ID: 598

Economic Viability and Constraints of Broiler Farming in Bangladesh

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Abstract

This study examined domestic water access, water quality, environmental impacts, and associated health outcomes in Ibadan Metropolis, Nigeria. A cross-sectional survey of 450 households across urban core, peri-urban, and peripheral zones achieved a response rate of 96.8%. Quantitative analysis involved descriptive statistics and laboratory water quality assessment, while qualitative methods explored institutional and governance dynamics. Results show heavy dependence on groundwater sources, with boreholes (42.4%) and hand-dug wells (24.2%) dominating household supply. Only 18.7% reported piped water access and 21.3% experienced reliable service. Mean per capita consumption was 46.7 L/person/day, below recommended standards. Although physicochemical parameters were largely within guideline limits, nitrate exceedance occurred in 18.4% of groundwater samples, and microbial contamination was widespread. Environmental impacts included groundwater depletion (43.1%), surface water pollution (46.4%), and seasonal well failure (37.8%). Household-reported disease prevalence indicated malaria (58.2%), diarrhea (34.7%), and suspected schistosomiasis (12.4%), with higher occurrence among users of shallow wells and surface water. The findings demonstrate that reliance on self-supply groundwater combined with declining infrastructure reliability contributes to water insecurity and health risks. Integrated water management, infrastructure rehabilitation, water quality monitoring, and community health education are recommended to enhance urban water sustainability.

Key Words: *Water resources development; Domestic water use; Water quality; Public health; Urban water scarcity; Nigeria*

Introduction

Water is essential for human survival, ecosystem stability, and socio-economic development, supporting public health, food security, industrial productivity, and environmental sustainability (World Health Organization, 2022; UN-Water, 2023). However, freshwater resources remain unevenly distributed globally, with rapidly urbanizing regions experiencing increasing water stress due to population growth, infrastructure deficits, and environmental degradation (UNICEF & World Health Organization, 2023; World Bank, 2023).

Water resources development encompasses the planning and management of surface and groundwater systems to meet domestic, agricultural, and industrial demands. Contemporary governance frameworks emphasize Integrated Water Resources Management (IWRM), yet implementation remains fragmented in many developing countries (Global Water Partnership, 2021; OECD, 2023).

Nigeria's urban water sector illustrates these challenges. Rapid population growth has outpaced infrastructure expansion, leading to persistent inequalities in water access and increasing reliance on private groundwater abstraction (National Bureau of Statistics, 2022; Adebayo & Oladipo, 2024). Such patterns raise concerns regarding sustainability, environmental degradation, and public health risks, particularly in rapidly expanding cities where informal water supply systems dominate (Lapworth et al., 2021; Foster & MacDonald, 2023).

This study therefore investigates the environmental and health implications of water resources development and household water utilization in Ibadan Metropolis.

Conceptual Framework

Historically, water supply systems in Nigeria relied on rainwater harvesting and untreated surface and shallow groundwater sources. Modern infrastructure development improved coverage but failed to match urban expansion, contributing to persistent deficits. Water resources development activities such as dam construction and groundwater abstraction can alter hydrological regimes, degrade ecosystems, and create favorable conditions for disease vectors (A.S. Adeoye, personal communication, February 23, 2026). Environmental consequences include groundwater depletion, sedimentation, pollution, biodiversity loss, and land degradation. The study aligns with Sustainable Development Goals, related to health, water, sustainable cities, climate resilience, and ecosystem protection.

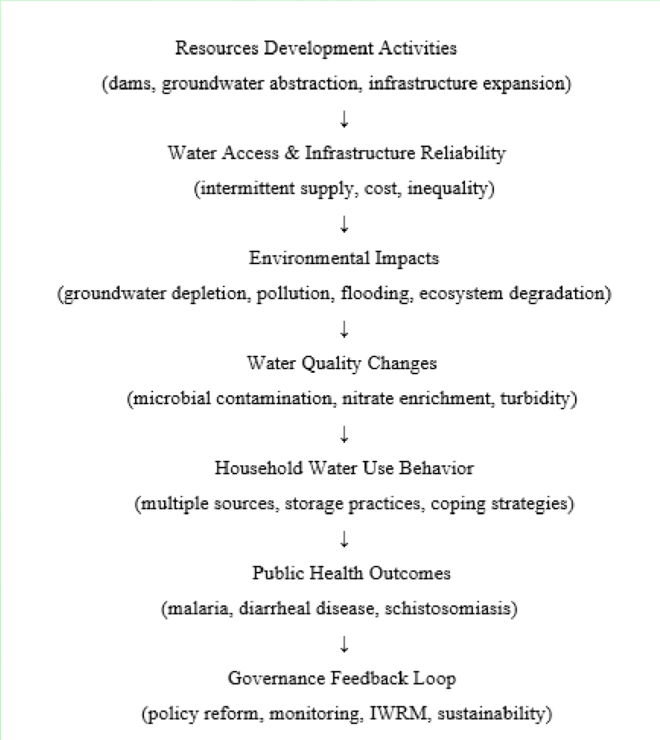

Figure 1. This framework illustrates the dynamic interactions between water development, environmental integrity, and public health vulnerability within rapidly urbanizing settings.

