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Sustainable Water Supply and Distribution Systems in Enugu Metropolis: Challenges, Infrastructure Assessment, and Strategic Interventions

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Abstract- ***The water supply system in Enugu Metropolis has historically faced significant operational and structural challenges, characterized by production levels far below installed capacity, aging infrastructure, and unsustainable management frameworks. This study assesses the current state of water production, transmission, and distribution within the Enugu State Water Corporation (ENSWC). Utilizing a mixed-methods approach involving technical infrastructure audits and socio-economic household surveys, the research identifies critical bottlenecks including power supply instability, frequent pipe bursts, and a high rate of non-revenue water. Findings indicate that while recent governmental interventions under the "180-day water project" have significantly improved supply through the 9th Mile 24/7 Water Scheme and the establishment of water galleries, long-term sustainability remains contingent on comprehensive network rehabilitation, metering, and improved governance. The study recommends a dual-phase strategy involving immediate technical repairs and long-term institutional reforms to ensure financial viability and equitable water access for all residents.***

Keywords: ***Water Distribution, ENSWC, Enugu Metropolis, Infrastructure Sustainability, Urban Water Management.***

I. INTRODUCTION

Water supply and distribution systems are fundamental pillars of urban infrastructure, essential for public health, economic productivity, and environmental sustainability. In Enugu State, Nigeria, the responsibility for providing potable water rests with the Enugu State Water Corporation (ENSWC). However, for over two decades, the metropolis has grappled with a "water jinx," where residents faced acute shortages despite the presence of significant water schemes like Ajalli, Oji River, and Iva Valley.

The water supply and distribution systems is a process of collecting, transporting, treatment of water and final distribution to the residents in a particular community to meet their water demand. The demand may include for domestic, industrial, institutional and commercial, public uses, fire demand and water required compensating for losses in wastes and thefts. The essential elements of a public water supply scheme may consists of intakes and reservoirs; a water treatment plant having screening, sedimentation, filtration, disinfection units; elevated tanks and stand pipes which provide storage to meet peak demands occurring for limited periods; values which control the flow of water in the pipe system; hydrants which provide a connection with the water in the mains for fighting fires, flushing streets; mains, sub-mains and branch lines which carry the water to the individual homes etc.

A functional water supply and distribution system should be able to estimate the water demand i.e. per capita demand based on the forecast of future population. The per capita demand will depend on the size of the city, climatic conditions, types of gentry and habits of the people, industrial and commercial activities, quality of water supplies, pressure in the distribution system, development of sewage facilities, cost of water, policy of metering and method of charging. In a well regulated system, there is need to fix regulators to work out economic water tariffs, keeping into considerations of households. Moderately high water price rates will encourage users to use water more efficiently, help to generate funds to maintain existing the water infrastructures and help build new infrastructure for expansion. The state governments need to exhibit political courage to

effect the necessary charges to encourage use of public water supply as against the use of packaged waters which is currently the practices in the city. This research is looking at the existing water infrastructures in Enugu and how it can be utilized effectively to service the need of the population with a view to making it very efficient and functional. Water supply for human consumption is one of the basic necessities for human existence. Municipal water supply system that provide portable water to a wide array of commercial property and domestic use buildings including apartments, condominiums, duplex housing and single family dwellings, schools, public buildings and commercial enterprises has become a major challenge in many cities especially in Enugu State. The purpose of municipal water delivery systems is to transport potable water from a water treatment facility to residential consumers, for use in drinking water, water for cooking, water for sanitary conditions, and other water use in a domestic environment. A municipal water supply system cannot service its customers unless there is a continuous supply of water to meet domestic consumption needs in the broadest sense and water needs for fire protection. It is necessary to properly harness the water sources to meet this fundamental requirement.

Water supply selections are affected by quality of water and quantity of water. The quality of water must meet the regulatory requirement of residential communities with populations not exceeding three thousand (3000) persons and combined residential and commercial communities that serve a population demand over 3,000 while quantity of water must be adequate to meet consumer consumption and fire demands at any time of the day, day of the week and week of the year. The major challenge to maintaining a continuous or uninterrupted supply of water for urban water supply demand may be as a result of drought; growing demand that cannot be met by the treatment plant; lack of adequate storage capacity; other communities drawing water from the same supply services such as a lake or a river a major commercial fire or wild land/urban interface fire that exhausts the water supply; and undetected underground leakage on the pipe distribution system. The maximum daily consumption demands must be satisfied at all times with the quantity of water available, even during periods of drought or after years of community growth. As the urbanization comes the water delivery system needs to expand.

