

Water Pollution, Waste Management, and Public Health Risks in Keffi
Local Government Area, Nasarawa State, Nigeria

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Abstract

Environmental management is a growing public health and development priority in Nigeria, where rapid urbanization and poor waste management have worsened water pollution challenges, particularly in towns like Keffi, Nasarawa State. Consequently, this study guided by the WHO-UNICEF WASH Framework and using a mixed-methods design, assessed the major sources of water pollution and the effectiveness of waste management in Keffi LGA. Findings revealed that sewage and faecal contamination from open defecation (30%), heavy metal pollution (25%), dumpsite and culvert leachates (25%), and agricultural runoff (20%) are the primary sources of water pollution. Public health risks are highest from poorly coordinated waste disposal (35%) and waterborne diseases (30%), exacerbated by inadequate sanitation infrastructure, indiscriminate dumping, and weak regulation. The study recommends improving sanitation facilities, enforcing a ban on open defecation, establishing an organized waste management system, strengthening sanitation laws, and engaging community leaders and NGOs in public sensitization to promote safer waste disposal and protect public health.

Key concepts: Environmental Health Management, Environmental Sanitation, Waste Management, and Water Pollution

Introduction

Environmental management has emerged as a critical public policy priority in developing countries, particularly amid rapid urbanization, population growth, and expanding socio-economic activities. Nigeria, like many African nations, continues to grapple with environmental degradation stemming from poor waste disposal and water pollution, which undermine public health and sustainable development efforts (Afon, 2017; Ogedengbe & Akinbile, 2004). In numerous urban and peri-urban areas, the absence of efficient waste management systems and inadequate access to clean water have intensified environmental and public health concerns.

Water is an indispensable natural resource crucial for sustaining life, agriculture, and industrial development. However, water bodies in Nigeria have become increasingly susceptible to contamination due to indiscriminate disposal of domestic, commercial, and industrial waste (WHO, 2022). Key sources of water pollution include sewage discharge, open defecation, industrial effluents, agricultural runoff, and unregulated dumping. In urban centers like Keffi Local Government Area (LGA), poor waste management practices have worsened water pollution, contaminating rivers, streams, and groundwater sources essential for public consumption (NASEPA, 2023).

Keffi, a rapidly growing town in Nasarawa State and a gateway to Nigeria's Federal Capital Territory, Abuja, has experienced significant population growth in recent years. This demographic expansion has increased solid waste generation and placed immense strain on the area's already limited waste management infrastructure (Abubakar & Dogo, 2019). The widespread practice of indiscriminate refuse disposal, the proliferation of

illegal dumpsites, and the blockage of drainage systems have compounded water contamination problems and created severe environmental hazards.

The health implications of these conditions are substantial. Waterborne diseases such as cholera, typhoid, and dysentery remain prevalent, especially during the rainy season when floods spread contaminants into residential areas and water sources (WHO, 2022). In addition to public health risks, inadequate waste management has led to increased disease vectors, environmental hazards, and the deterioration of the area's urban landscape (Ogedengbe & Akinbile, 2004).

While environmental regulatory agencies such as the Nasarawa State Environmental Protection Agency (NASEPA) and national environmental laws are tasked with addressing these challenges, enforcement and policy implementation remain weak in Keffi. Factors such as insufficient funding, logistical difficulties, limited community participation, and public apathy have hindered effective environmental sanitation and water resource protection (Afon, 2017). Furthermore, the scarcity of contemporary empirical studies focused specifically on water pollution and waste management practices in Keffi has limited the availability of evidence-based data for policy formulation and targeted interventions. Against this backdrop, the study seeks to assess the major sources of water pollution and evaluate the effectiveness of waste management practices and their implications for public health in Keffi Local Government Area, Nasarawa State.

Statement of the Problem

Environmental degradation, particularly in the form of water pollution and poor waste management, has become a significant public health and developmental concern in

Nigeria. In Keffi Local Government Area (LGA) of Nasarawa State, the problem has been exacerbated by rapid urbanization, increasing population growth, and expanding socio-economic activities. These dynamics have led to a surge in solid and liquid waste generation, overwhelming the town's waste management infrastructure, which remains largely inadequate and poorly maintained (Abubakar & Dogo, 2019). The prevalent practices of indiscriminate waste disposal, proliferation of illegal dumpsites, and blocked drainage systems have contributed significantly to the contamination of water sources, threatening both environmental quality and public health (Nasarawa State Environmental Protection Agency [NASEPA], 2023).

