Assessing The Economic Cost of Public Water Supply Inequality Among Households in Makurdi, Nigeria

SAAKUMA ORTSERGA[1], FELIX K. KWAGHSENDE[2], TIMOTHY T. GYUSE[3]
[1,2,3]*Department of Urban and Regional Planning, Rev. Fr. Moses Orshio Adasu University Makurdi, Benue State.*

Abstract- ***The challenge of access to safe and reliable public water supply by residents remains daunting in many Nigerian towns and cities due to population growth. A reduction in public water supply inequality contribute to health and economic well-being of urban residents. This study investigated the economic cost of public water supply inequality among households in Makurdi town, Nigeria with focus on how inequality of access to public water supply influences households' expenditure and economic well-being of residents. The objective of the study is; to estimate the economic implications of not having access to public water supply, and recommend ways that can ameliorate the inequality and lead to safe and reliable public water supply for all residents. The study stratified Makurdi town into 23 neighborhoods, while the systematic sampling technique was used to select 399 household respondents across the neighborhoods. Structured questionnaire, and interview were used to collect data for the study. The Morenikeji modeling for calculating cost of land was adopted and modified to calculate the economic cost of alternative water supply in Makurdi town. Findings of the study revealed that majority of households respondents (67%) are poor, and households spent 37% of their monthly income accessing alternative water sources. This amount is high, unsustainable and above the stipulated 4%-15% charged by water utility service providers. The study concluded that, public water supply inequality affects the economic well-being of households in Makurdi town and it is a threat to poverty reduction, sustainable urban growth and development. The study recommended improved public water infrastructure investment, and a decentralized public water supply approach that is backed by a definite policy to enhance service delivery and minimize economic stress.***

Key words: Economic Cost, Public Water Supply, Water Supply Inequality, Household Expenditure, Makurdi, Nigeria And Urban Water Access

I. INTRODUCTION

Safe and reliable public water supply is one of the fundamental and basic need of cities. In the last two decades, World attention has been drawn to the challenges of urbanization such as access to safe and reliable public water supply in cities. The United Nations Sustainable Development Goal Six (2023), reinforces the importance of access to improved safe and reliable public water supply for sustainable socio-economic progress of cities. Research by Lebeka, Twomey & Krurger (2021) & Wadwekar & Kapshe 2023, have shown that household's access to public water supply have decreased in urban areas due to the rapidly increasing population without correspondent investment in water infrastructure to take care of the increasing population, thereby pushing consumers to go for alternative sources of water supply.

Public water supply refers to organized water supply to a large population by public utilities, commercial organizations, and community endeavors usually via a system of pumps and pipes. It is one of the public amenities that the cost of production is above the capacity of many individuals for which Government takes responsibility in its production and distribution. Public water supply systems are crucial to properly functioning cities. While inequality refers to the uneven distribution of physical, social and economic welfare in a community. Inequality is used here to refer to a situation of unequal possession of certain distributive amenities such as public water supply.

According to Jideonwo (2014), in terms of financial cost, public water sources are cheaper to the beneficiary compared to alternative sources of water supply that often cost twice the amount to access, operate and maintain. Despite its affordability to the beneficiary, approximately 1.2 billion people Worldwide still lack access to safe public water supply owing to lack of effective large scale public water supply infrastructure, (Chitonge, 2020). The absence and inadequate provision of these water infrastructure have led to dependence on alternative sources of water supply that are very costly to afford, use and maintain by individual households in urban centers. This situation is far more challenging in Sub-Saharan Africa, where it is estimated that 319 million people or almost half of the region's population is

without access to improved public water supply sources (WHO/UNICEF, 2021). In Nigeria, it is estimated that two out of three Nigerians living in urban areas do not have access to improved public water supply (Ohwo & Abotutu, 2014). This situation has created inequality in access to public water supply in urban areas which leads residents to search for alternative sources of water supply at a higher economic cost, (Babuna, Yang, Tulcan, Dehui, Takase & Guba, 2023).