The United Nations considers universal access to clean water a basic human right, and an essential step towards improving living standards of people worldwide. Communities that suffer poor supply of water are typically economically poor as well, with their residents trapped in an ongoing cycle of poverty. Economic opportunities are routinely lost to the time- consuming processes of acquiring water where it is not readily available. Water is obviously essential for hydration and for food production. The state of drinking water supplies can be quantified by four essential characteristics of quality, quantity, reliability and cost.

As population grows by day, the challenge to meet user demands of water also increases. At the pivot of this crisis are women and children who are saddled with the responsibility of sourcing water for daily domestic uses. This situation have contributed to child poverty and resulted to child abuse. This exercise is usually a morning and evening routine. Majority of these children who are in primary and secondary schools sacrifice their private study time in order to source water for domestic uses.

There is continuous shortage of water supply and distribution in Enugu that hampers the development of economic activities within the city. The inhabitants of Enugu ab-initio relied more on use of rivers and streams as a source of water. The sordid state of water supply in Enugu started with the development of the town. In early days, the Aria layout, the Colliery layout (Udi Siding), and Hill top that formed the starting point of Enugu, had a water reservoir of about five (5) million capacity. The reservoir that is the Iva valley scheme serve the growing population until new scheme started developing. A critical examination on historical development of Enugu municipality will reveal clearly that the water supply development is not commensurate to the population growth. The shortage of water has been a very big problem to the residents of Enugu metropolis. The Enugu urban has been characterized by recurring water scarcity. Some areas have water occasionally while some are totally out of the water supply and

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distribution scheme. For instance, some areas and layout at Awkunanaw, Maryland, New GRA, Trans Ekulu, Abakpa Nike and Emene are yet to be included in the water supplies that are equipped with water distribution facilities. Sequel to this development, inhabitants of these areas have resorted to well water, water tankers, open streams, rainwater and spring water.

When there is no running tap water in most of the buildings in Enugu, the consequence is that toilets get filled up with undisputed human wastes, creating critical health hazards for the population. This portends serious threat to dangers of epidemics from this singular situation if not checked. Most of the existing Water distribution taps are not operational for several months. The inhabitants of Enugu are at the whims and caprices of the water tanker vehicle drivers. People who cannot afford to pay high cost of water, travel to any available stream around to fetch water for cooking and drinking. Besides, as one walks around the city, one regular scene early morning or evening is the long queue around private dug water wells, plastic and metallic tanks sourcing for water. Lots of times are spent to get water including the risk involved in crossing road with busy traffic. Water scarcity is experienced everywhere in the city. The water corporation in Enugu state who have the mandate of supply and distribution and sale of water to inhabitants of Enugu also have water tanker vehicles that purchase water from boreholes at Nineth (9th) mile area and supply to their various facilities and individual homes. This is embarrassment that even government ministries, parastatals, institutions (academic and nonacademic), secondary schools and commercial business owners have purchased their water tanker vehicles for sourcing water. In most homes where there is water supply, there is no proper design of water distribution network to service the upper floors of such buildings.
This government Agency (Enugu State Water Corporation) ENSWC in charge of water supply and distribution have their existing water schemes at Ajalli River and Oji River outside Enugu to supply water to inhabitants in Enugu and its environs. These water schemes operate minimally or below their installed capacity due to administrative bottlenecks and lack of technical expertise to manage the water scheme effectively. The demand for water in Enugu is driven by rapid urbanization and population growth, yet the supply has often been intermittent and unreliable. This gap has forced many households to rely on expensive tanker trucks or unsafe shallow wells, leading to increased economic burdens and public health risks. This article examines the technical and socio-economic dimensions of the water crisis in Enugu, evaluates recent progress, and proposes a roadmap for a sustainable future.

II. METHODOLOGY

This study employed a comprehensive research design combining quantitative and qualitative data collection methods. A technical assessment of existing waterworks, including the Ajalli Treatment Plant, Oji River Scheme, and Iva Valley involved reviewing production data, power availability, and the frequency of network failures. Questionnaires were administered to households across Enugu Urban (North, South, and East LGAs) to gauge satisfaction levels, willingness to pay (WTP), and current water sourcing patterns. Geophysical Survey was conducted to identify alternative groundwater sources and evaluate the feasibility of expanding the borehole-based schemes. Review of ENSWC internal reports, historical maps of the distribution network, and recent academic literature on urban water management in Nigeria.

