Investigating the Impact of Inadequate Water Supply on the Environmental Health of Enugu's Urban Residents

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Abstract
The inadequate supply of water poses serious risks to public health, sanitation, and environmental sustainability, undermining efforts to achieve Sustainable Development Goal 6 (SDG 6), which aims to ensure the availability and sustainable management of water and sanitation for all by 2030. This study examined the effects of inadequate water supply on the environmental health of urban residents in Enugu Urban, Enugu State, Nigeria. A descriptive survey research design was adopted, targeting a population of 1,029,400 people across three local governments in Enugu Urban. A sample size of 400 was determined using the Taro Yamane formula, and data were collected through a structured questionnaire. Quantitative data were analyzed using frequency, percentage, means, and standard deviations, while simple linear regression analysis was employed to test the stated hypotheses using SPSS (version 25). The findings revealed that the current state of water supply infrastructure significantly negatively impacts access to potable water in Enugu Urban. The study confirmed that inadequate water supply adversely affects the environmental health of residents. Additionally, the study discovered a significant difference between the Enugu Urban water supply system and the targets outlined in Sustainable Development Goal 6 (SDG 6). It concluded that inadequate water supply is a critical driver of poor environmental health in Enugu Urban. To address these issues, the study recommends comprehensive rehabilitation of infrastructure, increased community engagement in water planning, and the adoption of sustainability frameworks such as the Predictive Iterative Sustainability Model (PISM) to improve planning and service delivery. It also emphasizes the need for a coordinated, inclusive, and well-funded approach to enhance water access and environmental health outcomes in Enugu Urban.

INTRODUCTION

Access to clean and adequate water supply is a critical issue in many urban areas of Nigeria, with Enugu urban being a prime example. Despite its status as a major city, Enugu faces severe water scarcity, impacting a significant portion of its population. Residents rely on unregulated sources such as private boreholes and water vendors, many of which do not meet safety standards. This situation leads to serious health risks, including waterborne diseases and increased exposure to environmental contaminants.

While several studies have examined water supply challenges, most focus on rural areas or general trends, neglecting the urgent environmental health implications in urban centers like Enugu. Research mainly highlights infrastructural decay and policy failures without adequately addressing the direct health outcomes for urban populations. Additionally, there is a lack of comprehensive studies on how inadequate water supply contributes to environmental hazards, such as water pollution and waste disposal, particularly in densely populated areas.

Furthermore, the literature on Sustainable Development Goal 6 (SDG 6), which aims for the sustainable management of water and sanitation, is insufficiently linked to urban water-

related health issues in Nigeria. Many studies view SDG implementation merely as a policy challenge, failing to connect it with the pressing environmental health consequences faced by vulnerable populations, including women and low-income households.

This research aims to fill that gap by analyzing the effects of inadequate water supply on the environmental health of residents in Enugu urban, situating the analysis within the framework of SDG 6. By doing so, it seeks to provide evidence-based insights that can guide local urban planning and national policy interventions to improve water supply and environmental health outcomes.

REVIEW OF THE RELATED LITERATURE

Inadequate Water Supply

Water supply is a critical process that ensures the provision of water in adequate quantity and quality for various human needs, including drinking, sanitation, domestic use, industrial activities, and agriculture. In urban areas, it encompasses the effective abstraction, treatment, distribution, and regulation of water to meet the demands of a growing population (Okafor, Dim, and Ezeabasili, 2023). It is essential to understand that water supply is not merely about the physical availability of water; it also demands reliability, safety, and accessibility for end-users in a sustainable and equitable manner. Robust water supply systems are indispensable for promoting public health, enhancing economic productivity, and ensuring environmental sustainability, particularly in developing countries like Nigeria, where infrastructure deficits and governance failures persist and undermine effective service delivery (Asomba and Ofodu, 2024).

Inadequate water supply undeniably refers to the alarming situation where households or communities lack adequate access to clean, safe, and dependable water for vital daily activities such as drinking, cooking, hygiene, and sanitation (WHO, 2020). This issue encompasses both quantitative inadequacies (insufficient volume) and qualitative failures (unsafe or contaminated water). In urban environments, this crisis arises from a combination of failing infrastructure, limited water sources, and poor governance. In Enugu, the consequences are stark, with irregular water delivery, a reliance on unsafe alternatives, and a glaring lack of investment in the expansion and maintenance of water infrastructure. Addressing these challenges is not just necessary; it is imperative for ensuring the well-being of the community.