In many cities of developing countries, public water supply inequality is common and many households depend on alternative sources whose cost add physical social and economic burdens. Many of those affected are usually lower income and/or people on marginal incomes, (Ochungo, Ouma, Obiero, & Odero, 2019). For example, a study by Maurya, Misra, Anderson & Vashist, (2016), found that the middle and poor household groups in Naivasha town in Nakuru County, Kenya, spend more than the 15% households' income stipulated by water utilities company on alternative water supply. Study by Lebeka, et al (2021), & Cherunya, (2015), found that Nairobi city has a huge unequal and inequitable consumption of the available public water supply hence forcing resident to rely on water vending. According to Kujinga, Vanderpost, Mmopelwa, & Wolski, (2014), the case in Ngamiland in Botswana is not different as households spend about 11% of their income buying bottled water because consumers do not trust water from other sources for drinking purpose.

In Nigeria, the case is not different as studies in several towns and cities have shown that there is high inequality in the distribution of public water supply that result to economic costs. For instance, despite investments and reforms in public water supply, many residents of Lagos still lack access to public water supply. This has made households to turn to alternative sources such as borehole, wells or street vendors to meet their needs which has exposed consumers to financial costs, (Kujinga, et al 2014). Similarly, the Warri Urban Water Board is moribund, making it incapable of supplying public water to households in Warri-Effurun metropolis. This situation has forced the inhabitants of the metropolis to depend on other sources of water supply whose quality may not be guaranteed because of their susceptibility to quality degradation by leachate from waste disposal dumps and other sources of pollution, thereby exposing resident to health hazards which end up imposing financial costs, (Ohwo & Abotutu 2014). In a similar vein, in Nnewi, a town popular for it commercial and industrial activities in Anambra State, most of the households depend on borehole, well water and sachet water as major water sources, Jordan &Wyatt, (1989). Research on public water supply in urban areas of Nigeria have shown a strong link between inequality in the distribution of public water supply and economic cost of providing alternative water supply.

Reducing public water supply inequality is essential and crucial for public health, and economic well-being of residents in cities, (Ohwo & Abotutu 2014). According to Rudi, Massuda, Paula, Lago, Atun, Nunes & Casto, (2021) public water supply inequalities account for approximately 2.4 million deaths annually and contribute to 41% of global diseases and 19% of child mortality worldwide. This is in addition to decrease in per capita GDP growth of cities, affecting the economic well-being of the people and increasing urban poverty, (Smiley 2017). Understanding the economic cost of public water supply inequality forms an important part of understanding and investigating the problem for effective public water supply policy and management. Sadly, there is little or lack of empirical studies focusing on economic burden of public water supply inequality among households in Makurdi town in particular. This study intends to close that gap.

II. LITERATURE REVIEW

The economic cost of water supply refers to both the private and any other external costs to the society or individual arising from production, distribution and consumption of water supply services. Economic cost of public water supply inequality in urban areas encompass, cost of drilling borehole, cost of buying water from water vendors which end up imposing financial costs to the people affected.

Public water supply inequality in urban areas has direct and indirect economic cost to the affected residents. According to (Smiley 2017), the direct cost of public water supply inequality in urban areas, are those cost borne by organization and individual to procure the resource/service from the point of origin until it is delivered to the consumers. The components of direct cost include capital cost,

operations and maintenance costs, cost of procurement and transmission and personnel cost. The indirect cost of public water supply inequality in urban areas on the other hand encompasses, cost that impact an individual's productivity either as a function of time, safety or opportunity lost. For example, time spent commuting or time spent to access water and the health hazard associated with alternative water supply as a result of public water supply inequality are the indirect economic cost on those affected.

Economic cost is the combination of losses of any good and services that have a value attached to them by any one individual. Economic cost is used mainly by economist as means to compare the prudence of one course of action with that of another. The comparison includes the gains and losses precluded by taking a course of action as well as those of the course taken itself. Economic cost can either be capital cost or financial cost.

i. Capital cost: are one-time expenditure on construction, enhancement, or acquisition of assets such as equipment and land that will benefit the project for more than one financial year. Capital cost of water supply includes but is not limited to, construction of dams, purchase of water storage facilities, construction of private wells, amount invested in cars, bike, wheelbarrow to ease the burden of water collection.

ii. financial cost; is the day-to-day cost of running a household or business and other recurrent charges involved. The financial cost of water supply includes but is not limited to cost of buying water, water treatment cost, cost of buying fuel, and cost of repair of water facilities.