Figure 1: Map of Nigeria with Enugu State verged in red colour
Source: Administrative Map of Nigeria from Wikipedia Image, (2021)

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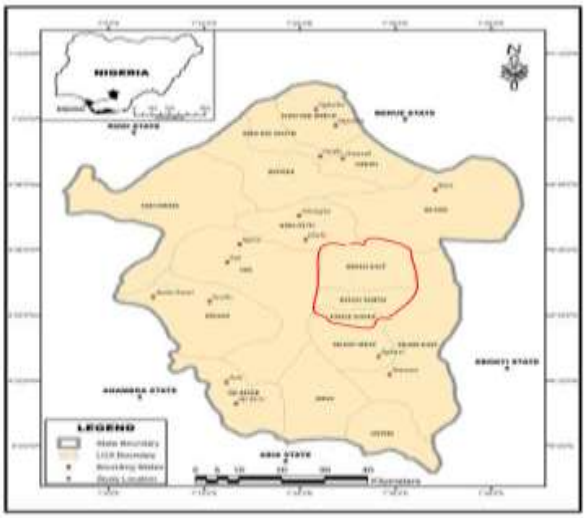

Figure 2: Map of Enugu state with Enugu metropolis (Enugu North, Enugu South and Enugu East Local Government Area verged in red colour
Source: Administrative Map of Nigeria from Wikipedia Image, (2021)

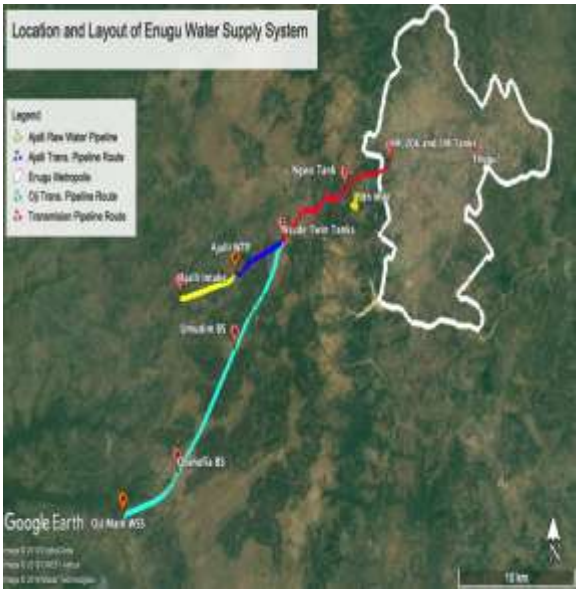

Plate 1: Location and Layout of Enugu Water Supply System

III. RESULT

The primary sources of water for Enugu Metropolis include:

- Ajalli Waterworks: Historically the largest supplier, though often hampered by mechanical failures and power outages.
- Oji River Scheme: A vital source that has undergone recent rehabilitation to boost its output.
- 9th Mile 24/7 Water Scheme: A modern borehole-based project commissioned in late 2023, designed to provide a steady supply to the city.
- Iva Valley: The oldest scheme (est. 1924), primarily serving the Uwani and GRA areas through gravity-fed systems.

The distribution network is characterized by aging asbestos-cement and cast-iron pipes, many of which are over 50 years old. This leads to:

- High Non-Revenue Water (NRW): Significant volumes of treated water are lost through leakages and unauthorized connections.
- Intermittent Supply: Due to power instability and the need for frequent repairs, many areas receive water only a few days a week.
- Infrastructure Vandalism: Intentional damage to pipelines for illegal tapping remains a persistent issue.

Table 1: Water Sourcing Options for Residents of Enugu Metropolis

Source	Average Cost (Naira/m³)	Reliability	Quality
ENSWC Pipe-borne	200 - 300	Low/Improving	High (Treated)
Tanker Trucks	800 - 1,000	High	Variable
Private Boreholes	300 - 400	Medium	Variable
Shallow Wells	Low (Initial Cost)	High (Seasonal)	Low (Unsafe)

Survey results reveal a stark contrast between ENSWC customers and non-customers. While ENSWC water is the most affordable (when available), the unreliability of the service forces residents to spend a disproportionate amount of their income on alternative sources.

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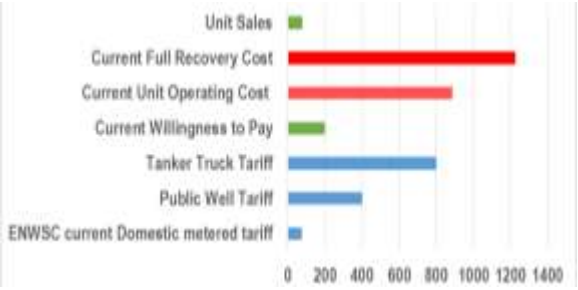

Figure 3: Unit sales, unit costs, water tariff in Naira/m3
Source: Enugu State Water Corporation (ENSWE)

Rather than there being a lack of need or demand from potential water customers, the main issue resides in ENSWC's capacity to supply water effectively (good pressure, good water quality, continuous service). The analysis from the survey reveal that there is urgent need to enhance ENSWC's ability to supply water to its customers given its capacity to produce and distribute water to its current active customers initially, and then to inactive and new customers.

