clearly identify the plan maintenance practice, with 73.3 percent stating that there is no proposed maintenance for Community Water Boreholes in their region and 26.7 percent stating that there is proposed maintenance for Community

Water Boreholes in their zone.

4.5.2 Maintenance pattern of the community water boreholes

Repair maintenance is the most commonly used maintenance method or pattern, according to the analysis in Table 4.8 below, with 56.3 percent of respondents choosing it. Preventive maintenance is used by 23.8 percent of respondents, other methods of maintenance are used by 17.0 percent of respondents, and only 2.9 percent of respondents claim to be belated.

Table 4.8: Maintenance pattern

Variable	Frequency	Percentage
Schedule maintenance	9	2.9
Preventive maintenance	74	23.8
Repair	175	56.3

Others	53	17.0
Total	311	100.0

Source: Author field work, 2020.

4.5.3 Body incharge of maintenance of the community water boreholes

According to figure 4.8 below, the community (consumers) is believed to be in charge of maintaining the Community Water Boreholes, with 79.8% of 311 respondents saying the boreholes are maintained by the community, 18.3 percent saying the boreholes are maintained by private personalities, and 1.9 percent saying the boreholes in their zone are maintained by the government.

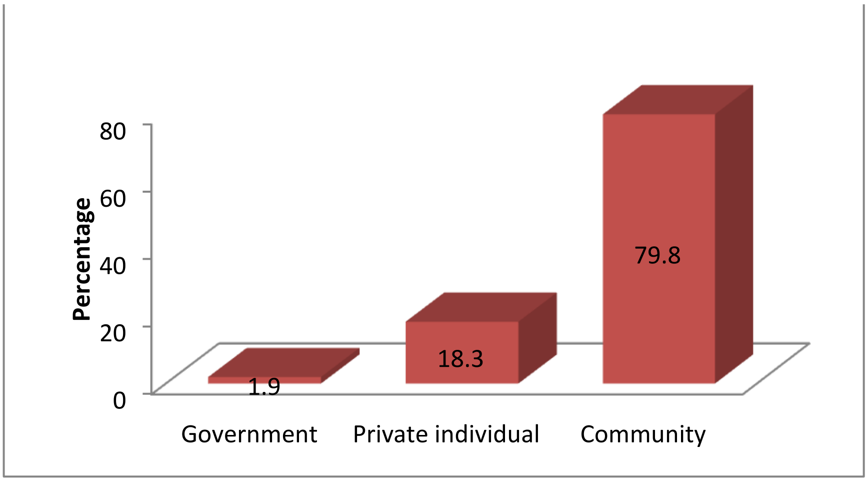


Figure 4.8: Body in charge of maintenance
Source: Author field work, 2020.

4.5.4 Seasonnality of the community water boreholes

The Community Water Boreholes in the research region are mainly (when operating) all around the year in generating water, with 87.5 percent of people indicating that they function all around the year, and the minority of 12.5 percent declaring that the

Community Water Boreholes in their zone are functions seasonally.

4.6 Analysis of Personal Observation and Oral Interview

4.6.1 Data acquired from the field work using checklist table

The names of the bodies that provide Community Water Boreholes, the coordinates of the identified Community Water Boreholes in Bida Metropolis, the year drilled, type, condition, and power source for the boreholes are computed in the Tables below according to their location in each political ward in Bida Metropolis.

Note that the terms mechanized (electric pump), hand pump, and Abuja Electricity Distribution Company (i.e. the organization in charge of electricity supply in the Metropolis) are used in the table below.

The characteristic Table in appendix C was created after the data from the field survey was entered into Microsoft Excel. The table was then imported into Google Fusion Table to experiment with the data obtained in the field and map visualization from

Google Fusion Table, as shown in figure 4.9.