Water pollution in Keffi is primarily linked to the unchecked disposal of domestic sewage, agricultural runoff, industrial effluents, and unregulated dumping of refuse into water bodies. These pollutants have rendered rivers, streams, and groundwater sources unsafe for domestic use, exposing residents to recurrent outbreaks of waterborne diseases such as cholera, typhoid, and dysentery. This public health challenge intensifies during the rainy season when floods carry pollutants into residential areas and water supply systems (World Health Organization [WHO], 2022). Additionally, the accumulation of unmanaged waste contributes to the spread of disease vectors and degrades the aesthetic and ecological integrity of the urban environment (Ogedengbe & Akinbile, 2004).

Although environmental regulatory frameworks, including the operations of NASEPA and national environmental laws, are designed to address these hazards, enforcement in Keffi remains weak and inconsistent. Multiple challenges, such as inadequate funding, poor logistics, insufficient technical manpower, weak institutional capacity, and low

public awareness and participation, continue to undermine efforts toward effective environmental sanitation and water resource management (Afon, 2017). Consequently, existing interventions have failed to sustainably mitigate the escalating health and environmental risks posed by water pollution and poor waste management in the area.

Moreover, a noticeable gap exists in contemporary empirical studies specifically addressing the magnitude of water pollution and waste management practices in Keffi. The limited availability of localized, evidence-based data has restricted policymakers and environmental managers from formulating effective, context-specific interventions (Abubakar & Dogo, 2019). It is within this context that the present study is undertaken to investigate the sources of water pollution, assess the associated environmental and health impacts, and evaluate the effectiveness of current waste management practices in Keffi LGA. The study aims to assess the major sources of water pollution and evaluate the effectiveness of waste management and their implications for public health in Keffi Local Government Area, Nasarawa State.

Conceptual Review

Water Pollution

Water pollution refers to the contamination of water bodies such as rivers, lakes, and groundwater through the introduction of harmful substances that degrade water quality and render it unsafe for human, agricultural, industrial, and ecological use (WHO, 2022). Ogedengbe and Akinbile (2004) further describe it as the alteration of water's physical, chemical, or biological properties by waste materials, making it unfit for its intended purposes. Both definitions emphasize the environmental and health hazards associated

with polluted water sources. However, while WHO's definition highlights the sources and outcomes of contamination, it underrepresents the socio-economic and governance-related factors contributing to water pollution in urban settings like Keffi. Similarly, Ogedengbe and Akinbile (2004) adopt a broad environmental lens but overlook specific local practices such as indiscriminate dumping and open defecation, which are prevalent contributors to water pollution in peri-urban Nigerian towns. This study adopts a context-specific approach by interrogating these operational and governance gaps in existing definitions.

Sources and Causes of Water Pollution

Adeniran et al., (2020) They stated that, water pollution in urbanizing areas like Keffi Local Government Area is primarily driven by unregulated human activities and poor environmental management practices. Major sources include the indiscriminate disposal of domestic waste, agricultural runoff, and effluents from small-scale industries, which discharge untreated waste into nearby rivers, streams, and open drains. In areas with inadequate waste collection systems, households and market centers often rely on nearby water bodies as dumping grounds for solid and liquid wastes. Additionally, the use of chemical fertilizers and pesticides in farming communities contributes to nutrient loading in surface water, leading to eutrophication and deterioration of water quality (Olalekan et al., 2019). Open defecation and poorly constructed pit latrines near water sources further increase microbial contamination, posing severe health risks such as cholera, typhoid, and diarrhea outbreaks in Keffi LGA (World Health Organization [WHO], 2023).

Implications of Water Pollution for Public Health

Abubakar & Dibal,(2021) The persistent contamination of water sources in Keffi LGA has significant public health consequences, particularly for vulnerable groups such as children, pregnant women, and the elderly. Residents depending on polluted surface and groundwater for drinking, cooking, and personal hygiene face heightened exposure to waterborne diseases. According to the World Health Organization, contaminated water contributes to over 485,000 diarrheal deaths annually worldwide (WHO, 2023), a risk evident in Keffi's recurring cases of water-related illnesses. Furthermore, exposure to chemical pollutants like heavy metals and pesticides from agricultural runoff can lead to chronic health conditions such as cancer, neurological disorders, and reproductive complications. The inadequacy of potable water infrastructure, coupled with weak regulatory enforcement on waste disposal and environmental sanitation, exacerbates these health risks and undermines the overall well-being of communities in the area (Odipe et al., 2022).

