# Wastewater Management in Africa: Challenges and Recommendations

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**ABSTRACT:** In Africa, the growing population and industrial growth have resulted in a notable increase in wastewater generation, affecting the quality of water in the region. Wastewater treatment plays a crucial role in safeguarding the environment, public health, aquatic organisms, and water resources, reducing environmental impact, and adhering to regulations. However, the current methods for treating wastewater in Africa fall short of these goals, resulting in substantially poor environmental and health outcomes and inadequate provision of safe water and essential sanitation. Poor wastewater management in several African countries has led to severe health risks for humans, animals, and aquatic ecosystems. This poses a particular threat to vulnerable groups like children, women, and the disabled residing in rural and remote areas with limited access to healthcare. Hence, this article aims to shine a spotlight on the difficulties in managing wastewater in Africa and to recommend several plausible strategies to tackle this issue. A literature search to find the most recent and relevant research papers from various databases, such as Scopus, Web of Science, PubMed, and Google Scholar, along with resources from the World Health Organization, was conducted. The selection criteria focused on including the most recent and relevant publications published in English to facilitate comprehension, analysis, and interpretation of the secondary data. Essentially, addressing the challenge of wastewater management in Africa requires developing indigenous innovative technologies, transitioning to a sustainable economy, establishing wastewater treatment infrastructures in rural and remote areas, enhancing operation and maintenance practices, training treatment facility workers, improving electricity supply, strengthening government participation and support, encouraging public involvement, setting local water quality benchmarks, and international financial and technical support. By tackling the problem of insufficient wastewater treatment in Africa, it is possible to achieve Sustainable Development Goal 6, which centers on ensuring clean water and sanitation for all.

**KEYWORDS:** Africa, wastewater treatment, water pollution

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## Introduction

Access to clean and safe water is a fundamental necessity for many countries worldwide, including Africa.[1] Water pollution and scarcity are pressing issues confronting humanity globally.[2] Factors such as industrialization, population growth, and inadequate wastewater treatment, among others, are responsible for this crisis.[3] The practice of discharging untreated wastewater into the environment continues to persist in developing countries despite advancements in wastewater treatment.[4]

The continuous generation of wastewater from human activities has led to a significant accumulation of untreated sewage in the environment.[5] According to WWAP,[6] 90% of the wastewater generated globally is discharged into the environment without any prior treatment. Many African countries particularly struggle with this issue, often disposing of wastewater and sewage indiscriminately. This uncontrolled discharge of untreated wastewater is a major contributor to the high levels of environmental pollution and degradation experienced in these regions.[7] The primary sources of water pollution in Africa include agricultural runoff, municipal wastewater, hospital effluent, industrial discharge, and urban stormwater drainage.[8]

In Africa, efforts to enhance water quality, including wastewater treatment, are falling behind urbanization and population growth due to several challenges the region faces.[9,10] According to Onu et al.,[4] the quality of Africa's water resources will degrade further in the coming years. Unless immediate steps are taken to effectively manage the wastewater that is produced,[4] this degradation will make disease burdens worse, including the rise in vector-borne diseases like malaria and waterborne diseases like cholera and dysentery. It will also pose more threats to public health and the environment.

The increasing global water scarcity and pollution, particularly from improper sewage discharge, highlight the need for African countries to address the challenges in wastewater management. This includes shifting from the current linear wastewater treatment approach, which prioritizes disposal, to a circular economy model that emphasizes recovery, wastewater reuse, and maximizing wastewater efficiency through recycling.[10] This shift is essential for achieving sustainability. Sustainable development and effective water resource management play pivotal roles in the transformation toward a sustainable circular wastewater management system.[10]

The increasing need for safe and affordable clean drinking water on a global scale has made it imperative to implement effective wastewater management and recycling practices.[2] This is essential to address environmental pollution and prevent the anticipated wastewater crisis in Africa. Wastewater treatment is crucial for ensuring access to clean and potable water, including achieving Millenium Development Goals.[11,12] For instance, considering that the burden of water collection

falls disproportionately on girls and women, improving wastewater treatment is crucial for promoting gender equality and empowering women (Goal 3).[13] Improving water quality can lower child mortality. Consequently, improving wastewater treatment systems is critical for achieving Goal 4, which targets reducing child mortality rates.[14]

It is critical to highlight the key challenges African nations face in wastewater treatment and establish suitable strategies, including regulations, for wastewater management to ensure access to safe and clean water in Africa. This article aims to shed light on the key challenges that African countries face in managing wastewater. Several sustainable strategies for enhancing wastewater management are recommended to mitigate the adverse effects of inadequately treated wastewater on public health and the environment while also fostering access to safe and clean water.