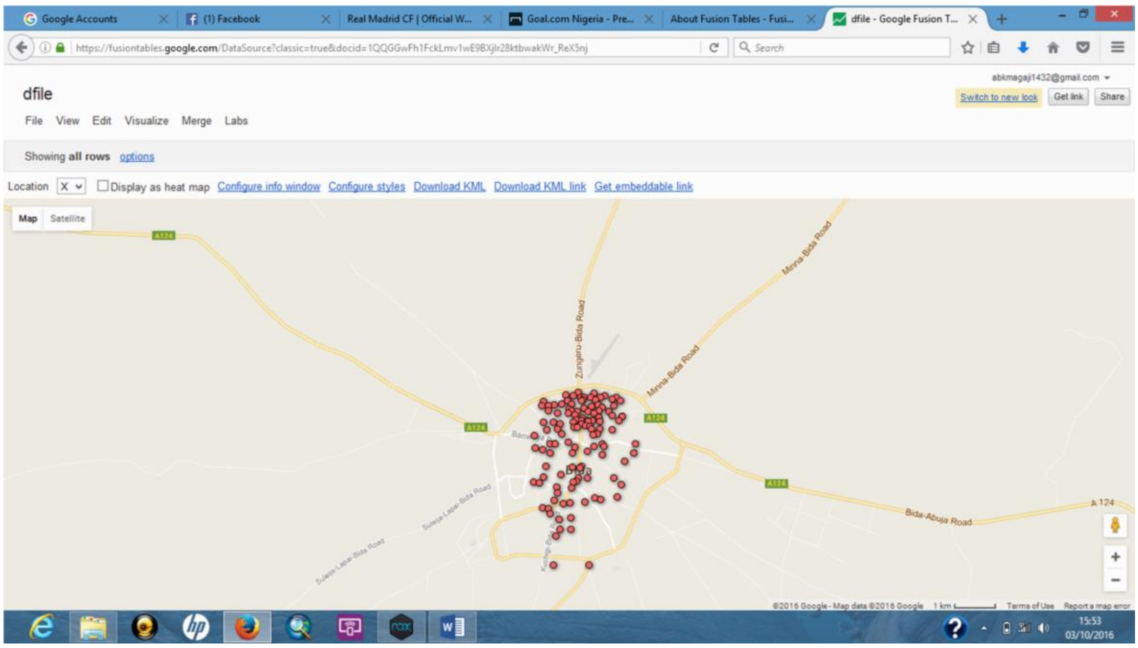
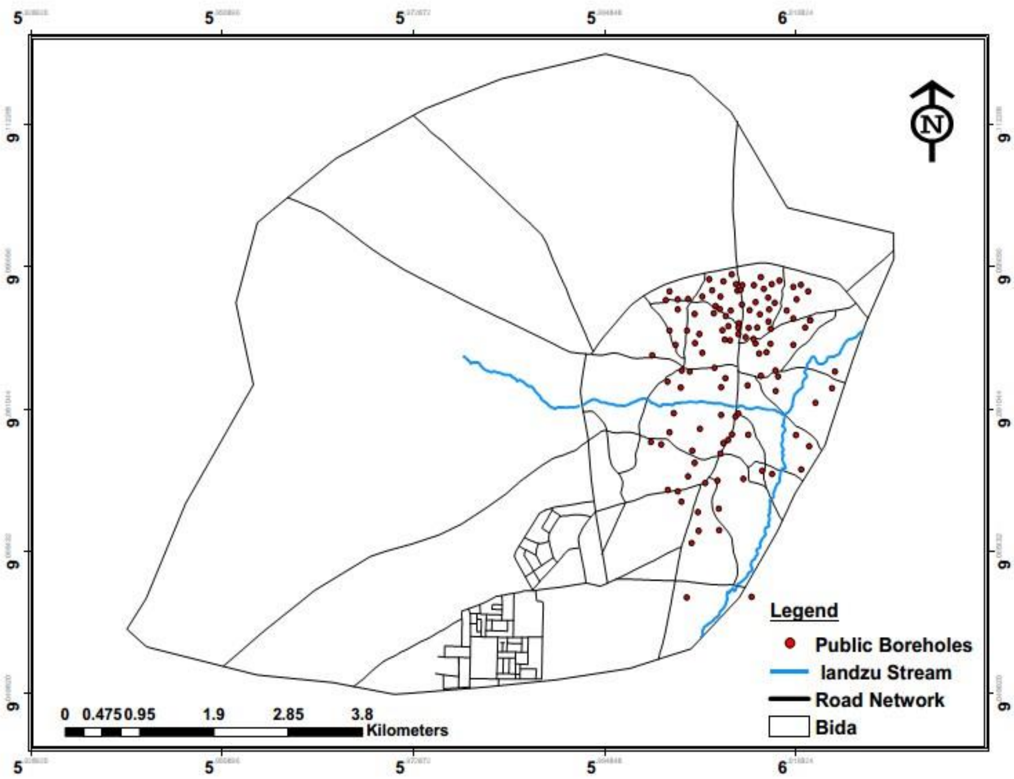


Figure 4.9: Google fusion Map visualization of Community Water Boreholes point in Bida Metropolis.

Source: Author analysis, 2020.

Data are kept in numerous Tables in the web that internet users may see and download, and Google Fusion Tables is an experimental data visualization web tool to visualize, gather, and transfer data Tables. It also allows for the download of the Tables' KML file so that the points may be viewed from Google Earth directly for site view and verification of the data (Table) upload in Google Fusion Tables. It is extensively used by a variety of professions all around the world, and data is exchanged among users. The data from Table 1 is imported into ArcGIS 10.1 to create a point map depicting the spatial distribution of Bida's Community Water Boreholes.



4.6.2 Spatial distribution of community water boreholes in Bida

Figure 4.10: Spatial Distribution of Community Water Boreholes in Bida using ArcGIS.
Source: Author analysis, 2020.

The map displayed above (figure 4.10) depicts the spatial distribution of Community Water Boreholes in Bida Metropolis, which includes a total of 135 hand-pumped and motorized Community Water Boreholes. The map is subjected to "Average

Neighbourhood Analysis" in ArcGIS 10.1 to identify the pattern of distribution of Community Water Boreholes in the region, with the result shown in figure 4.11 below.