Waste Management

Waste management is broadly understood as the process of collecting, transporting, processing, recycling, and disposing of waste in ways that reduce adverse health and environmental effects (Afon, 2017). Abubakar and Dogo (2019) expand this view by defining it as a systematic process involving the regulation, control, and treatment of waste from generation to final disposal, aimed at minimizing environmental hazards and protecting public health. Both definitions accurately outline the technical operations of waste management. However, Afon's definition neglects the institutional and participatory aspects vital for effective implementation in rapidly growing urban centers

like Keffi, while Abubakar and Dogo (2019) focus predominantly on regulatory processes without acknowledging the influence of social behaviors, public awareness, and community engagement on waste disposal practices. This study builds on these gaps by exploring both technical and socio-cultural dimensions of waste management within the Keffi context.

Waste Management Practices and Environmental Impact

Waste management practices in Keffi Local Government Area remain largely inefficient and uncoordinated, contributing significantly to environmental degradation. The absence of structured waste collection systems has led to the proliferation of illegal dumpsites in residential areas, markets, and along roadsides. Most households and business operators engage in open dumping and indiscriminate burning of refuse, which releases harmful gases like carbon monoxide and methane into the atmosphere, contributing to air pollution and climate change (Olalekan et al., 2019). Additionally, uncollected waste often clogs drainages and waterways, especially during the rainy season, leading to flooding and contamination of surface water sources. The limited capacity of local authorities to enforce waste management regulations and provide adequate disposal facilities exacerbates the situation, leaving communities vulnerable to environmental hazards and associated health risks.

Implications of Poor Waste Management for Public Health

The failure of effective waste management systems in Keffi has direct implications for public health, with an increase in disease prevalence and sanitation-related illnesses. The accumulation of decomposing waste provides breeding grounds for disease vectors such

as mosquitoes, flies, and rodents, which are responsible for the spread of malaria, cholera, typhoid fever, and respiratory infections (Adeniran et al., 2020). Additionally, exposure to smoke from burning refuse introduces toxic substances into the air, contributing to respiratory problems, particularly among children and the elderly. The presence of unmanaged waste in public spaces also affects mental well-being and community aesthetics, lowering the overall quality of life. Without urgent investment in modern waste management infrastructure and public health education campaigns, Keffi LGA risks experiencing worsening environmental health crises.

Empirical Review

The Major Sources of Water Pollution

Olalekan (2020), in his study *Environmental Sanitation and Public Health in Nigeria: A Review*, applied the Environmental Public Health Model and conducted a content analysis of government reports, policy documents, and public health data from 2000 to 2019. The study identified weak policy implementation, ineffective waste disposal systems, and inadequate public health education as key factors contributing to persistent environmental health problems in Nigeria. These challenges, according to the findings, have resulted in recurring outbreaks of cholera and the spread of vector-borne diseases in both urban and rural settings. Olalekan recommended stricter enforcement of sanitation laws, grassroots-driven sanitation initiatives, and expanded public health education campaigns to address these risks.

While this study provides valuable insights into the systemic issues affecting environmental sanitation in Nigeria, it is limited by its exclusive reliance on secondary data, which may overlook current, on-the-ground realities and community-level

experiences. Additionally, although the recommendations are relevant, the study did not propose clear, context-sensitive strategies for implementing these measures, particularly within Nigeria's institutionally weak and resource-constrained environment. A more inclusive research approach incorporating primary field data would have strengthened the study's practical applicability, especially in peri-urban towns like Keffi, where local practices and community dynamics significantly influence sanitation outcomes.