IV. DISCUSSION

The study found a high willingness to pay among residents for improved services. Approximately 83% of ENSWC customers expressed readiness to pay 200 Naira/m³ for a guaranteed 24-hour supply. Non-customers also showed a strong interest in private connections, with many willing to pay for installation through monthly installments.

The household surveys, coupled with the analysis of current water tariffs, show that there is a market for water, which has been created by ENSWC's failure to provide water within its service area. As a result, Enugu residents, including ENSWC customers, rely on a wide range of water sources, such as water tankers, private boreholes, private and public wells, and sachets.

Excluding households and institutions that have invested in their own water resource supply, the current prices of most of these alternative sources are far higher than the ENSWC water tariffs. Having no other choice, most households and institutions pay these higher prices for this water.

To achieve financial break-even, ENSWC will clearly have to sell more water, thereby enabling better amortization of its non-variable costs (administrative costs, staff, and assets). However, its absolute energy, maintenance and chemical costs will also rise as water supply increases. The next phases of the assignment will involve running simulations to assess the variation in unit costs compared to the increase in water production.

V. CONCLUSION AND RECOMMENDATIONS

The water supply situation in Enugu is transitioning from a state of chronic failure to one of active recovery. While the recent increase in production capacity is commendable, the "last mile" water consistently to every household—remains. The high rate of NRW and the fragility of the old distribution network are the primary obstacles to achieving a truly sustainable system. Financial sustainability for ENSWC is achievable if the corporation can transition to a metered, revenue-driven model supported by reliable service delivery.

Recommendations
Short-Term Measures (0-12 Months):

- Aggressive Leak Detection and Repair: Prioritize the replacement of the most damaged sections of the distribution network to reduce NRW.
- Universal Metering: Implement a phased rollout of prepaid meters to ensure accurate billing and discourage wastage.
- Enhanced Security: Collaborate with local communities to protect water infrastructure from vandalism.

Long-Term Strategic Interventions (2026-2030)

- Full Network Overhaul: Replace aging asbestos pipes with modern HDPE or Ductile Iron pipes.
- Renewable Energy Integration: Deploy solar power solutions at pumping stations to mitigate the impact of national grid instability.
- Institutional Reform: Transition ENSWC towards a more autonomous, performance-based

management structure to improve operational efficiency.

- Public-Private Partnerships (PPP): Explore PPP models for the management of specific water schemes or billing operations.

REFERENCES

[1] Al-Layla, A. S., et al. (1978). Water Supply Engineering Design. Ann Arbor Science Publishers.

[2] Chukwurah, G. (2018). Challenges and Opportunities of Water Supply in Enugu Metropolis, Nigeria. ResearchGate Publication.

[3] Enugu State Water Corporation (2026). ENSWC, Enugu State Housing Corporation Move to Strengthen Collaboration for Improved Water Supply. Press Release, January 2026.

[4] Ezemerihe, A. N. (2022). Water Supply and Distribution System for Enugu State. Ph.D. Research Seminar, Department of Civil Engineering, Chukwuemeka Odumegwu Ojukwu University, Uli Anambra State.

[5] Mbah, P. (2024). Commissioning of the 9th Mile 24/7 Water Scheme. Official Enugu State Government Statement, March 2024.

[6] Shamir, U. and Salomons, E. (2008). Optimal real-time operation of urban water distribution systems using reduced models. J. Water Resour. Plan. Manag. 134: 181–185.

[7] Shao, Y., Yang, Y.J., Jiang, L., Yu, T. and Shen, C. (2014). Experimental testing and modelling analysis of solute mixing at water distribution pipe junctions. Water Res. 2014: 133–147.

[8] Sheikholeslami, R. and Kaveh, A. (2015). Vulnerability assessment of water distribution networks: graph theory method. Int. J. Optim. Civ. Eng. 5: 283–299.

[9] World Bank (2025). Nigeria Sustainable Urban and Rural Water Supply, Sanitation and Hygiene (SURWASH) Program. Technical Report.

[10] White, G.F., Bradley, D. and White, A. (1972). Drawers of Water - Domestic Water Use in East Africa. University of Chicago, Press, U.S.A.

[11] Wright, R., Stoianov, I. and Parpas, P. (2014). Dynamic topology in water distribution networks. Procedia Eng., 70: 1735–1744.

[12] Zhu, X., Jie, Y., Huaqiang, C., Yaguang, K. and Bishsi, H. (2019). Water distribution network modelling based on NARX. Proc. Int. Fed. Autom. Control, 48: 11072–11077.

[13] Zilberman, D. and Schoengold, K. (2005). The use of pricing and markets for water allocation. Can. Water Resour. J., 30: 47–54.