4.6.2.1 Graph depicting average neigbourhood analsis of community water boreholes distribution in Bida

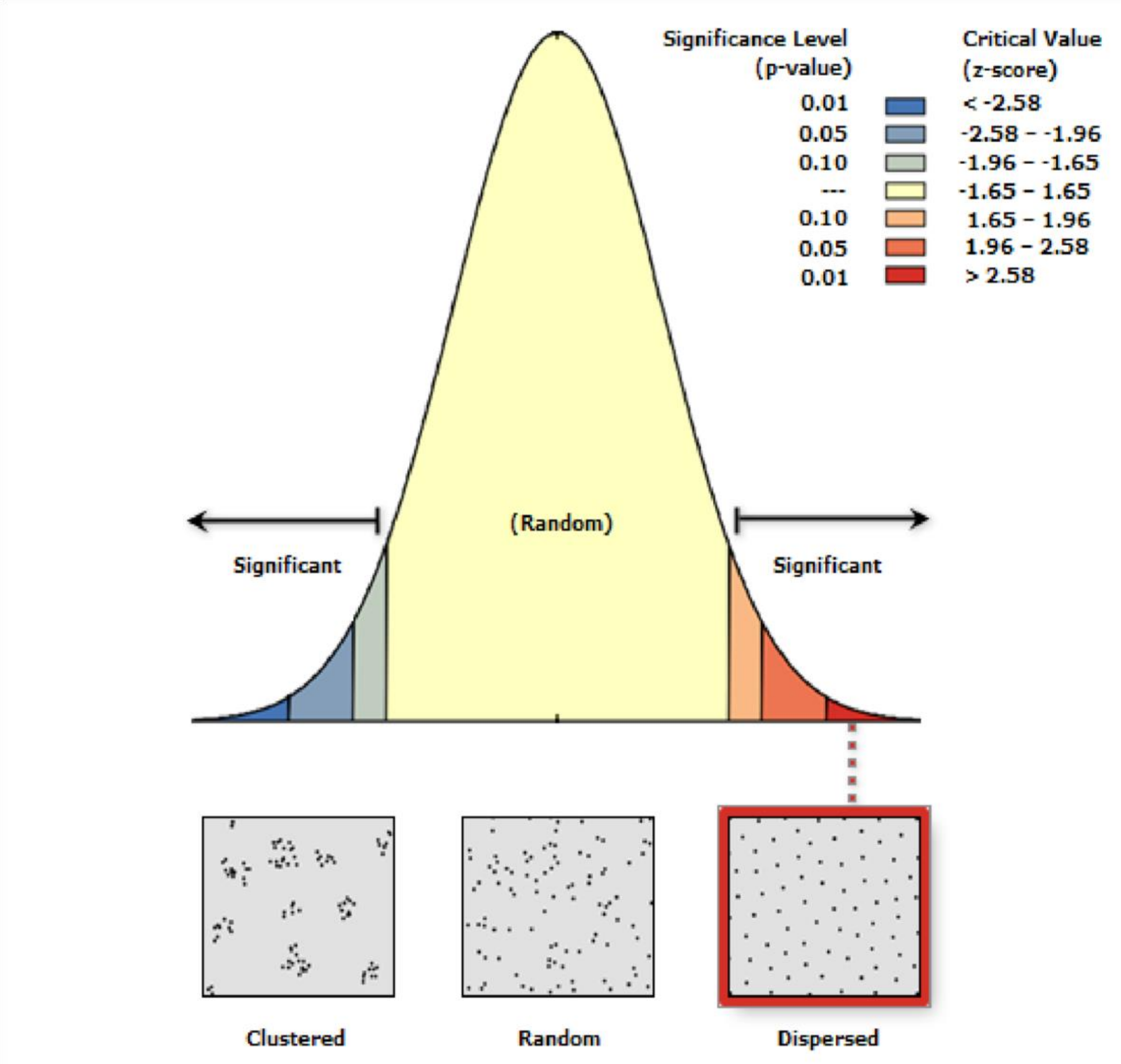


Figure 4.11: Average Neigbourhood Analysis
Source: Author analysis, 2020.

The graphic representation (figure 4.11) above depicts the pattern of distribution of Community Water Boreholes in Bida, which are spread dispersedly throughout the territory. An even further analysis was carried out in the ArcGIS 10.1 environment on the spatial distribution of these Community Water Boreholes to determine the impact of these Community Water Boreholes utilities in the research region in corelation to human populace. A service radius was marked out using the geospatial tool in the Arc tool box of the ArcGIS environment, and the analysis outcome is shown below.

4.6.2.2 Buffer analysis of spatial distribution of community water boreholes in Bida

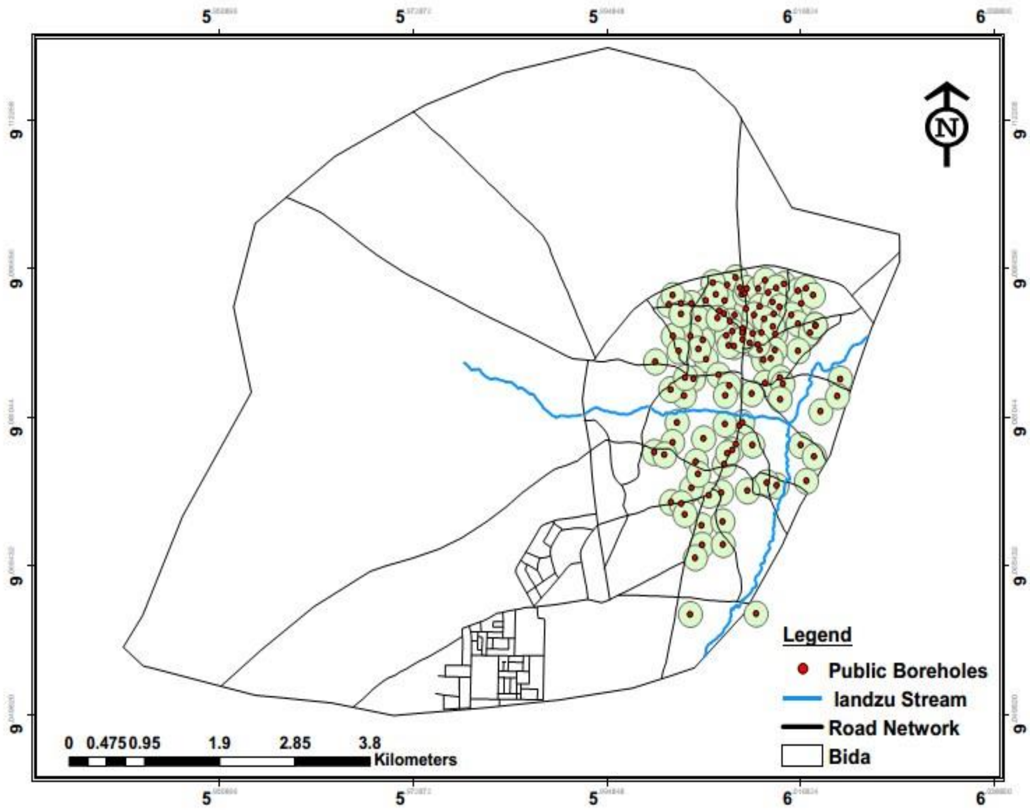


Figure 4.12: Buffer analysis
Source: Author analysis, 2020.

The cushioning of the desired location Bida, with a buffer radius of 150m and a total of 135 Community Water Boreholes point outcomes, clearly shows that people in the northern part of the neighborhood have much more access to these utilities, as houses within the radius of 150m have access to 2-3 or more, while other houses in the southern part of the area have at most two (2).