Effect of Waste Management and its Implications to Public Health

Obeta (2019), in his work *Water Supply and Sanitation Services in Nigeria: An Overview of Challenges and Prospects*, contributed to understanding public health risks associated with water and sanitation systems in Nigeria. Adopting the Water-Sanitation-Health (WASH) Framework, the study reviewed policy documents, WHO/UNICEF Joint Monitoring Programme reports, and government publications over nearly three decades. It found that frequent outbreaks of waterborne diseases such as cholera, dysentery, and typhoid are closely linked to poor sanitation infrastructure, unregulated waste disposal, and limited access to safe water, particularly in urban slums and rural communities. The study also highlighted systemic issues like outdated infrastructure, weak institutional coordination, and chronic underinvestment in water and sanitation services as underlying causes of these vulnerabilities.

Obeta recommended a multi-pronged strategy involving the rehabilitation of public sanitation facilities, implementation of integrated WASH programs, improved water governance, and increased funding for the sector. However, the study's reliance on secondary data without supporting primary fieldwork limits its depth, as it potentially

overlooks local waste disposal behaviors, informal water supply arrangements, and indigenous coping strategies common in underserved areas. Furthermore, while the recommendations rightly emphasize infrastructural and governance reforms, the study did not sufficiently address socio-cultural and behavioral factors influencing water use and sanitation habits, which are critical for sustainable public health outcomes. It also fell short of interrogating the entrenched political and bureaucratic obstacles historically impeding WASH program implementation in Nigeria.

In summary, while both Olalekan (2020) and Obeta (2019) provide important perspectives on environmental sanitation and water management challenges in Nigeria, their methodological limitations point to a need for localized, community-based empirical studies. Bridging this gap through mixed-methods research that combines policy analysis, public health data, and community-level inquiry is essential for developing context-specific, actionable solutions. This is particularly relevant in peri-urban areas like Keffi, where environmental health challenges are shaped not only by infrastructural deficiencies but also by socio-cultural practices, governance structures, and levels of public awareness.

Theoretical Framework

This study is anchored on the Water-Sanitation-Health (WASH) Framework, an internationally recognized model developed by the World Health Organization (WHO) and UNICEF's Joint Monitoring Programme (JMP) in the early 2000s. The framework was introduced to address evidence showing that access to safe water, adequate sanitation, and proper hygiene practices are essential determinants of public health in low- and middle-income countries. It offers a structured model for examining how

deficiencies in water and sanitation services contribute to the spread of waterborne and sanitation-related diseases.

The WASH Framework assumes that safe drinking water, effective sanitation infrastructure, and hygiene practices are interdependent and that health risks increase when any of these services is lacking. It advocates integrated, multi-sectoral interventions that simultaneously address water quality, sanitation, and hygiene behavior, making it highly relevant for investigating water pollution, poor waste management, and recurring disease outbreaks such as cholera and typhoid in Nigeria. However, the framework has faced criticism for being overly focused on infrastructure and service delivery, often overlooking socio-political, economic, and cultural factors influencing water and sanitation access. It also tends to favor top-down, technocratic approaches, sometimes neglecting community participation and informal coping systems, which are crucial for sustainable outcomes. These limitations suggest the need to complement WASH with additional perspectives like the Social Determinants of Health (SDH) Theory to capture broader structural and behavioral influences on public health.

Table 1.1 major sources of water pollution in Keffi Local government Area (LGA), Nasarawa State

Variable	Frequency	Percentage
Heavy-metal contamination from petroleum and agricultural runoff	115	30
Sewage and faecal contamination from open defecation and poor sanitation	89	25
Dumpsite and culvert leachate polluting streams	107	25
Agricultural and soil runoff carrying agrochemical residues	75	20
Total	386	100

Source: Field Survey 2025

The analysis of respondents' views on the major sources of water pollution in Keffi Local Government Area reveals that sewage and faecal contamination from open defecation and poor sanitation is the leading contributor, accounting for 30% of pollution cases. This is largely due to inadequate toilet facilities, leaking soakaways, and indiscriminate

disposal of human waste. Heavy metal contamination from petroleum spills, vehicle emissions, and agricultural runoff contributes 25%, as harmful substances such as lead, cadmium, and iron enter water bodies through soil and surface runoff. Similarly, dumpsite and culvert leachate polluting streams also accounts for 25%, with illegal dumping of household refuse, animal waste, and plastics into open drains and waterways exacerbating water quality problems. Lastly, agricultural and soil runoff carrying agrochemical residues makes up 20% of the pollution, as fertilizers, pesticides, and organic waste are washed into rivers and wells, particularly during the rainy season. These findings highlight the multifaceted nature of water pollution in Keffi, driven by a combination of poor waste management, inadequate sanitation infrastructure, and unregulated environmental practices.