Environmental Health

Environmental health is a branch of public health that examines how external physical, chemical, and biological factors affect health and behaviors. It focuses on assessing and managing factors such as water quality, waste management, air pollution, and vector control (USEPA, 2021).

This field is vital for preventing disease and promoting well-being, especially for vulnerable populations like children, the elderly, and those in low-income areas. Poor environmental conditions, such as contaminated water and hazardous waste, can lead to serious health issues, including respiratory diseases, gastrointestinal infections, and certain cancers (Joshua et al., 2023).

Key aspects of environmental health include monitoring and regulating air and water quality. Air pollution from industrial activities and vehicle emissions poses significant health risks, while access to clean drinking water is essential for preventing waterborne diseases. Effective sanitation and water treatment systems are critical components of public health strategies (Milstein and Stark, 2025; Manisalidis et al., 2020).

Water Supply Infrastructure

Water supply infrastructure includes the essential systems and facilities that extract, treat, store, and distribute water to users. This network comprises dams, reservoirs, treatment plants, pipelines, pumping stations, and service connections (Ajayi and Olagunju, 2022). A robust infrastructure is critical for delivering sufficient quantities of safe water to households, institutions, and industries.

In urban centers like Enugu, reliable water infrastructure is vital for everyday life and public health. However, many Nigerian cities struggle with outdated and poorly maintained systems. Issues such as leaking pipes, inadequate treatment capacity, and inconsistent electricity supply to pumping stations contribute to water loss and contamination risks (Asomba and Ofodu, 2024).

These problems are exacerbated by rapid urbanization, population growth, and insufficient investment in infrastructure. Without proper maintenance and expansion, these systems cannot keep pace with demand, particularly in low-income areas. According to UN-Habitat (2023), the lack of resilient water infrastructure in African cities is a major barrier to achieving Sustainable Development Goal 6, which promotes sustainable water management and equitable access. Thus, improving the quality and reliability of water supply infrastructure is essential for enhancing access to water and reducing health risks associated with scarcity and contamination.

METHODOLOGY

This study employs a descriptive survey research design, which is highly effective for systematically collecting and analyzing data on the current state of water supply and its environmental health implications in Enugu urban.

Enugu urban, the lively capital of Enugu State in southeastern Nigeria, includes three key local government areas: Enugu North, Enugu South, and Enugu East. Characterized by high population density and rapid urbanization, this city features a mix of affluent estates and informal settlements.

However, Enugu urban faces significant challenges with water accessibility, as many residents rely on unregulated and unsafe sources due to inadequate infrastructure and inconsistent public water supply. Addressing these concerns is vital for the health and well-being of the community.

The population for this study comprises all residents of Enugu Urban, along with essential stakeholders including officials from the Enugu State Water Corporation, environmental health officers, and community leaders. The total population is established at 1,029,400 across the three local governments in Enugu Urban: Enugu East (397,700), Enugu North (347,500), and Enugu South (284,200) (National Bureau of Statistics, 2022 projected population for Enugu State). This data is crucial for understanding the community dynamics and the role of water management in the region.

A sample size of four hundred (400) was calculated using Yamane's (1967) formula, with respondents allocated proportionately: 155 from Enugu East, 135 from Enugu North, and 110 from Enugu South.

The selection process employed a two-stage sampling technique. First, stratified sampling divided Enugu urban into three local government areas. Second, purposive sampling targeted individuals with essential insights, including officials from the Enugu State Water Corporation, environmental health officers, and community leaders, ensuring a rich and informed data collection.

The data collection relied on structured questionnaires designed to gather quantitative information about water access, including sources, frequency, costs, and the prevalence of water-related illnesses.

In-depth interviews were conducted with officials from the Enugu State Water Corporation, health officers, and community representatives to obtain qualitative insights into institutional challenges and policy implementation. Additionally, observational data were collected to assess the condition of water infrastructure and sanitation facilities in selected areas.
The quantitative data from the questionnaires were analyzed using SPSS version 25. Descriptive statistics, such as frequencies, percentages, means, and standard deviations, were used to explore the research questions, categorizing items with a mean score of 3.00 or higher as agreed or strongly agreed, and those below as disagreed. We employed simple linear regression analysis to examine the relationship between inadequate water supply and environmental health outcomes.