4.6.3 Map of Bida showing spatial distribution motorised and manual community water boreholes

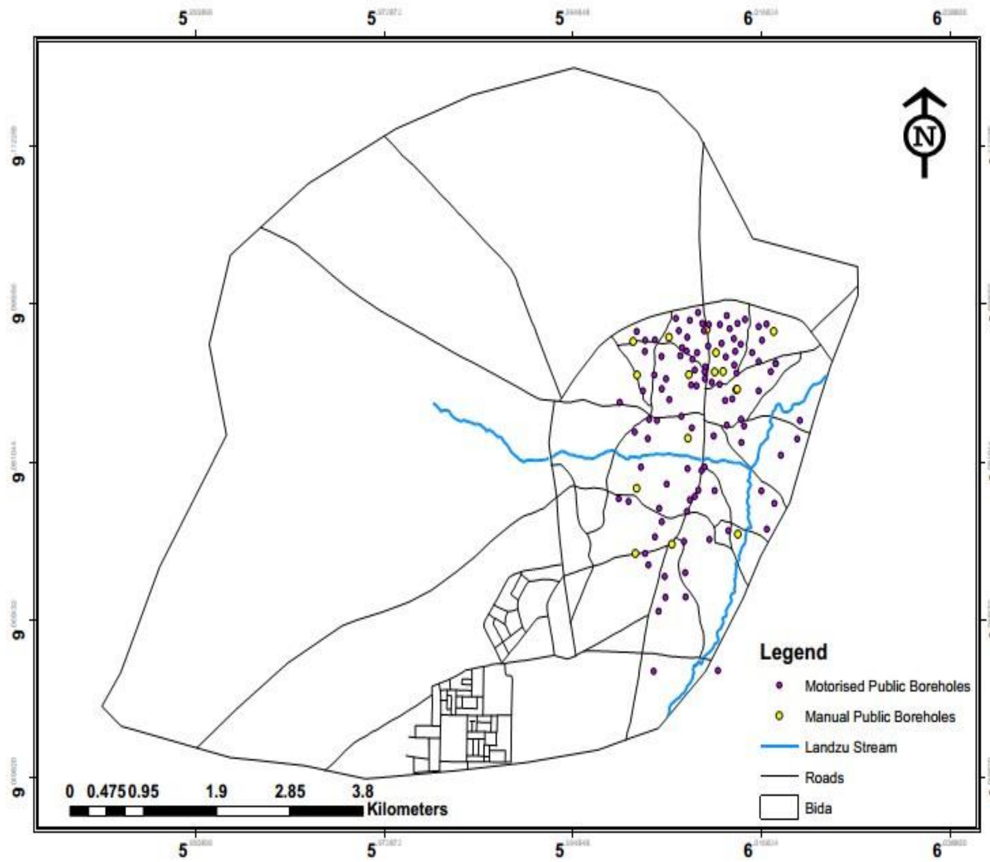
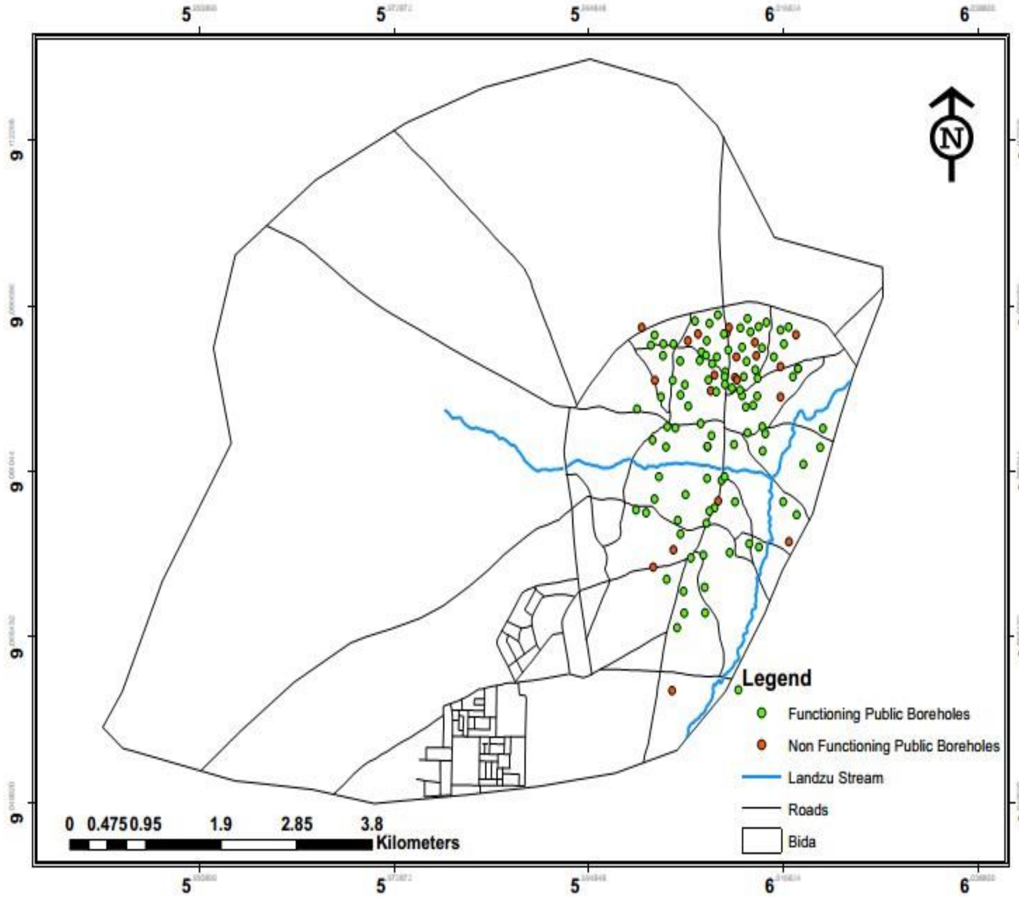


Figure 4.13: Spatial distribution of motorised and non-motorised Community Water Boreholes
Source: Author analysis, 2020.



4.6.4 Map of bida showing spatial distribution of functioning and nonfunctioning community water boreholes

Figure 4.14: Spatial distribution functioning and non-functioning community water boreholes
Source: Author analysis, 2020.