Methodology

Study Area

The study was conducted in Ibadan Metropolis, southwestern Nigeria, a rapidly urbanizing city characterized by a tropical wet-and-dry climate with bimodal rainfall (1,200–1,500 mm annually) and basement complex geology that influences groundwater occurrence and availability. The metropolis exhibits marked spatial inequalities in water supply infrastructure across urban core, peri-urban, and peripheral zones.

Research Design

A mixed-methods approach was adopted, integrating quantitative household surveys with qualitative institutional interviews and focus group discussions. This design enabled comprehensive assessment of domestic water utilization, water quality, governance structures, and associated environmental and public health implications.

Sampling Procedure

A multi-stage sampling technique was used. First, the metropolis was stratified into urban core, peri-urban, and peripheral zones. Communities within each zone were selected proportionately based on population size. Households were then chosen using systematic sampling. The final sample comprised 450 households, ensuring adequate representation and statistical reliability.

Data Collection

Data for the study were collected using multiple complementary methods to ensure comprehensive coverage and triangulation of findings. Structured household questionnaires were administered to obtain information on socio-demographic characteristics, sources of domestic water, utilization patterns, sanitation conditions, and self-reported health outcomes. In addition, water samples collected from wells, boreholes, piped taps, and surface water sources were subjected to laboratory analysis to determine physicochemical and microbiological quality parameters. Qualitative insights were further generated through key informant interviews conducted with stakeholders in the water supply and health sectors, as well as focus group discussions aimed at capturing community perceptions, experiences, and coping strategies related to water access and use. Secondary data were also sourced from relevant health, environmental, and water supply agencies to complement and validate primary data.

Data Analysis

Quantitative data were analyzed using descriptive statistics and spatial analysis techniques to examine variations in water access and quality across urban zones. Qualitative data were transcribed and subjected to thematic analysis. Findings were triangulated across data sources to enhance validity and reliability.

Results

Socio-Demographic Characteristics

The socio-demographic profile indicates a predominantly economically active population, with most respondents aged 26–55 years. Household size averaging 4–6 persons suggest moderate domestic water demand, while educational variation across zones reflects spatial inequality influencing water awareness and treatment practices. Higher tertiary education levels in urban core communities corresponded with greater adoption of household treatment measures and diversified water sourcing strategies, whereas peri-urban and peripheral areas exhibited stronger dependence on untreated groundwater and surface water sources.

Table 1. Socio-demographic characteristics (n = 450)

Variable	*Category*	*Frequency*	*Percentage*
Age	18–25	54	12.0
	26–40	176	39.1
	41–55	148	32.9
	>55	72	16.0
Gender	Male	238	52.9
	Female	212	47.1
Household size	1–3	98	21.8
	4–6	244	54.2
	≥7	108	24.0
Education	Primary	92	20.4
	Secondary	186	41.3
	Tertiary	172	38.2

Water Sources and Quality

Results demonstrate widespread reliance on self-supply groundwater systems. Boreholes serve as the dominant primary source (42.4%) due to perceived reliability and improved taste compared to piped supply (18.7%). However, many households utilize multiple sources simultaneously as a coping mechanism against intermittent supply. Per capita water consumption (46.7 L/day) falls below recommended standards, indicating constrained water access and potential hygiene limitations. Supply reliability emerged as the strongest determinant of water source selection, followed by affordability and proximity. Storage practices, including container storage and rooftop tanks, were prevalent, increasing risks of post-collection contamination and vector breeding.

Table 2. Household water sources

Source	*Frequency*	*Percentage*
Borehole	191	42.4
Hand-dug well	109	24.2
Piped supply	84	18.7
Surface water	43	9.6
Rainwater	23	5.1

Average consumption: 46.7 L/person/day

Physicochemical analysis shows acceptable pH and TDS levels, reflecting relatively stable hydrogeochemical conditions. However, turbidity exceedance suggests sediment transport and surface runoff contamination, particularly during rainy seasons. Elevated nitrate levels detected in groundwater samples likely reflect contamination pathways linked to onsite sanitation systems and agricultural runoff. Microbial contamination was substantial across wells and surface water sources, with E. coli detection indicating fecal pollution and inadequate protection of water sources. Spatial analysis revealed higher contamination rates in peri-urban and peripheral zones characterized by high population density, poor sanitation infrastructure, and shallow groundwater tables.