RESULT AND DISCUSSIONS

This study offers a comprehensive evaluation of how inadequate water supply profoundly affects the environmental health of residents in Enugu, shedding light on a critical issue that impacts community well-being.

Table 1. Mean score and standard deviation on the effect of current state of water supply infrastructure on access to potable water in Enugu urban

Items	N	Sum	Mean ($\bar{X}$)	Std. Deviation	Decision
The current water supply infrastructure in Enugu Urban is insufficient to meet the daily water needs of residents	342	1132	3.31	0.47	Agree
The condition of the public water system forces the residents of Enugu urban to rely on alternative sources like tankers or boreholes	342	1179	3.45	0.50	Agree
Effort, time, and money spent daily to access water affects productivity, hygiene, and school attendance, especially for women and children	342	1101	3.22	0.58	Agree
The cost of purchasing water due to unreliable supply infrastructure places a financial burden on many households	342	1152	3.37	0.49	Agree
Residents of Enugu urban are not adequately informed about water supply issues and improvement plans	342	1248	3.65	0.42	Strongly Agree
Recent government efforts did not make any significant improvement in access to potable water in most of Enugu urban area	342	1255	3.67	0.44	Strongly Agree
Limited access to potable water affects the cleanliness and hygiene of many homes	342	1275	3.73	0.39	Strongly Agree
Cluster Mean/Pooled Standard Deviation	**7**	**24.40**	**3.49**	**0.47**	**Strongly Agree**

The analysis presented in Table1 above shows that mean scores of the first four items are above the cutoff point of 3.00 but below 3.50 indicating agree. While the mean scores for the last three items are above 3.50 depicting strongly agree. This shows that all the items are the effect of current state of water supply infrastructure on access to potable water in Enugu urban.

The overall cluster mean score of 3.49 is a strong indication that the items are the effect of the current state of water supply infrastructure on access to potable water in Enugu urban. The low pooled standard deviation of 0.47 is an indication that the opinions of the respondents are consistent.

Table 2: Coefficients Summary for the Regression Model

Variables	Coefficient (B)	Std. Error	t-value	p-value
Access to potable water	-0.104	32.926	32.926	0.000[b]
Current state of water supply infrastructure l	0.231	8.738	8.738	0.000

The constant (B= -0.104, p<0.05B = -0.104, p < 0.05B= -0.104, p<0.05) represents access to potable water when the current state of water supply infrastructure is zero. This value indicates the negative effect of the current state of water supply infrastructure on access to potable water in Enugu Urban. The coefficient for the current state of water supply infrastructure (B=0.231, t=8.738,p<0.05B = 0.231, t = 8.738, p < 0.05B=0.231,t=8.738,p<0.05) demonstrates a weak and statistically insignificant positive effect on access to potable water. For any single damage in the state of water supply infrastructure, access to potable water decline by 0.104 units, holding other factors constant. Hence, the current state of water supply infrastructure has a significant negative effect on access to potable water in Enugu urban.

Table 3: Mean Score and Standard Deviation on how inadequate water supply affected the environmental health of urbanites in Enugu urban

Items	N	Sum	Mean ($\bar{X}$)	Std. Deviation	Decision
Poor state of water supply infrastructure contributes to environmental pollution in Enugu Urban	342	1138.86	3.33	0.80	Agree
Poor access to water makes it difficult to maintain proper sanitation and hygiene p**ractices** in many household	342	1217.52	3.56	0.67	Strongly Agree
Inadequate water supply in Enugu Urban contributes to the spread of waterborne diseases in low-income areas	342	1190.16	3.48	0.58	Agree
Lack of adequate water supply leads to increased open defecation in some parts of the city	342	1063.62	3.11	0.99	Agree
People in slums and ghetto areas suffer from dysentery due to drinking unsafe water	342	1227.78	3.59	0.62	Strongly Agree
Families in low income areas regularly experience water-related health issues (such as diarrhea or typhoid) due to poor water access	342	1282.50	3.75	0.49	Strongly Agree
Cluster Mean/Pooled Standard Deviation	**6**	**20.82**	**3.47**	**0.69**	**Agree**

The statistical analysis in Table 3 indicates that 2 items have mean scores above the cutoff point of 3.00 but below 3.50 showing agree. While the mean scores for the remaining 3 items

are above 3.50 depicting strongly agree. This shows that all the items are how inadequate water supply affected the environmental health of urbanites in Enugu urban.
The overall cluster mean score of 3.45 is a strong indication that the items are how inadequate water supply affected the environmental health of urbanites in Enugu urban. The low pooled standard deviation of 0.57 is an indication that the opinions of the respondents do not differ remarkably on the items.