According to Jordan & Wyatt (1989), water supply system will inevitably fail to perform as designed if they are not operated and maintained properly. The operation and proper maintenance of water supply system is only possible when they are sufficient knowledge about what it cost to maintain and sustain a water supply system. The important point is that the cost of operating and maintaining a water supply system must be estimated in advance for proper understanding and maintenance. Poor public water supply system in cities is largely due to lack of knowledge on the estimated cost needed to operate, maintain and sustain supply for various water uses (Francisco, Samiria, Francis, Tais & Tereza, 2022). To address the challenges of public water supply inequality involving government decision-making, estimation of the alternative cost of water supply incurred by individual households is needed to support decision regarding the public water policy, allocation and investments.

Estimating water supply cost involves considering various factors like water sources, treatment, distribution, and demand. A common approach is to use a combination of cost-based and demand-based estimation. Cost based estimation considers the expenses incurred in providing the water services, while demand-based estimation reflects the valve consumers place on water. Furthermore, the specific method used can vary depending on the context, such as type of user and the data available. Below is a detailed breakdown of the cost based and demand-based estimation.

The cost-based water estimation includes

i. Production and treatment cost: this includes cost of extracting, treatment and storing of water supply.
ii. Distribution cost: this covers the expenses associated with transporting water to consumers, including infrastructure maintenance and energy cost.
iii. Administrative and overhead cost: this includes the cost of billing customer service and general operational expenses.

The Demand based water estimation

i. Value of water: this considers the willingness of consumers to pay for water, which can fluctuate depending on factors like time of the year, weather, and water availability.
ii. Opportunity cost: this includes the potential benefits lost looking for water rather than other socio-economic benefits.
iii. Externality cost: this considers the social and environmental costs associated with water use, such as water pollution or the loss of natural habitats.

In this study the cost based was modified to estimate the cost of alternative water supply to individual households.

III. METHODOLOGY

3.1 Study Area

Makurdi town is located between latitude 7°37¹ and 7° 47¹ North and longitude 8° 27¹ and 8° 40¹ East (see Figure 1). Makurdi is the Capital and administrative hub of Benue state with a population of about

297,398 as at 2006 National Population Census (2006). And an estimated population of 472,000 in 2024 (United Nation Population, 2024). The town is located within Makurdi Local Government Area with eleven (11) council wards namely; Clark/Market, Wadata/Ankpa, North Bank I &II, Wailomayo, Fiidi, Modern Market, Bar, Agan, Mbalagh and Central/South Mission Council Ward, (see figure 1). Makurdi town is divided by the river Benue with neighborhoods on both banks of the river. Makurdi town has undergone rapid development with new neighborhoods covering Council wards like Wailomayo, Wadata/Ankpa, Central/South Mission, Clark/Market, as shown in (figure 1) and the remaining council wards are completely outside the urban space.

Makurdi town has joined other urban centres in the country in sustaining itself through formal and informal activities which urban centers in developing countries are usually associated with, the bulk of its residents are employed in the civil service structure comprising of the Federal, State and Local Government establishments while a few of its population are employed in the banking, insurance, industries and few private outfits. Majority of its population depends on informal activities such as trading, commercial motorcycling, taxi driving, while at the outskirt of the town, a number of people are involved in urban agricultural as a source of livelihood.

Public water supply plays a significant role in shaping the daily lives of residents and the economic dynamics of the town. The primary source of public water supply in Makurdi town comes from River Benue, which flows through the town. Water is drawn from the river, treated and then distributed to residents through the Makurdi Water works. In addition to this source of water supply, alternative sources like boreholes, water vendors and wells are used by residents especially in areas where the public water system is less accessible.

One of the main challenges facing public water supply in Makurdi town is irregularity of supply. Residents often experience disruption in service due to outdated infrastructure, inadequate water treatment capacity, and power supply affecting pumping stations, [14]. The water distribution network in Makurdi is not fully comprehensive, leading to some areas experiencing low pressure or no access to treated water. Residents in these areas often rely on alternative sources like private boreholes, hand-dug wells or even purchasing water from private vendors. Figure 1 shows the built-up areas of Makurdi town.