According to the following study, the Bida Metropolis has a total of 135 Community Water Boreholes divided throughout 14 political wards. Table 4.9 shows that of the 14 wards in the Metropolis, Masaga B has the most Community Water Boreholes (18), followed by Cheniyan ward with 16, Kyari ward with 14, Masaba B with 13, and Mayaki Ndajiya, Nassarafu, and Wadata with 6 boreholes apiece. The first four wards with the greatest number are all located in the Metropolis' northern region. According to the aforementioned study, 20 of the 135 Community Water Boreholes in Bida Metropolis are manual, while

115 are motorized, with 112 Community Water Boreholes in excellent working order and the other 23 determined to be defective and not working at the time of the field visit.

A total of 362,500 litres of reservoirs is correlated with 115 mechanized boreholes across the 14 political wards, and the area covered by the physical structures (reservoir base) connected with the utilities is assessed to be 1,584m2 (1.584km2).

Table 4.9: Database summary of community water boreholes in Bida across 14 political wards

Ward Name	Number of Boreholes	Manual	Motorised	Functioning Boreholes	Non-functioning Boreholes	Reservoir Capacity (litres)	Coverage Area (m^2)
Barik	7	1	6	6	1	15000	78
Cheniyan	16	2	14	13	3	49000	206
Dokodza	8	2	6	7	1	16000	152
Kyari	14	2	12	11	3	40000	186
Landzu	7	1	6	7	0	18000	90
Masaba A	8	2	6	6	2	17000	60
Masaba B	13	1	12	11	2	40500	175
Masaga A	8	3	5	5	3	13000	60
Masaga B	18	2	16	12	6	55000	213
MayakiNdajiya	6	1	5	6	0	15000	70
Nassarafu	6	0	6	5	1	16000	72
UmaruMajiA	8	1	7	7	1	24000	92
Umar MajigiB	10	1	9	9	1	28000	120
Wadata	6	1	5	6	0	16000	70
Total	135	20	115	112	23	362,500	1,584

Source: Author field work, 2020.

4.7 Summary of Findings

The data gathered and analyzed from the field work shows that the northern part of Bida Metropolis has a higher concentration of Community Water Boreholes, which is attributable to a agglomeration of physical development predominantly for housing property use, which includes both medium and high density households, as made reference to the southern part, which is more organizational landuse, low density households, and s Furthermore, the North receives considerably less water from the public utility board (Niger State Water Board) than the South, which had a sufficient supply at the time of the field visit.

Boreholes are viewed as an appropriate substitute source of household water supply in Bida metropolis, as an overall of 135 Community Water Boreholes, both hand-pumped and motor-powered, have been sunk across Bida's 14 political constituencies in the last 15-20 years, with the motorized type outnumbering the manual type by 115 to 20. The study also reveals that 112 of the total 135 Community Water Boreholes are in good working order, with the other 23 Community Water Boreholes not operating at the time

of the field visit.

The provision of Community Water Boreholes in the area is the responsibility of the government, non-governmental organizations (NGOs), private individuals, and communal efforts, with the government playing a principal part in the establishment of these utilities primarily through the Ward Development Project platforms (WDP). Our findings also show that, in comparison to Donor and Community decisions, planning regulations had a less influence on borehole site. The study discovered that community decision is the most important factor in determining where these utilities are located (this is accomplished after the neighbourhood has either invested financially to drilling a borehole for itself or has sought funding from other organisations or people to drill boreholes).

The data also reveals that the Abuja Electricity Supply Company (AEDC) is the main source of power for the motorized boreholes, while generators are the main alternate source of power for the boreholes when the main supply from AEDC is unavailable.

According to the findings, the most accessible times for these commodities are between 6-9 a.m. and 4-7 p.m. in the morning and afternoon, respectively. The average distance traveled to reach the utilities is 100-150 meters, with an average of 2-3 trip per user of the boreholes, and an average of 40-60 homes served by each borehole.

This investigation also revealed that there is no scheduled maintenance for the boreholes. Maintenance is usually performed only once a severe defect is discovered, rather than on a planned basis, and is primarily done by the community (users).

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Domestic water supply is a critical necessity for a community's effective operation, as water is required for a variety of purposes. Boreholes should thus be regarded as an essential source of household water because their source is, to a large extent, safe for human consumption. This study attempted to depict the spatial distribution of water boreholes, their efficiency and effectiveness, condition, and maintenance plan, among other things, as well as make recommendations that, if followed, will improve domestic water supply through the use of boreholes and effective maintenance of these utilities.

5.2 Recommendations

1. Provision of Community Water Boreholes should be based on planning regulations, such as selecting the most suitable site for the utility's location through planning surveys and procedures, to provide efficient and high-quality service. During the installation procedure, higher grade materials should be used for the utilities in order to obtain a high degree of utility durability and increase reservoir capacity.

2. Solar power is heavily recommended as a source of electricity for utilities, as AEDC may not be dependable due to the country's current power supply situation.

3. To ensure that utilities last a long time, a maintenance schedule should be designed for both periodic and preventative maintenance. This may be accomplished by establishing a maintenance department in the neighbourhood. This agency will be in charge of inspecting these utilities on a regular basis to ensure that they are adequately maintained.

4. Before drilling Water Boreholes and conducting geodetic tests, the underground Water Table should be checked to ensure that the locations where these utilities are installed have sufficient underground Water reservoirs to avoid seasonal supply by the intended Water Borehole and to ensure long-term supply and accessibility.

5. Standard material should be use during the installation of the Water Boreholes and the use of substandard materials be avoided to allowed for long time life span (Durability) and also to achieved sustainability of the Water Boreholes.

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APPENDIX A

CENTER FOR HUMAN SETTLEMENT AND URBAN AND DEVELOPMENT, (CHSUD)

POSTGRADUATE SCHOOL

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE NIGERIA

QUESTIONNAIRE TO THE INHABITANT OF BIDA METROPOLIS OF NIGER STATE ON THE SPATIAL IMPACT ANALYSIS OF COMMUNITY WATER BOREHOLES IN BIDA METROPOLIS.

(SECTION ONE)

1. Name of Ward: ____.
2. Gender: male____. Female____.
3. Age: A. <18___. B.18-30___. C.31-45___. D. >45___.
4. Occupation: A. Farming___. B. Trading___. C. Civil servant___. D. Others_______.
5. Marital status: A. Single___. B. Married___. C. Widow___. D. Divorced___.
6. Gross Income: A. below #10,000__. B. #11,000-#20,000__. C. #21,000#30,000__. D. above #30,000__.