Table 4: Coefficients Summary for the Regression Model

Variables	Coefficient (B)	Std. Error	t-value	p-value
Environmental health of urbanites	-0.107	0.0784	32.976	0.000[b]
Inadequate water supply	0.676	0.068	8.738	0.000

The constant (B= -0.107, p<0.05B = -0.107, p < 0.05B= -0.107, p<0.05) represents the environmental health of urbanites when inadequate water supply is zero. This value indicates the negative effect of inadequate water supply on environmental health of urbanites. The coefficient for social condition of work (B=0.676,t=8.738,p<0.05B = 0.676, t = 8.738, p < 0.05B=0.676,t=8.738,p<0.05) demonstrates a strong and statistically significant negative effect of inadequate water supply on environmental health of urbanites. For every one-unit decline in water supply, environmental health of urbanites worsens by 0.676 units, holding other factors constant. Therefore, inadequate water supply negatively affected the environmental health of urbanites in Enugu urban.

Table 5: Mean Score and Standard Deviation on extent does the existing water supply system in Enugu urban align with the targets of Sustainable Development Goal 6 (SDG 6)

Items	N	Sum	Mean ($\bar{x}$)	Std. Deviation	Decision
Irregular access to safe pipe water in Enugu Urban do not align with universal access to safe and affordable drinking water of SDG 6	342	1234	3.61	0.49	Strongly Agree
Water losses due to leakages and broken pipes are common[n Enugu urban and do not align with water-use efficiency and Sustainability	342	1162	3.40	0.67	Agree
Poor integrated or coordinated water resource management system in Enugu urban affect water-use efficiency and sustainability	342	1176	3.44	0.58	Agree
There is limited engagement of urban residents in planning, monitoring, or feedback processes regarding public water systems	342	1244	3.64	0.56	Strongly Agree
Significant effort has not taken place in pipe replacement and network expansion in parts of the city.	342	1279	3.74	0.86	Strongly Agree
Achieving universal access to clean water in Enugu Urban by 2030 is realistic if current efforts continue	342	1258	2.68	0.72	Disagree
Cluster Mean/Pooled Standard Deviation	**6**	**21.51**	**3.59**	**0.65**	**Strongly Agree**

The statistical analysis in Table 5 indicates that 2 items have mean scores above the cutoff point of 3.00 but below 3.50 showing agree. The mean score for the last item is below 3.0 cutoff point indicating disagree. While the mean scores for the remaining 3 items are above 3.50 depicting strongly agree. This shows that all the items shows the extent the existing water supply system in Enugu urban do not align with the targets of Sustainable Development Goal 6 (SDG 6).

The overall cluster's mean score of 3.59 is a strong authentication that that all the items shows the extent the existing water supply system in Enugu urban do not align with the targets of Sustainable Development Goal 6 (SDG 6). The low pooled standard deviation of 0.65 is a strong indication that the opinions of the respondents do not differ remarkably on the items

Table 6: Coefficients Summary for the Regression Model

Variables	Coefficient (B)	Std. Error	t-value	p-value
Enugu urban water supply system	3.235	0.0983	32.926	0.000[b]
Targets outlined in SDG 6	0.598	0.068	8.738	0.000

The constant (B=3.235, p<0.05B = 3.235, p < 0.05B=3.235,p<0.05) represents the baseline level of Enugu urban water supply system alignment with the targets outlined in SDG 6. This value indicates a significant difference between Enugu urban water supply system and the targets outlined in Sustainable Development Goal 6 (SDG 6). The coefficient for targets outlined in SDG 6 (B=0.598,t=8.738,p<0.05B = 0.598, t = 8.738, p < 0.05B=0.598,t=8.738,p<0.05) demonstrates a strong and statistically significant difference between Enugu urban water supply system and the targets outlined in SDG 6. For each point outlined in SDG 6, Enugu urban water supply system misalignment increased by 0.598 units, holding other factors constant. Hence, there is a significant difference between Enugu urban water supply system and the targets outlined in Sustainable Development Goal 6 (SDG 6).