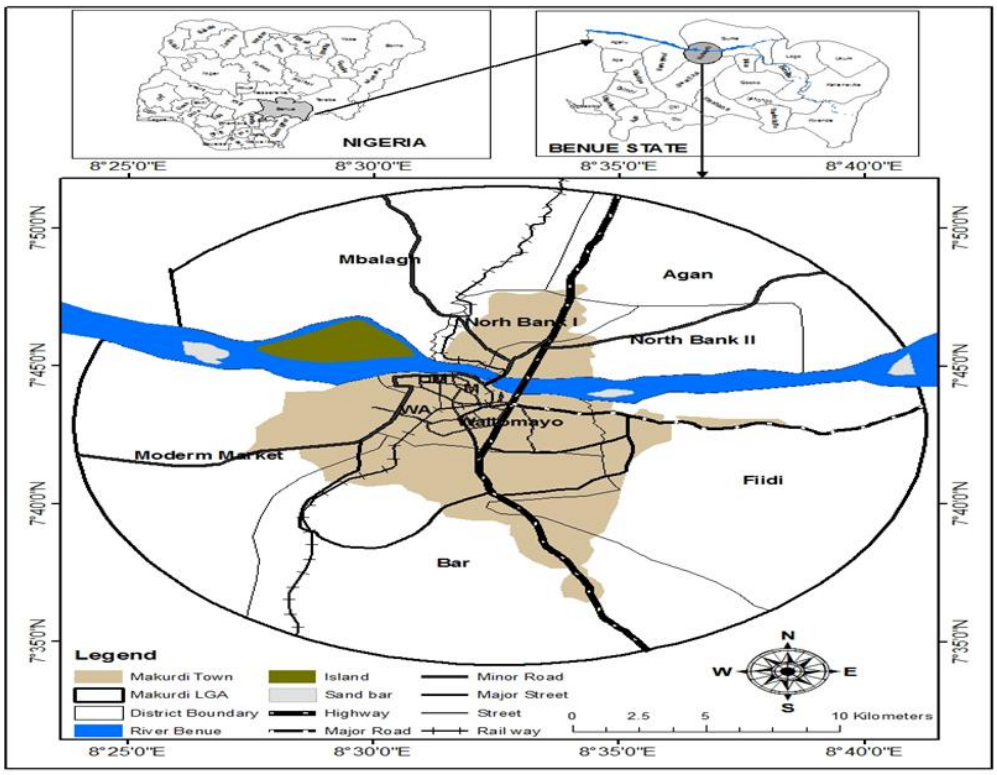

Fig 1: Makurdi LGA showing Council wards and contiguous built-up areas.
Source: Benue State Ministry of Lands and Survey

3.2 Method of sampling

A total of 399 questionnaires were administered through the assistance of enumerators. The systematic sampling method was use to distribute questionnaires to the selected sample size. The first house at the entrance of each neighborhood were selected systematically at interval of five houses in the study area. Household members from 18 years and above, knowledgeable about water supply and the economic cost of water supply were given questionnaires to answer.

3.3 Method of data collected and Analysis

To estimate the economic cost of not having access to public water supply in Makurdi town, the study made use of primary data sources. Data on capital cost (purchase of storage facilities, construction of private well and boreholes, amount invested in bike, wheelbarrow to ease the burden of collecting water) were collected.

Similarly, financial cost (cost of buying water, water treatment cost, amount spent on hospital bill as a result of health hazard from contaminated water sources, cost of fueling bike and power to provide water for households) were also collected. These were analysed using Morenikeji modeling for calculating cost of land. The modeling was adopted and modified to calculate cost of alternative water supply.