## Challenges of Wastewater Management in Africa

In many African nations, inefficient wastewater management arises from the significant challenges that the region faces. The following are some of the challenges faced by several countries in Africa regarding wastewater management:

The prevalence of insufficient sewer treatment facilities in many African nations poses a significant challenge to wastewater treatment.[8] For instance, Addis Ababa, the capital of Ethiopia, directs less than 3% of its wastewater to treatment facilities. The Kaliti treatment plant, initially designed to serve a population of 50 000 in 1982, was only catering to 13 000 individuals after nearly three decades of operation in Addis Ababa. The limited connections from households to the municipal sewerage network account for this disparity. Moreover, in Kenya's Kisumu district, malfunctioning pump stations cause sewage overflow at access points located upstream of the pump stations, resulting in the direct discharge of sewage into Lake Victoria.[14] Meanwhile, in Bamako, Mali, there is a lack of sewer networks, with nearly 80% of the population relying on on-site sanitation facilities due to the difficulties in acquiring treatment sites.[15] Furthermore, Rwanda's city of Kigali lacks a central sewer network or a centralized sewage treatment plant.[16] The most common methods of sewage disposal in the city are septic tanks with soak-away pits and pit latrines, with only a few semi-centralized sewage treatment plants in isolated areas.[17]

In addition to limited treatment facilities, wastewater quality monitoring is frequently inadequate in many African nations.[18] Many laboratories in wastewater treatment facilities only monitor a limited number of parameters,[8] primarily due to a lack of effective monitoring systems. For example, in Kampala, Uganda, the absence of an efficient monitoring system makes monitoring and regulating wastewater discharge from industries challenging.[8]

Inadequate water resource distribution, poor government policies, and a lack of institutions hinder progress toward Sustainable Development Goals related to wastewater management in many African countries. In Libya, for instance, the existing sewage treatment plants in cities like Tobruk produce suitable effluent, but poor government planning and mismanagement of wastewater contribute to the overall inefficiency of the treatment process.[19] Moreover, the lack of clear criteria for targeting water supply and sanitation sector performance, as well as weak enforcement of existing laws, further exacerbate the challenges faced in wastewater treatment in Libya.[20]

Financial constraints present significant obstacles to enhancing treatment facilities and procuring efficient monitoring equipment in existing treatment plants across Africa.[8] Hence, this hinders the modernization and optimization of wastewater treatment processes, impacting the overall effectiveness and efficiency of the systems in the region. For example, in Nairobi, Kenya, the reliance on a jar tester dating back to 1938 persists due to limited financial resources for necessary upgrades.[8] Factors such as insufficient financial resources, weak regulatory enforcement, and ineffective governance significantly worsen the challenges of waste handling, including wastewater management, in Cameroon.[21]

Urban areas often serve as the primary location for water treatment plants, including wastewater treatment facilities, in many African countries. The concentration of wastewater treatment facilities primarily in urban areas poses a significant obstacle to effective wastewater management, as the development of water treatment infrastructure, including wastewater treatment systems, often neglects rural and hard-to-reach areas for adequate water management. As a result, this often leads to significant contamination and pollution of water bodies in these regions. In Libya, for example, the concentration of water supply and sanitation activities in urban areas, where 89% of the population resides, puts rural areas at a disadvantage, impacting the planning, implementation, and management of water supply and sanitation in those underserved communities.[22]

Unreliable power supplies significantly hinder wastewater treatment efforts across several African countries.[9] Consequently, many treatment plants struggle to operate effectively due to a lack of constant electricity, resulting in insufficient wastewater treatment in the region.[10] In Nigeria, for instance, unpredictable power supply is a major impediment to wastewater recovery, second only to the enormous capital expenditure required for the process.[23]

