Archives of Current Research International

Volume 25, Issue 10, Page 261-277, 2025; Article no.ACRI.145989
ISSN: 2454-7077

From Waste to Resource: Assessing Governance Models for Implementing Circular Economy Principles in Urban Water and Nutrient Management in Ghana

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Authors' contributions

This work was carried out in collaboration among all authors. This project was conducted jointly by the authors. The authors reviewed and agreed on the final manuscript. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/acri/2025/v25i101566

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://pr.sdiarticle5.com/review-history/145989

Systematic Review Article

Received: 21/08/2025
Published: 18/10/2025

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Cite as: *Christian Kofi Sarpong, Daniel Frimpong, Paul Obeng Tachie, Stephanie Haizel Arkoh, and Christopher Kanpiim. 2025. "From Waste to Resource: Assessing Governance Models for Implementing Circular Economy Principles in Urban Water and Nutrient Management in Ghana". Archives of Current Research International 25 (10):261–277. https://doi.org/10.9734/acri/2025/v25i101566.*

ABSTRACT

The shift from linear to circular economy systems is critical for sustainable water and nutrient management, particularly in developing countries such as Ghana. This paper explores governance models shaping the implementation of circular economy principles, state-regulated, collaborative, public-private, community-based, and adaptive, through a systematic review of peer-reviewed literature published between 2018 and 2025. The review was conducted using databases such as Scopus, Web of Science, and Google Scholar, applying inclusion criteria focused on governance frameworks in circular economy transitions. Findings reveal that state-regulated frameworks, including Ghana's National Plastics Management Policy and Circular Economy Roadmap, provide essential direction but face weak enforcement and limited financing. Collaborative platforms like the Waste Recovery Platform and Circular Bio-Economy Innovation Hub foster innovation but require long-term financial sustainability. Public-private partnerships mobilize investment but risk political interference and limited transparency, while community-led initiatives enhance legitimacy but often lack safety and technical integration with formal systems. Adaptive governance emerges as the most promising model, offering flexibility through integrated tools and monitoring mechanisms. The paper concludes that Ghana's transition to a circular economy will require stronger state enforcement, sustainable financing mechanisms for collaborative platforms, transparent regulatory safeguards for public-private projects, formal recognition and training for community actors, and the adoption of adaptive monitoring frameworks. These targeted recommendations strengthen the policy and institutional pathways for sustainable resource management in Ghana.

Keywords: Circular Economy; water and nutrient management; governance models; public-private partnerships; community participation; adaptive governance; Ghana.

1. INTRODUCTION

Globally, urban water and nutrient flows are increasingly recognized as important environmental, social, and economic challenges (Jian, 2025). Urbanization leads to the rapid generation of more organic waste and wastewater, and most of the world's cities lack the infrastructure needed to handle them safely (Lema, 2025). This results in water scarcity, pollution of water bodies, eutrophication, and the loss of useful nutrients. Principles of circular economies, such as closing material loops, restoring natural systems, and minimizing waste, offer the potential to turn environmentally harmful waste into valuable resources (Sesay & Fang, 2025; Debrah et al., 2022).

The problem is notably sharp in Sub-Saharan Africa. Less than 10 % of wastewater generated is properly treated before being released into the environment, and many urban areas rely on informal sanitation or water reuse of untreated or partially treated wastewater, exposing individuals to health and environmental risks (Nyika & Dinka, 2025; Agbo et al., 2025; Sesay & Fang, 2025). But that informal reuse here is itself a measure of local practice that can potentially be tied and transformed into resource recovery with appropriate regulation (Tahiru, 2024).