Modeling for private water supply cost in Makurdi metropolis

$$Yt = X1+(X2\times X3) +X4+X5+X6+(X7\times X8) +X9+X10+(X11\times X12) +X13+X14+(X15\times X16) +X17$$

Yt =Total cost of water supply

X1 = Official cost of drilling borehole or digging a wall

X2 = Number of times you use energy power to provide or pump water

X3 = Cost per pump of water

X4 = Other cost incurred for supply of water

X5 = Cost of material needed for storage of water

X6 = Official fee paid for transporting water

X7 = Number of times water is transported

X8 = Cost per transport

X9 = Other cost incurred for providing water

X10 = Official fee paid for treatment of water borne diseases

X11 = Number of times victim visit hospital for catch up

X12 = Cost per visit to hospital for checkup

X13 = Other cost incurred as a result of treating water borne diseases

X14 = Official cost of buying water

X15 = Number of times water is bought

X16 = Cost per Purchase

X17 = Other cost incurred due to water purchase.

IV. RESULTS

4.1 socio-economic characteristics of respondents

Though not central to this study, data on the socio-economic characteristic of respondents helped to place the findings in context, knowing that the impact and ability to cope with economic cost of public water supply inequality depends on socio-economic status of the residents, like gender, occupation and income were collected and analysed, and the data is presented in table 1

Table 1: socio-economic characteristics of respondents

Variables	Categories	Frequency	Percentage
Gender	Male	261	65.4%
	Female	138	34.6%
Occupation	Net employed	93	23.3%
	Employed in the formal sector	146	36.6%
	Employed in the informal sector	160	40.1%
Income	120,000-500,000 per annul	150	37.6%
	501,000-1,000,000 per annul	139	34.8%
	1,001,000-5,000,000	97	24.3%
	5,001,000 and above	13	3.3%

Source: Authors field work 2024

Occupation: The occupation status of household's respondent shows that, 23% of respondents are not employed, 36.6% are employed in the formal sector, and 40.1% of respondent are employed in the informal sector. This implies that a greater percentage of household respondent have no sustainable livelihood and an additional burden of providing water for themselves will affects their economic well-being.

Income level: On income of household, the result shows that, 37.6% of respondents have an annual income of 120,000-500,000 per annul, 34.8% respondents have an annual income of 501,000-1,000,000 per annul, 24.3% respondents have an annual income of 1,001,000-5,000,000 per annul and 3.3% of household's respondents have an annual income of 5,000,000 and above. This suggest that the majority of the respondent are poor and their income is too small to have additional burden of providing water for themselves as this will affect their economic well-being.

4.2 Economic cost of Public Water Supply Inequality

Data for the economic cost of public water supply inequality is hereby presented in table 2. The data on the economic cost of public water supply inequality by the affected households' respondents revealed that, a total of ₦ 235,727,300 is spend by household to access water supply as a result of unreliable public water supply in Makurdi town. A detail breakdown of the economic cost (capital and financial cost) is discussed below.

Table 2 Estimated economic cost of household's alternative water supply in Makurdi