Water treatment plants in several African nations face another challenge in wastewater management: determining the correct dosage of coagulants, particularly when dealing with fluctuating turbidity levels.[9] For instance, in Nairobi, the turbidity of raw water can spike to 5000 nephelometric turbidity units during the rainy season due to soil erosion upstream, while dropping to less than 10 nephelometric turbidity units in the dry season.[9] The variability in turbidity levels complicates the task of dosing coagulants for operators at these facilities.[8]

Many African regions often neglect disinfection, a critical step in wastewater treatment processes.[8] Treated effluent is commonly discharged directly into water bodies without proper disinfection, posing health risks to aquatic life, humans, and livestock, who rely on these water sources for various purposes.[24,25] More containment has shown that many wastewater treatment plants in South Africa keep dumping effluent into bodies of water that contain high levels of enteric pathogens like *Vibrio* genus. This makes the water bodies worse and poses a big health risk to the public.[26-30] Meanwhile, at the Dandora plant, effluent flows into the Nairobi River, where livestock drink contaminated water,[8] presenting a serious threat to the health of humans, animals, and aquatic organisms in the region. The foremost environmental challenges facing urban centers in Sudan include the lack of adequate wastewater treatment facilities, including inefficient disinfection of wastewater. The high prevalence of waterborne diseases, accounting for 80% of reported illnesses in the country, directly links to this deficiency in environmental sanitation.[31]

The lack of public engagement in wastewater treatment policies and participation in many African nations also acts as a significant barrier to efficient water treatment, including wastewater management, in the region. The primary cause of this is the lack of public awareness and education about wastewater treatment, along with its potential impact on human health, the environment, and aquatic organisms. According to Thebe and Mangore,[32] Egypt's wastewater treatment systems face one major challenge: low public awareness in the country.

In many African nations, the lack of adequate resources and maintenance of water treatment facilities limits efficient wastewater treatment. For example, in Zimbabwe, despite the fact that there are 137 wastewater treatment plants, the country still faces significant challenges in wastewater treatment. According to Graham Sustainability Institute University of Michigan,[33] the primary constraint to effective wastewater treatment in urban centers in Zimbabwe is the lack of financial resources to upgrade and overhaul the old wastewater collection and treatment facilities. Moreover, wastewater treatment in Gabon faces significant challenges due to intermittent water supplies, a lack of sanitation infrastructure to separate waste from drinking water, and inadequate wastewater and rainwater networks.[34] Additionally, the lack of an integrated system for managing hazardous and toxic waste results in a lack of cooperation among stakeholders in Botswana.[4] Inadequate distribution of water resources, poor government policies, and insufficient institutions for wastewater remediation further aggravate this lack of cooperation.[35]

The fragmentation of responsibilities across several ministries, as well as the lack of clearly defined roles and incentives for efficient coordination within the water management sector, also serve as significant challenges that many African countries face in managing wastewater. The Democratic Republic of Congo (DRC), for instance, faces significant challenges in wastewater treatment despite having over 50% of the African continent's water reserves.[36] The DRC's water sector is highly centralized, yet multiple ministries and organizations fragment the responsibilities for water management, including wastewater handling. This fragmentation of responsibilities, coupled with a lack of clearly defined roles and incentives for effective coordination, has hindered the efficient management of water, including wastewater, in the country.[37] The lack of access to clean water in the DRC contributes to the increasing prevalence of disease and malnutrition, highlighting the urgent need for improved water treatment processes in the country.[38]

Inadequate management and a shortage of skilled and experienced technical personnel also pose significant obstacles to effective wastewater management in Africa. Ineffective management and a lack of skilled and experienced technical staff in South Africa have led to the inability to address failures in municipal water services.[39]

The barriers faced by several African nations in wastewater management often result in an increasing incidence of pollution and contamination of water bodies by pathogenic microorganisms, such as pathogenic bacteria, viruses, and parasites. Hence, it is crucial to highlight the health implications of a lack of proper wastewater management in Africa.