(SECTION TWO)

7. What is the main source of water in your area? A. Well___. B Tape ___. C Borehole ___. D. water vendor
8. Is there public borehole in your Area? Yes___. No___.
9. Do you use the borehole in your area? Yes___. No___.
10. What is the type of the Borehole in your Area? A. Manual___. B. Motorized type___.
11. If motorized, what is the source of power use for the Borehole? A. AEDC___. B. Solar___. C. Generator___.
12. In case of failure, what is the alternative source to 5 above? A. AEDC___. B. Solar___. C. Generator___.
13. What is the condition of the borehole in your area? A. functioning___. B. Not functioning___.

14. How long as the borehole been in existence? A. Less 5yrs___. B .5-10yrs. C.1115yrs. D.16- 20yrs
15. Who provided the borehole utility? A. Government___. B. private individual. C. community effort___. D. Non-governmental organization (NGOs) ___.
16. What was the base for the location of the borehole in your area? A. ward project___. B. Community decision___. C. Planning regulation___. D. Donor's decision___.
17. What time of the day is the borehole accessible? A. 24hours___. B. 6-9am & 47pm. C. 6-10am___. D. Other specify___.
18. What is the average distance you travel to access the utility? A. <50m___. B. 50100m___. C. 101-150m___. D. above 150m___.
19. How many trips do you make to the borehole? A. Ones___. B. Two___. C. Three D. Other specify___.
20. How many number of household does the borehole serve? A. <20___. B. 2040___. C. 41-60___. D. above 60___.
21. Is there any maintenance plan for the utility? Yes___. No___.
22. How is the utility maintained? A. Schedule maintenance___. B. Preventive maintenance___. C. Repair___. D. Other specify___.
23. Who maintained the utility? A. Government___. B. private individual___. C. community___. D. NGOs___.
24. Is the borehole all year round or seasonal? A. All year round___. B. Seasonal___

APPENDIX B

CENTER FOR HUMAN SETTLEMENT AND URABN DEVELOPMENT (CHSUD)

POSTGRADUATE SCHOOL

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE NIGERIA

CHECKLIST TABLE ON THE SPATIAL IMPACT ANALYSIS OF COOMUNITY

S/N	Coordinate Lat.	long	Type M	N	Year	Condition F	N	Power source			alternative			litres	Sq.m
01															
02															
03															
04															
05															
05															
06															
07															
08															
09															
10															
11															
12															
13															
14															
15															

WATER BOREHOLES IN BIDA METROPOLIS

APPENDIX C

ATTRIBUTE TABLE FOR 135 COMMUNITY WATER BOREHOLES IN BIDA METROPOLIS

S/N	Name of Ward	Lat	Long	Provider	Year Drilled	Type	Condition	Reservoir (Litres)	Power Source
1	Cheniyan	6.010314	9.090379	Government	2008	Motorised	Functioning	4000	AEDC
2	Cheniyan	6.007645	9.092273	Government	2012	Motorised	Functioning	3000	AEDC

3	Cheniyan	6.0101 66	9.093 973	Government	2012	Motori sed	Functioning	3000	AEDC
4	Cheniyan	6.0099 97	9.094 668	Government	2005	Motori sed	Functioning	3000	AEDC
5	Cheniyan	6.0094 97	9.095 739	Private individual	2008	Motori sed	Functioning	3000	AEDC
6	Cheniyan	6.0085 4	9.094 972	Government	2012	Motori sed	Functioning	3000	AEDC
7	Cheniyan	6.0069 11	9.095 193	Government	2008	Motori sed	Functioning	4000	AEDC
8	Cheniyan	6.0093 85	9.091 781	Private individual	2013	Motori sed	Functioning	2000	AEDC
9	Cheniyan	6.0081 47	9.091 942	Government	2011	Motori sed	Functioning	3000	AEDC
10	Cheniyan	6.0082 27	9.093 307	Government	2010	Motori sed	Functioning	4000	AEDC
11	Cheniyan	6.0061 18	9.093 308	Government	2012	Manua l	Not-Functioning	-	-
12	Cheniyan	6.0072 58	9.093 977	Government	2014	Motori sed	Not-Functioning	3000	AEDC
13	Cheniyan	6.0044 66	9.093 032	Government	2012	Motori sed	Functioning	3000	AEDC
14	Cheniyan	6.0033 12	9.093 023	Government	2013	Motori sed	Functioning	3000	AEDC
15	Cheniyan	6.0019 14	9.092 912	Government	2008	Manua l	Functioning	-	-
16	Cheniyan	6.0023 51	9.093 873	Government	2009	Motori sed	Functioning	3000	AEDC
17	Masaga B	6.0138 19	9.091 908	Government	2013	Motori sed	Not-Functioning	2000	AEDC
18	Masaga B	6.0106 88	9.092 433	Government	2009	Motori sed	Functioning	3000	AEDC
19	Masaga B	6.0105 2	9.094 067	Private individual	2013	Manua l	Not-Functioning	-	-
20	Masaga B	6.0107 34	9.094 583	Government	2009	Motori sed	Not-Functioning	3000	AEDC
21	Masaga B	6.0120 43	9.094 558	Government	2016	Motori sed	Functioning	3000	AEDC
22	Masaga B	6.0128 35	9.095 432	Government	2013	Motori sed	Functioning	3000	AEDC
23	Masaga B	6.0149 65	9.095 061	Private individual	2009	Motori sed	Functioning	3000	AEDC
24	Masaga B	6.0131 91	9.094 161	Government	2008	Motori sed	Functioning	3000	AEDC
25	Masaga B	6.0140 96	9.094 665	Government	2008	Motori sed	Functioning	3000	AEDC
26	Masaga B	6.0165 61	9.094 36	Government	2010	Motori sed	Functioning	3000	AEDC
27	Masaga B	6.0174 68	9.094 62	Government	2012	Motori sed	Functioning	3000	AEDC
28	Masaga B	6.0122 4	9.092 708	Government	2013	Motori sed	Functioning	3000	AEDC
29	Masaga B	6.0136 72	9.093 18	Government	2011	Motori sed	Not-Functioning	3000	AEDC