Neighborhood	Cost of drilling borehole	Cost of digging well	Cost of pumping water & maintainers (borehole) (year)	Cost of transport (year)	Cost of storage containers	Cost of treatment for water borne disease	Cost of buying water (year)	Total cost of household's water supply
Wadata	16,500,000	4,950,000	7,560,000	3,000,000	1,860,000	1,432,800	19,123, 200	54,426,000
Achusa	3,300,000	450,000	480,000	259,200	150,000	127,500	1,329,600	6,096,300
Nyon Layout	6,600,000	1,050,000	1,560,000	864,000	970,000	308,600	2,212 900	13,565,500
Old GRA	1,100,000	-	240,000	129,600	270,000	93,000	648,000	2,480,600
New GRA	2,200,000	-	960,000	90,000	450,000	110,400	1,353,600	5,164,000
Owners Occupier	1,100,000	150,000	-	64,800	250,000	41,000	249,600	1,855,400
Judges quarters	1,100,000	150,000	360,000	67,200	500,000	40,000	432,000	2,649,200
Gyado Villa		150,000	120,000	-	20,000	23,000	249, 800	562,800
Wurukum	2,200,000	1,950,000	960,000	648,000	660,000	388,800	2,745,600	9,552,400
Nyiman Layout	1,100,000	600,000	-	259,200	300,000	109,200	1,113,600	3,482,000
Tse-Adi	1,100,000	300,000	240,000	312,000	240,000	86,000	532,800	2,810,800
Gaadi	7,700,000	900,000	3,600,000	750,000	1,680,000	336,600	3,921,600	18,888,200
BIPC Quarters	-	-	-	129,600	20,000	17,000	864,000	1,030,600
Benue State University	-	-	-	64,800	1,310,000	876,000	5,558,400	7,809,200
Logo II	1,100,000	1,050,000	240,000	388,800	530,000	197,400	2,160,000	5,666,200
Logo I	6,600,000	2,400,000	1,560,000	240,000	470,000	371,400	2,678,400	14,319,800
Airforce Base	1,100,000	-	180,000	90,000	850,000	284,800	16,800	2,521,600
Welfare Quarters	3,300,000	1,350,000	840,000	300,000	550,000	232,100	428,400	7,000,500
Yaikyor	7,700,000	1,650,000	1,920,000	504,000	480,000	301,700	2,212,800	14,768,500
NorthBank	12,100,000	3,900,000	8,280,000	3,240,000	1,540,000	1,112,200	7,562,400	37,734,600
High Level	7,700,000	900,000	3,240,000	1,166,400	1,500,000	528,000	6,614,400	21,648,800
Federal Housing	1,100,000	-	-	64,800	80,000	17,500	432,000	1,694,300
NASME	-	-	-	133,000	210,000	37,000	267,000	647,000
Total	84,700,000	21,900,000	32,340,000	12,632,400	13,294,000	7,035,000	62,051,100	₦235,727,300

Source: Authors field work 2024

4.2.1 Capital cost of Alternative water supply

Table 2 shows that the capital cost on water assets that will benefit households for more than a year; such as construction of borehole, hand dug well, and storage facilities used for collecting water, were estimated to cost the affected households about ₦119,894,000. A breakdown of the capital cost shows that ₦84,700,000 was used for motorize boreholes, ₦21,900,000 was used for hand dug well, and ₦13,294,000 was used by the affected households to purchase water storage facilities like overhead tanks and other smaller water storage containers like buckets. The findings revealed that households in the study area spent huge amount of money acquiring water assets as a result of unequal and unreliable public water supply. This suggest that, household's dependence on alternative sources of water supply add heavy financial burden to affected households. This finding agrees with the findings of (Babuna et al 2023).

4.2.2 Financial cost of alternative water supply

Data in table 2 shows that, the day to day running cost of alternative water supply by affected households in the study area was estimated to a total amount of ₦ 114,058,500 as the running cost incurred by the affected households' respondents. A breakdown of the day to day running cost shows that, maintainers of borehole, payment of electricity bills, and purchase of fuel used in powering the borehole is ₦ 44,972,400 in a year. Financial cost incurred for treatment of water borne diseases as a result of unreliable public water supply was estimated to cost households ₦ 7,035,000. And ₦ 62,051,100 is the financial cost incurred by households in buying water in a year. As shown in table 2, buying water from water vendor is the variable with the highest financial cost used in day to day running of household water supply. Households in the study area spent huge amount of money buying water from water vendors. A tank of water cost ₦25,000, while 20 liters' container of water cost between ₦50 to ₦100 and even ₦200 in some neighborhoods, depending on the location and distance from water source. Many households buy water for drinking purpose and other households uses. Even households with public water supply and boreholes still buy bottle water or sachet water popularly known as pure water for drinking purposes, because they don't trust these sources of water supply for drinking purpose. This have placed a heavy financial burden on households affected by public water supply inequality. This suggest that households spend an average of ₦ 874 per capita every day to access water for households needs and ₦26,220 every month to access water. This amount is 37% of a household on a minimum wage of 70,000 which is above the stipulated 4% - 15% stipulated by the Ministry of Water Resources. This implies that, the provision of water by individual households is not sustainable and a threat to economic well-being of households in the study area.

V. CONCLUSION AND RECOMMENDATIONS

The study concluded that, public water supply inequality affects the economic well-being of households in Makurdi town and it is a threat to poverty reduction, sustainable urban growth and development. The study recommended infrastructure investment, and a decentralized public water supply approach that is backed by a definite policy to enhance service delivery and minimize economic stress in Makurdi town.

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