## Health Implications of Inadequate Wastewater Management in Africa

Inadequate wastewater treatment facilities pose significant health implications for human populations, biodiversity, and the environment. In several African nations, the lack of proper wastewater management and sanitation infrastructure has resulted in infections from waterborne pathogens, which typically originate from inadequately treated wastewater discharged into the environment. Consequently, there is an outbreak of waterborne diseases such as cholera, hepatitis A, diarrhea, and typhoid, among others, leading to health crises related to water contamination.[39] For instance, studies in the Eastern Cape Province of South Africa have identified potentially pathogenic organisms in the microbiological quality of wastewater treatment plant effluents, posing a serious health risk to communities.[40] Moreover, studies have shown that the discharge of inadequately treated effluents from wastewater treatment facilities negatively impacts the physico-chemical characteristics of the receiving watersheds, underscoring the health risks linked to inadequate wastewater treatment.[41] This health consequence is particularly concerning for vulnerable populations, such as children, women, and the disabled, who live in rural and remote regions where access to healthcare facilities is inadequate. The health of wastewater treatment plant workers is also at risk due to the potential risks associated with wastewater effluents. The presence of antibiotic-resistant *Vibrio* strains in wastewater final effluents in rural communities in the Eastern Cape Province of South Africa raises concerns about the potential health risks faced by wastewater treatment plant workers.[42]

Also, the profiling of bacterial diversity in wastewater treatment plants in several African countries, including South Africa, has revealed the significant abundance of bacterial pathogens in these systems, emphasizing the potential health risks faced by workers in wastewater treatment facilities.[43] The occurrence of specific heavy metals, such as arsenic, nickel, lead, zinc, and cadmium, in wastewater at levels surpassing the recommended thresholds also underscores the substantial health hazards that wastewater treatment plant workers may confront. This is due to the potential for exposure to these metals to lead to moderate-to-severe adverse health effects in individuals.[44] Moreover, the potential exposure of wastewater treatment plant workers to respiratory and enteric bacterial pathogens in South Africa[45] serves as an indicator of the potential health implications faced by personnel in wastewater treatment facilities across Africa.

Given the substantial public health implications of wastewater treatment for humans, animals, and the ecosystem in Africa, it is imperative to address the significant obstacles that African countries encounter in achieving effective wastewater treatment. Addressing the health risks associated with improper wastewater management in Africa is crucial to ensuring the well-being of the population, especially those who rely on water sources containing inadequately treated wastewater for their livelihoods and daily use. The implementation of comprehensive measures to ensure the protection of the health and safety of wastewater treatment plant workers is also essential.

## The Way Forward

To address the challenges encountered by African countries in managing wastewater effectively and to achieve Sustainable Development Goal 6 (clean water and sanitation), which is crucial for the achievement of the 2030 Sustainable Development Program, which seeks to eradicate severe poverty and safeguard the environment,[46] the following strategies are recommended:

African nations should implement innovative and cost-effective technologies to enhance the water sector, including wastewater treatment processes. Governments in Africa should ensure sustainable and sufficient investments in research focused on developing local technologies in the water sector,[47] including wastewater treatment, and ensuring that they adhere to international standards. These technologies should be good at stopping algae growth, use little energy, come up with cheap ways to clean up on-site, combine pond systems with biological treatment methods, use constructed wetland systems, make sure that wastewater is properly disinfected, and make it easier to clean up groundwater.[8] The use of agricultural biomass as a substance for capturing and facilitating chemical reactions in wastewater treatment is one promising avenue for exploration. The growing interest in using agricultural biomass and waste as an adsorbent and catalyst in wastewater treatment stems from its distinctive chemical composition, widespread availability, cost-effectiveness, and renewable nature.[48] Agricultural waste usually has lignin, hemicellulose, and cellulose as its main polymers.[49] The lignin polymer also has polar organic functional groups like ether, phenolic, carboxylic, ketones, aldehydes, and alcohols.[49] These organic functional groups possess the capability to capture wastewater contaminants through multiple binding mechanisms.[50,51]

The products of wastewater treatment, including sewage, can be of immense benefit in agriculture, especially as a valuable source of nutrients and irrigation,[52] provided they meet the applicable limits required by regulations. A study that looked at the environmental impact of using sewage from wastewater treatment plants in agriculture found that most of the heavy metals in the sewage sludge were in a stable form, which made it less likely that they would move into crops even though they were present in high concentrations.[53] As a result, it is critical to establish robust monitoring systems to ensure that wastewater treatment adheres consistently to regulatory standards, thereby facilitating their safe and effective utilization, including in agriculture.