30	Masaga B	6.0144 67	9.092 636	Government	2012	Motori sed	Functioning	3000	AEDC
31	Masaga B	6.0169 54	9.093 017	Government	2010	Motori sed	Functioning	10000	Solar
32	Masaga B	6.0183 01	9.093 878	Government	2004	Manua l	Not-Functioning	-	-
33	Masaga B	6.0158 1	9.091 807	Government	2010	Motori sed	Functioning	2000	AEDC
34	Masaga B	6.0165 63	9.090 9	Government	2009	Motori sed	Not-Functioning	4000	AEDC
35	Masaga A	6.0111 08	9.088 859	Government	2008	Motori sed	Functioning	4000	AEDC
36	Masaga A	6.0114 27	9.089 874	Private individual	2003	Manua l	Not-Functioning	-	-
37	Masaga A	6.0116 65	9.089 65	Government	2013	Motori sed	Functioning	3000	AEDC
38	Masaga A	6.0124 36	9.089 918	Private individual	2004	Manua l	Not-Functioning	-	-
39	Masaga A	6.0115 75	9.091 808	Government	2004	Manua l	Not-Functioning	-	-
40	Masaga A	6.0127 32	9.091 384	Government	2010	Motori sed	Not-Functioning	3000	AEDC
41	Masaga A	6.0139 82	9.089 768	Government	2012	Motori sed	Functioning	3000	AEDC
42	Masaga A	6.0137 3	9.090 579	Government	2009	Motori sed	Functioning	3000	AEDC
43	Kyari	6.0179 61	9.089 927	Government	2011	Motori sed	Functioning	3000	AEDC
44	Kyari	6.0185 37	9.090 709	Private individual	2012	Motori sed	Functioning	3000	AEDC
45	Kyari	6.0165 77	9.088 037	Community Effort	2008	Motori sed	Not-Functioning	3000	AEDC
46	Kyari	6.0139 59	9.088 124	Private individual	2002	Manua l	Functioning	-	-
47	Kyari	6.0122 32	9.088 164	Private individual	2014	Manua l	Functioning	-	-
48	Kyari	6.0126 5	9.087 065	Government	2013	Motori sed	Functioning	2000	AEDC
49	Kyari	6.0135 03	9.087 226	Government	2008	Motori sed	Functioning	4000	AEDC
50	Kyari	6.0120 1	9.088 686	Government	2010	Motori sed	Functioning	4000	AEDC
51	Kyari	6.0185 37	9.090 709	Government	2012	Motori sed	Functioning	3000	AEDC
52	Kyari	6.0128 43	9.084 646	Government	2013	Motori sed	Functioning	3000	AEDC
53	Kyari	6.0145 2	9.085 211	Government	2014	Motori sed	Functioning	3000	AEDC
54	Kyari	6.0148 43	9.084 554	Government	2012	Motori sed	Functioning	3000	AEDC
55	Kyari	6.0113 25	9.083 559	Government	2013	Motori sed	Not-Functioning	3000	AEDC
56	Kyari	6.0145 47	9.082 944	Government	2009	Motori sed	Not-Functioning	4000	AEDC

57	Masaba B	6.0102 45	9.089 927	Government	2008	Motori sed	Functioning	3000	AEDC
58	Masaba B	6.0088 35	9.091 162	Government	2012	Motori sed	Functioning	3000	AEDC
59	Masaba B	6.0091 08	9.090 08	Government	2010	Motori sed	Not-Functioning	3000	AEDC
60	Masaba B	6.0084 3	9.089 632	Private individual	2003	MN	Functioning	-	-
61	Masaba B	6.0093 03	9.088 519	Government	2012	Motori sed	Functioning	3000	AEDC
62	Masaba B	6.0087 11	9.088 605	Government	2009	Motori sed	Not-Functioning	3000	AEDC
63	Masaba B	6.0102 78	9.089 214	Private individual	2012	Motori sed	Functioning	3000	AEDC
64	Masaba B	6.0057 62	9.089 186	Government	2013	Motori sed	Functioning	3000	AEDC
65	Masaba B	6.0061 33	9.087 156	Government	2015	Motori sed	Functioning	3000	AEDC
66	Masaba B	6.0052 25	9.091 422	Government	2010	Motori sed	Functioning	8000	Solar
67	Masaba B	6.0074 51	9.091 476	Government	2011	Motori sed	Functioning	2500	AEDC
68	Masaba B	6.0043 77	9.089 59	Government	2010	Motori sed	Functioning	3000	AEDC
69	Masaba B	6.0052 79	9.088 224	Government	2012	Motori sed	Functioning	3000	AEDC
70	Masaba A	6.0003 73	9.086 892	Government	2011	Motori sed	Functioning	3000	AEDC
71	Masaba A	11.996 069	9.087 491	Government	2008	Motori sed	Functioning	2000	AEDC
72	Masaba A	11.999 07	9.087 683	Government	2003	Manua l	Not-Functioning	-	-
73	Masaba A	11.996 906	9.089 805	Private individual	2009	Motori sed	Functioning	3000	AEDC
74	Masaba A	11.999 93	9.091 677	Government	2011	Motori sed	Functioning	3000	AEDC
75	Masaba A	6.0023 68	9.089 583	Government	2005	Manua l	Not-Functioning	-	-
76	Masaba A	6.0030 45	9.088 025	Private individual	2013	Motori sed	Functioning	3000	AEDC
77	Masaba A	6.0032 94	9.091 912	Government	2015	Motori sed	Functioning	3000	AEDC
78	Landzu	6.0075 37	9.085 506	Government	2009	Motori sed	Functioning	3000	AEDC
79	Landzu	6.0046 87	9.085 103	Government	2013	Motori sed	Functioning	3000	AEDC
80	Landzu	6.0087 64	9.084 387	NGOs	2012	Motori sed	Functioning	3000	AEDC
81	Landzu	6.0083	9.083 362	Government	2008	Manua l	Functioning	-	-
92	Landzu	6.0036 47	9.083 324	Government	2010	Motori sed	Functioning	3000	AEDC
83	Landzu	6.0021 15	9.083 971	Government	2012	Motori sed	Functioning	3000	AEDC