On the other way interview with a local Environmental Health Officer and people in the community in Keffi LGA.

In an interview with a local Environmental Health Officer in Keffi LGA, the officer identified sewage and faecal contamination from open defecation and poorly maintained soakaways as the leading cause of water pollution in the area. He noted that during the rainy season, faecal matter often washes into streams and wells, posing serious public health risks. The officer also highlighted heavy metal contamination from petroleum spills, mechanical workshops, and agricultural runoff as a significant contributor. Dumpsite and culvert leachates were cited as another major source, with refuse and animal waste dumped into drains and streams like Rafin Kongo and Rafin Dutse, leading to blocked waterways and polluted water sources. Additionally, agricultural runoff containing fertilizers and pesticides contributes to chemical pollution, especially during floods. The officer recommended improved sanitation infrastructure, stricter waste disposal regulation, and increased community awareness initiatives to address these challenges sustainably.

Table 1.2 the effectiveness of waste management and their implications for public health in Keffi LGA.

Variable	frequency	Percentage
Poorly coordinated and informal waste disposal practices	107	35
Increased public health risks from waterborne diseases	97	30
Proliferation of disease vectors due to accumulated waste	115	20
Weak enforcement of environmental sanitation regulations	67	15
Total	386	100

Source: Field survey 2025

The analysis of waste management effectiveness and its public health implications in Keffi LGA reveals that increased public health risks from waterborne diseases represent the most significant challenge, accounting for 35% of the overall problem. This is closely followed by poorly coordinated and informal waste disposal practices, which contribute 30%, largely due to the absence of structured waste collection services and widespread open dumping. The proliferation of disease vectors such as mosquitoes, flies, and rodents accounts for 20%, driven by accumulated refuse and blocked drainage systems that create ideal breeding grounds for vectors. Lastly, weak enforcement of environmental sanitation regulations contributes 15% to the problem, as limited resources, poor public awareness, and inconsistent policy implementation continue to undermine efforts at controlling waste and protecting public health in the area.

On the contrary the interviews with the respondents responds to major sources of water pollution in Keffi Local Government Area (LGA), Nasarawa State.

In an interview with an Environmental Health Officer in Keffi LGA, the officer identified **frequent waterborne disease outbreaks**, contributing about **35%** of the area’s environmental health problems, as the most pressing challenge, largely caused by contaminated water from poor waste disposal. He explained that **informal and poorly coordinated waste disposal practices**, accounting for **30%**, are widespread due to the absence of an organized waste management system, with refuse often dumped into open drains and culverts. Additionally, the **proliferation of disease vectors** such as mosquitoes, flies, and rodents, responsible

for around **20%** of public health risks, was linked to accumulated waste and blocked drainages. Finally, the officer highlighted that **weak enforcement of sanitation regulations**, contributing **15%**, continues to undermine effective waste management efforts, as environmental agencies struggle with limited resources and low public compliance.

Findings

- I The leading sources of water pollution in Keffi LGA are sewage and faecal contamination from open defecation and poor sanitation (30%), followed by heavy metal contamination (25%), dumpsite and culvert leachates (25%), and agricultural runoff (20%).

This indicates that inadequate sanitation infrastructure, indiscriminate waste disposal, and unregulated agricultural and mechanical practices are collectively driving the water quality crisis in the area.

- ii Poorly coordinated and informal waste disposal practices account for the highest public health risk in Keffi LGA at 35%, followed closely by increased public health risks from waterborne diseases (30%). This reflects how unmanaged refuse disposal directly escalates disease outbreaks, creates breeding grounds for vectors, and compromises water safety, especially during rainy seasons.

Recommendations

- i. Government should improve sanitation infrastructure and expand access to modern toilet facilities while enforcing a strict ban on open defecation. This should be complemented by community-based sensitization campaigns targeting

safe hygiene and sanitation practices to significantly reduce sewage-related water pollution.

- ii Government should Strengthen waste management regulations by establishing an organized, government-led waste collection and disposal system, coupled with stricter enforcement of environmental sanitation laws. Additionally, increase resource allocation to NASEPA and involve community leaders and NGOs in public awareness initiatives to promote collective responsibility for waste control and environmental protection.

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