Furthermore, regular training should improve the skills of personnel working in treatment facilities and keep them up-to-date on the latest technologies used in operating and maintaining wastewater treatment facilities, as inadequate expertise could compromise the functionality of such plants.

In addition, African countries must transition from reactive end-of-pipe water pollution control methods to proactive pollution prevention strategies.[8] Embracing a green economy and adopting cleaner production practices can help reduce wastewater discharge and promote resource recycling from wastewater.[54] The concept of circular economy involves reusing or recycling waste materials discarded within the economy to minimize the need for resource harvesting and consequently decrease environmental deterioration.[55] Implementing a green economy not only mitigates human activities' environmental impact on ecosystems but also contributes to water quality conservation and preservation.[9]

To address the lack of reliable energy supply systems, which are vital for wastewater treatment in Africa, the development and adoption of alternative energy sources, such as solar power, is crucial.[8] Furthermore, using wastewater or waste sludge to generate energy presents another viable option.[8] This approach not only enhances electricity access but also promotes sustainable energy practices in the wastewater treatment process.

Inadequate government support in the water sector leads to poor water quality. Politicians typically lack the political will to prioritize water and wastewater treatment, as these issues are not considered politically advantageous.[8] Establishing effective governance with an improved mechanism and institutional framework is crucial to overcoming the lack of political will and commitment toward wastewater treatment in Africa.[8] Moreover, enhancements in managing drinking water quality, wastewater discharge, and solid waste disposal are imperative. Therefore, regulatory authorities should enact legislation and

regulations mandating industries to set up on-site pre-treatment facilities.[8]

Many African nations adhere to the WHO guidelines for drinking water quality. However, inadequate monitoring tools, the lack of qualified laboratory personnel, and the absence of well-equipped laboratories in wastewater treatment facilities significantly contribute to substandard water quality control in the region.[8] Hence, African countries must invest in continuous and sustainable funding of water treatment facilities. To safeguard public health in the region, African countries must tailor their water quality monitoring standards to their unique circumstances and adhere to international regulatory standards such as those of the World Health Organization.[8]

To tackle the issue of fragmentation of responsibilities for wastewater management and the absence of well-defined roles and incentives for effective coordination, African nations should establish clear roles and responsibilities among ministries, enhance coordination through a centralized authority, and implement incentive structures to promote accountability. Additionally, investing in capacity building and strengthening policy frameworks will also improve wastewater management and ensure sustainable water resource management in the African region.

Moreover, African nations must prioritize and align with Sustainable Development Goal 6, which focuses on ensuring access to clean water and sanitation for all. Therefore, countries in Africa should ensure the establishment of water treatment plants, including wastewater treatment infrastructure, in rural and remote areas to promote equity in access to safe and clean water for all, especially for vulnerable populations such as women, children, the elderly, and people with disabilities. Improving water and wastewater treatment necessitates collective engagement from diverse stakeholders, including the community, non-governmental organizations (NGOs), and civil society. Currently, decisions related to water and wastewater treatment are often made without public engagement, resulting in limited awareness among the majority about the significance of wastewater treatment.[8] Involving the public can strengthen political determination when leaders actively seek community backing.[8] Providing training and educational programs becomes essential to enhancing public understanding of the interrelation between water and energy, water and health, and the importance of wastewater treatment.[8]

In addition, African countries should be provided with adequate international financial and specialized technical assistance to bolster their wastewater treatment systems, guarantee access to clean water, and safeguard the well-being of local ecosystems.

## Conclusion

Africa is currently facing significant challenges in water quality, necessitating a focus on improving wastewater treatment to meet Sustainable Development Goals. The existing methods for wastewater treatment are often resource-intensive in terms of chemicals, energy, and operations, making them unfeasible in many African regions due to inadequate infrastructure. Therefore, it is crucial to develop tailored wastewater technologies suitable for African countries. This endeavor requires collaborative efforts from various stakeholders, including governments, non-governmental organizations, and the private sector. Considering Africa's unique characteristics, the region needs to devise strategies to protect water quality. Moreover, international financial and technical support is vital for African nations to enhance wastewater treatment, ensure access to safe water, and promote healthy ecosystems in the region.

## Author Contribution

Ejovwokeoghene Joseph Omohwovo: Conceptualization and writing of the original draft through to final editing.

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