Ghana represents both obstacles and opportunities in the application of the circular economy to urban water and nutrient management (Africa Circular, 2025). Pilot and policy projects, including the "WIDER UPTAKE" project, are aiming to encourage treatment wastewater reuse and sludge and wastewater treatment plant-based biochar recovery and utilization in urban agriculture and other usages and to construct stakeholder partnerships, business models, and monitoring systems (Ahenkan et al., 2025). Governance inhibitors, however, can be observed: lack of a clear circular economy policy document, scarce regulation of resource recovery solutions, dispersed institutional mandates, and health and environmental protection fears all prevent scaling of such innovations (Ahenkan et al, 2025; Debrah et al., 2022).

The distance between technical potential and practical application argues that forms of governance, such as policy tools, institutional structures, enforcement agents, forms of cooperation among concerned parties, and public health protection, hold the key to supporting circular transitions in urban water and nutrient systems. The paper explored governance models of applying the principles of the Circular economy to Ghana's urban water and nutrient management.

2. LITERATURE REVIEW

2.1 Circular Economy in Water and Nutrient Management

"The circular economy concept seeks to move beyond linear models of "take–use–dispose" by promoting closing loops, waste valorisation, and regeneration of natural systems" (Fernandes & Cunha Marques, 2023; Peydayesh & Mezzenga, 2024). "In the context of water and nutrient management, the circular economy framework emphasizes recovering and reusing water, extracting nutrients (nitrogen, phosphorus) from wastewater and organic wastes, and integrating these recovered resources into productive uses such as agriculture" (Hamam et al., 2024).

2.1.1 Key technologies and strategies

Farfán Chilicaus et al. (2025) illustrate that "circular economy-oriented water management has made significant advancements on technological levels. Membrane bioreactors, constructed wetlands, and advanced oxidation processes are being increasingly used for wastewater treatment and water reuse safely and effectively". "Nutrient recovery techniques are also increasing; materials such as biochars, magnetic phases, and layered double hydroxides, as well as methods like struvite precipitation, are being used to recycle phosphorus and nitrogen from wastewater streams" (Akter et al., 2024; Chakraborty et al., 2023). "Eco-technologies like constructed wetlands serve twin purposes: treatment and natural purification at lower energy input, thus becoming increasingly viable in varied contexts" (Farfán Chilicaus et al., 2025).

2.1.2 Environmental, health, and agricultural benefits

"The circular management of water and nutrients has been linked to multiple co-benefits. Recovering nutrients reduces dependency on synthetic fertilizers, and returning organic matter to soils improves soil fertility and resilience (especially under climate change pressures)" (Crovella et al., 2024). "Water reuse helps alleviate water scarcity, reduces pollution loads in rivers and lakes, and can mitigate eutrophication" (Fiskal et al., 2019). Additionally, "the systematic map of nutrient recovery from human excreta and domestic wastewater highlights the potential to mitigate aquatic pollution while addressing nutrient insecurity" (Macura et al., 2024).

2.1.3 Barriers and constraints to implementation

Despite technological promise and demonstrated benefits, the implementation of circular economy approaches in water and nutrient management faces several barriers, as shown in Fig. 1. Economic constraints, particularly the cost of technologies and infrastructure, are frequently cited (Farfán Chilicaus et al., 2025). Regulatory and policy gaps, especially around standards for reuse and recovered products, hinder uptake (Akter et al, 2024). Institutional capacity is often weak, with fragmented governance, a lack of coordination among agencies, and insufficient stakeholder engagement limiting scaling. Health and safety concerns, e.g., potential pathogen transmission, chemical contamination, must be managed through rigorous treatment, monitoring, and regulation (Keraita et al., 2018).

2.1.4 Life Cycle and sustainability assessment perspectives

Life cycle assessment studies have become frequent in assessing the environmental outcomes of circular economy interventions in water and nutrient recovery (Rebello, 2024). Pausta et al. (2024) found that wastewater reuse for irrigation, sludge extraction for bio-based products, and nutrient biosolid recovery for soil amendment can yield significant reductions in greenhouse gas emissions and environmental burdens. Such Life cycle assessments help compare trade-offs among different recovery pathways (e.g., energy requirements vs. pollutant removal vs. nutrient yield), informing more environmentally and economically sustainable decision-making.