DISCUSSIONS

This study assessed the effect of inadequate water supply on environmental health in Enugu Urban, Nigeria. The first hypothesis indicated that the water supply infrastructure significantly hinders access to potable water. Findings revealed that the infrastructure is insufficient for residents' daily needs, forcing reliance on alternative sources like tankers or boreholes. This situation adversely affects productivity, hygiene, and school attendance, particularly for women and children. The financial burden of purchasing water due to unreliable infrastructure is significant, and residents are not well-informed about water supply issues. Recent government efforts did not substantially improve access to potable water, affecting household cleanliness and hygiene.

This aligns with UNICEF's Urban Utility Mapping (2024), which states that only 16 out of 36 Nigerian states have functional urban water utilities operating at about 25% capacity. A study by Adeoti, Kandasamy, and Vigneswaran (2023) highlighted inadequate funding, poor stakeholder engagement, and lack of maintenance as critical issues within urban water supply systems in Nigeria. Their Predictive Iterative Sustainability Model (PISM) aims to enhance these evaluations.

The second hypothesis revealed that inadequate water supply negatively impacts environmental health. Poor infrastructure contributes to pollution and hampers sanitation and hygiene, leading to waterborne diseases in low-income areas. Families in slums frequently suffer from health issues related to poor water access, corroborating findings from Babalola,

Kehinde, and Adebayo (2025), which linked contaminants to increased disease rates. A systematic review by Agbo, Jeffrey, and Sule (2025) also confirmed that poor sanitation and water access increase pollution risks in informal settlements.

The third hypothesis found significant discrepancies between Enugu's water supply system and Sustainable Development Goal 6 (SDG 6) targets. Irregular access to safe water and issues like leaks and poor resource management hinder alignment with universal access goals. Limited resident engagement in water system planning and significant gaps in infrastructure maintenance suggest that achieving universal clean water access in Enugu by 2030 is unrealistic. A study by Olabode and Comte (2024) reported that nearly 46% of Nigeria's water infrastructure is nonfunctional, blocking progress toward SDG 6.

CONCLUSION

This study has shown that the inadequate water supply in Enugu Urban significantly affects residents' access to clean drinking water. It contributes to poor environmental health outcomes and fails to meet the targets set by Sustainable Development Goal 6. The findings indicate that the current water infrastructure is inefficient, poorly maintained, and unable to meet the growing needs of urban residents. As a result, there is an increased reliance on alternative water sources, heightened vulnerability to waterborne diseases, environmental pollution, and financial burdens for households.

Despite recent government interventions, there are still substantial gaps in infrastructure development, public engagement, and sustainability planning. Therefore, addressing these challenges requires a comprehensive, well-funded approach to water resource management that includes community involvement. This will help ensure safe, equitable, and sustainable access to water for all residents of Enugu Urban.

Based on the findings of this study, the following recommendations are proposed:

1) The government and relevant agencies should prioritize the regular and continuous rehabilitation of existing water infrastructure and invest in expanding the piped water network across Enugu Urban. This includes replacing broken pipes, improving water treatment facilities, and ensuring a consistent electricity supply to support water distribution systems. If these improvements are diligently pursued, regardless of residents' economic status, they will enhance access to safe, affordable, and reliable water, reducing dependence on unsafe alternative sources.

2) To address the lack of public awareness and participation in water-related issues, structured programs should involve urban residents in water planning, monitoring, and feedback mechanisms. Public awareness campaigns should educate citizens on water conservation, sanitation practices, and the health risks associated with contaminated water, particularly in low-income and informal settlements.

3) Policymakers should adopt and localize sustainability models, such as the Predictive Iterative Sustainability Model (PISM), to guide effective planning, funding allocation, and maintenance of water systems. Strengthening institutional capacity, ensuring stakeholder collaboration, and enforcing regulations around water quality and infrastructure maintenance are critical to aligning Enugu's urban water supply systems with the targets of Sustainable Development Goal 6 (SDG 6) and improving environmental health outcomes.

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