Environmental Impacts and Health Outcomes

Reported environmental impacts indicate significant pressure on urban water ecosystems. Groundwater depletion (43.1%) reflects increasing abstraction associated with borehole proliferation, while seasonal well failure (37.8%) highlights aquifer recharge limitations and climate variability effects. Surface water pollution (46.4%)

was strongly associated with urban runoff, waste disposal, and upstream agricultural activities. Flooding incidents (31.1%) were reported in areas with inadequate drainage infrastructure, contributing to sedimentation and contamination of water bodies. Vegetation loss (25.3%) and watershed degradation further reduce infiltration capacity, exacerbating hydrological instability and declining water quality. Key informants highlighted urban runoff and upstream agricultural activities as drivers of sedimentation and water quality decline.

Environmental impacts

Household-reported disease incidence showed malaria prevalence in 58.2% of households, diarrhea in 34.7%, and suspected schistosomiasis in 12.4%. Disease prevalence patterns show strong relationships between water source type and health risk exposure. This indicates households relying on surface water and shallow wells reported higher malaria and diarrheal disease prevalence due to vector breeding conditions and microbial contamination. Storage practices, intermittent supply, and environmental sanitation challenges contributed to increased exposure to water-related diseases.

Table 3. Physicochemical and microbiological characteristics

Parameter	*WHO guideline*	*Mean*	*% Exceeding*
pH	6.5–8.5	7.1	4.2
Turbidity	<5 NTU	8.4	38.7
TDS	<1000 mg/L	412	6.4
Nitrate	<50 mg/L	57.2	18.4
Total coliform	0	78 CFU/100ml	48.6
E. coli	0	41 CFU/100ml	52.0

Table 4. Water source and health outcomes

Source	Malaria (%)	Diarrhea (%)	Schistosomiasis (%)
Piped water	39.2	18.5	4.8
Borehole	54.1	29.6	9.2
Well	63.3	41.2	14.7
Surface water	71.4	56.0	28.3

Discussion

Groundwater Dependence and Urban Water Inequality

The findings highlight growing dependence on groundwater as a coping strategy for unreliable public supply, reflecting broader urban water transitions across sub-Saharan Africa characterized by decentralized self-supply systems (Foster & MacDonald, 2023; Taylor et al., 2023). While groundwater provides short-term access benefits, uncontrolled abstraction raises sustainability concerns including aquifer depletion and declining water table levels (Lapworth et al., 2021). Inequalities in water access across spatial zones illustrate structural governance challenges and infrastructure deficits disproportionately affecting peri-urban populations (World Bank, 2022; Adebayo & Oladipo, 2024).

Water Quality Degradation and Environmental Drivers

Microbial contamination aligns with evidence of fecal pollution pathways associated with high-density settlements lacking adequate sanitation infrastructure (WHO, 2022; Nkhuwa et al., 2023). Elevated nitrate levels further suggest anthropogenic contamination linked to agricultural activities and onsite sanitation systems (Xu et al., 2022). Environmental impacts of water development, including aquifer depletion and watershed degradation, reinforce the interconnected nature of water quantity and quality challenges in urban systems (FAO, 2022; UNEP, 2021).

Public Health Implications

The strong association between unsafe water sources and disease prevalence underscores the persistent burden of water-related illnesses in urban Nigeria (Prüss-Ustün et al., 2024). Malaria prevalence reflects vector proliferation linked to water storage practices and poor drainage conditions (Afrane et al., 2021), while diarrheal disease prevalence highlights microbial contamination risks associated with unsafe water sources (UNICEF & WHO, 2023). These findings support integrated approaches combining water supply improvements, sanitation interventions, and community health education.

Institutional Fragmentation and Governance Challenges

Qualitative findings indicate fragmented institutional responsibilities and weak regulatory enforcement limiting effective water resource management (Olawuyi, 2022; OECD, 2023). Insufficient monitoring of groundwater abstraction and water quality further exacerbates environmental and health risks, emphasizing the need for coordinated governance frameworks integrating environmental protection, public health, and infrastructure development.

Implications for Sustainable Urban Development

The results demonstrate that water resources development without integrated environmental and health safeguards can intensify urban vulnerability. Integrated Water Resources Management offers a strategic pathway for balancing water demand, ecosystem protection, and health outcomes (Global Water Partnership, 2021; UNESCO, 2024).

Conclusion and Recommendation

The study highlights significant inequalities in water access in Ibadan Metropolis, with heavy reliance on groundwater and surface water due to unreliable piped supply. Water quality concerns, including microbial contamination and nitrate exceedance, combined with environmental impacts such as groundwater depletion, pollution, and flooding, pose considerable public health risks.

To address these challenges, the study recommends expanding and rehabilitating piped water infrastructure, regulating groundwater abstraction, monitoring water quality, promoting household treatment and safe storage, improving sanitation and drainage, enhancing institutional coordination, and raising community awareness. Longitudinal research is also needed to inform sustainable urban water planning.

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