2.1.5 Relevance of circular economy water & nutrient management to low-resource settings

In low- and middle-income settings, including many countries in Sub-Saharan Africa and Ghana, the relevance of the circular economy in water and nutrient management is particularly strong. These regions often have nutrient-deficient soils, limited access to synthetic fertilizers, underserved sanitation infrastructure, and a high prevalence of informal reuse practices. Accordingly, circular economy approaches that recover water and nutrients promise dual dividends: improving agricultural productivity and soil health, while reducing pollution and public health risks. Moreover, community-based, decentralized

Fig. 1. Barriers and Constraints to Implementation
Source: Authors Construct

systems and low-cost technologies are more feasible in these contexts, particularly where centralized systems are lacking or unaffordable (Fernandes & Cunha Marques, 2023).

2.2 Urban Water and Nutrient Management in Ghana

Urban water and nutrient management in Ghana is a growing concern due to rapid urbanization, population growth, and weak infrastructure systems. Ghana's cities, particularly Accra and Kumasi, face challenges in ensuring sustainable water supply, wastewater treatment, and nutrient recovery (Amenfia, E. 2020). The expansion of informal settlements has placed significant pressure on already inadequate sanitation and drainage infrastructure, contributing to water pollution and nutrient losses (Owusu, 2022).

Water resource management in Ghana has long been constrained by over-reliance on centralized systems, which often fail to provide equitable access and efficient service delivery. At the same time, untreated wastewater is frequently discharged into rivers and streams, affecting aquatic ecosystems and public health (Boadi & Kuitunen, 2019). Urban agriculture in cities such as Accra depends heavily on untreated wastewater for irrigation, raising concerns about food safety but also highlighting opportunities for nutrient recycling (Darko et al., 2025).

Nutrient management remains underdeveloped despite its potential contribution to circular economy practices. Most municipal waste streams, particularly organic waste and fecal sludge, are not harnessed for resource recovery (Kusi-Appiah et al., 2025). Recent initiatives, however, demonstrate a shift towards resource recovery and reuse models, including composting, biogas generation, and wastewater reuse for irrigation (Otoo & Drechsel, 2018). Such practices, though limited in scale, indicate pathways for integrating circular economy principles into Ghana's urban water and nutrient management frameworks.

Governance challenges remain a key barrier. Fragmented institutional responsibilities, weak enforcement of environmental regulations, and limited financing mechanisms hinder effective implementation of sustainable systems (Agyei et al., 2023). Addressing these gaps will require strengthening governance models that promote multi-stakeholder collaboration, private sector participation, and community engagement, in line with circular economy principles

2.3 Governance Models for Implementing Circular Economy Principles

The governance of circular economy principles in water and nutrient management is shaped by the interaction of institutions, policies, and stakeholders (Lasseur et al., 2024). Effective governance models provide the framework through which resources can be recovered, reused, and reintegrated into production systems (World Bank, 2024). In Ghana, as elsewhere in Sub-Saharan Africa, a variety of governance

approaches are evolving, ranging from state-led regulation to participatory and hybrid governance systems (Agyei et al., 2023). Fig. 2 indicates the models for implementing circular economy principles.

2.3.1 State-regulated governance

State-regulated governance models remain the backbone of circular economy implementation, relying on government institutions to set policies, standards, and enforcement mechanisms (United Nations Environment Programme, 2023). According to the Government of Ghana (2020*),* Ghana's government has increasingly recognized the importance of circular economy principles, particularly in waste and resource management. For instance, the National Plastics Management Policy and the Circular Economy Roadmap and Action Plan launched by the Ministry of Environment, Science, Technology, and Innovation (MESTI) provide policy direction to guide transitions away from linear models (MESTI, 2023). Such frameworks aim to institutionalize safe waste reuse, wastewater treatment, and nutrient recovery practices. While state regulation establishes legitimacy and ensures alignment with national development goals, weak enforcement and inadequate financing remain persistent challenges (Agyei et al., 2023).