84	Landzu	6.003768	9.085222	Government	2014	Motorised	Functioning	3000	AEDC
85	Umaru Majigi A	6.009908	9.080159	Private individual	2009	Motorised	Functioning	4000	AEDC
86	Umaru Majigi A	6.010269	9.080488	Government	2013	Motorised	Functioning	3000	AEDC
87	Umaru Majigi A	6.009524	9.078223	Government	2013	Motorised	Not-Functioning	3000	AEDC
88	Umaru Majigi A	6.009103	9.077587	Government	2010	Motorised	Functioning	4000	AEDC
89	Umaru Majigi A	6.008197	9.076108	Government	2012	Motorised	Functioning	3000	AEDC
90	Umaru Majigi A	6.011415	9.078157	Private individual	2007	Manual	Functioning	-	-
91	Umaru Majigi A	6.014141	9.073871	Government	2012	Motorised	Functioning	3000	AEDC
92	Umaru Majigi A	6.01302	9.074196	Government	2011	Motorised	Functioning	4000	AEDC
93	Umaru Majigi B	6.007858	9.073133	Government	2012	Motorised	Functioning	3000	AEDC
94	Umaru Majigi B	6.006452	9.072868	Government	2003	Manual	Functioning	3000	-
95	Umaru Majigi B	6.005606	9.069682	Government	2009	Motorised	Functioning	3000	AEDC
96	Umaru Majigi B	6.005686	9.067623	Government	2012	Motorised	Functioning	3000	AEDC
97	Umaru Majigi B	6.00802	9.070081	Government	2013	Motorised	Functioning	3000	AEDC
98	Umaru Majigi B	6.008058	9.067687	Private individual	2015	Motorised	Functioning	4000	AEDC
99	Umaru Majigi B	6.004898	9.066279	Government	2010	Motorised	Functioning	3000	AEDC
100	Umaru Majigi B	6.011799	9.060401	Government	2011	Motorised	Functioning	3000	AEDC
101	Umaru Majigi B	6.004329	9.06034	Private individual	2010	Motorised	Not-Functioning	-	AEDC
102	Umaru Majigi B	6.010828	9.073329	Government	2012	Motorised	Functioning	3000	AEDC
103	Nassarafu	6.021364	9.085077	Government	2013	Motorised	Functioning	3000	AEDC
104	Nassarafu	6.019139	9.081662	Government	2010	Motorised	Functioning	3000	AEDC
105	Nassarafu	6.016868	9.078139	Government	2011	Motorised	Functioning	3000	AEDC
106	Nassarafu	6.018396	9.076923	Government	2010	Motorised	Functioning	4000	AEDC
107	Nassarafu	6.021043	9.083259	Government	2010	Motorised	Functioning	3000	AEDC
108	Nassarafu	6.017509	9.074359	Government	2012	Motorised	Not-Functioning	-	AEDC
109	Mayaki Ndajiya	6.008271	9.080336	Government	2012	Motorised	Functioning	3000	AEDC
110	Mayaki Ndajiya	6.005848	9.078816	Government	2014	Motorised	Functioning	3000	AEDC

111	Mayaki Ndajiya	6.002835	9.080508	Government	2010	Motorised	Functioning	3000	AEDC
112	Mayaki Ndajiya	6.002334	9.078417	Private individual	2011	Manual	Functioning	-	-
113	Mayaki Ndajiya	6.004977	9.076406	Government	2009	Motorised	Functioning	3000	AEDC
114	Mayaki Ndajiya	6.00856	9.077267	Government	2010	Motorised	Functioning	3000	AEDC
115	Bariki	6.000234	9.077379	Private individual	2008	Motorised	Functioning	2000	AEDC
116	Bariki	6.0014	9.077109	Government	2012	Motorised	Functioning	3000	AEDC
117	Bariki	6.004464	9.073611	Government	2009	Motorised	Functioning	2000	AEDC
118	Bariki	6.005252	9.07509	Government	2008	Motorised	Functioning	2000	AEDC
119	Bariki	6.002168	9.072111	Government	2006	Manual	Not-Functioning	-	-
120	Bariki	6.003315	9.071976	Government	2013	Motorised	Functioning	3000	AEDC
121	Bariki	6.003724	9.070841	Government	2014	Motorised	Functioning	3000	AEDC
122	Wadata	6.00065	9.084257	Government	2012	Motorised	Functioning	4000	AEDC
123	Wadata	11.999032	9.083139	Government	2006	Manual	Functioning	-	-
124	Wadata	11.999356	9.084998	Government	2014	Motorised	Functioning	3000	AEDC
125	Wadata	11.996215	9.086496	Government	2008	Motorised	Functioning	3000	AEDC
126	Wadata	11.994415	9.085354	Government	2012	Motorised	Functioning	3000	AEDC
127	Wadata	11.993917	9.084419	Government	2009	Motorised	Functioning	3000	AEDC
128	Dokodza	11.996728	9.079238	Government	2014	Motorised	Functioning	2000	AEDC
129	Dokodza	11.997572	9.078102	Government	2011	Motorised	Functioning	2000	AEDC
130	Dokodza	11.997333	9.076695	Government	2008	Motorised	Functioning	2000	AEDC
131	Dokodza	11.996128	9.076036	Government	2012	Motorised	Functioning	2000	AEDC
132	Dokodza	11.998385	9.078529	Government	2006	Manual	Not-Functioning	-	-
133	Dokodza	11.994283	9.080369	NGOs	2008	Manual	Functioning	3000	AEDC
134	Dokodza	11.994469	9.078714	Private individual	2010	Motorised	Functioning	2000	AEDC
135	Dokodza	11.993228	9.080251	Government	2012	Motorised	Functioning	3000	AEDC