2.3.2 Collaborative and multi-stakeholder governance

Collaborative governance models emphasize the participation of multiple stakeholders, including government agencies, private companies, academic institutions, and civil society organizations (Wan, 2025). These models are particularly relevant in Ghana, where resource recovery projects require technical expertise, innovation, and social acceptance (Ghana Climate Innovation Centre, 2025). The Circular Bio Economy Innovation Hub, for example, has been designed as a co-ownership model that brings together ministries, research institutions, and businesses to build capacity in waste valorization and nutrient recovery (International Water Management Institute [IWMI], 2024). Similarly, the Ghana Waste Recovery Platform fosters dialogue and business linkages across sectors, supporting small enterprises in scaling up recycling and nutrient reuse activities (Waste Recovery Platform, 2022). Such collaborative frameworks offer opportunities for knowledge sharing and innovation; however, they may also encounter difficulties in sustaining partnerships and balancing the interests of diverse actors.

2.3.3 Public-private partnerships and hybrid models

Public-private partnerships and hybrid governance arrangements combine public oversight with private sector investment and expertise (Alidu, 2018). These models have gained traction in Ghana as mechanisms for financing and implementing circular economy initiatives. For example, hybrid waste-to-energy projects in Accra have demonstrated the potential for converting municipal waste into compost and energy while engaging both public agencies and private investors (Gyamfi et al., 2024). International collaborations such as the Go Circular Project, supported by development partners, also illustrate hybrid governance, where state actors, private enterprises, and civil society work collectively to reduce waste and promote recycling (Citi Newsroom, 2025). These models can accelerate the adoption of circular economy practices by mobilizing resources and improving efficiency; nevertheless, they require transparent contracting and mechanisms to safeguard public interests against purely profit-driven outcomes (Otoo & Drechsel, 2018).

2.3.4 Community and participatory governance

Community-based governance approaches highlight the role of local actors and informal systems in implementing circular economy principles (Asare et al., 2024). In Ghana, urban agriculture heavily relies on wastewater and organic waste, which are often managed informally by farmers and local entrepreneurs (Darko et al., 2025). Participatory models that integrate these practices into formal governance structures can enhance both efficiency and legitimacy. The Waste Recovery Platform, for example, has sought to link informal waste pickers with formal recycling enterprises, enabling communities to benefit from circular economy value chains (Waste Recovery Platform, 2022). Evidence from other Sub-Saharan African contexts indicates that participatory governance enhances social acceptance and ensures local knowledge is harnessed in circular economy interventions (African Circular Business Alliance, 2024). Nevertheless, challenges remain, particularly around technical capacity, financing, and alignment with national regulatory frameworks (Owusu, 2022).

Fig. 2. Governance Models for Implementing Circular Economy Principles
Source: Authors' construct

2.3.5 Adaptive and flexible governance

Given the complexity of urban resource systems, adaptive governance has been proposed as a means of integrating flexibility and innovation into circular economy implementation (Frijns et al., 2023). Adaptive governance blends regulatory frameworks, market incentives, and participatory mechanisms in ways that respond to local needs (Panda et al., 2025). Rangoni et al. (2023) argue that flexible governance, which combines assessment tools with stakeholder involvement, provides a pathway for measuring and advancing territorial circularity. In Ghana, initiatives such as the Circular Bio Economy Innovation Hub demonstrate how adaptive models can evolve by blending state oversight with collaborative, community, and private-sector roles (IWMI, 2024). Such approaches are particularly relevant in contexts where infrastructure and institutional capacity are limited, as they allow governance frameworks to respond to emerging challenges and opportunities.

3. METHODOLOGY

This paper applied a systematic review approach to assess the governance models of applying the principles of the Circular economy to Ghana's urban water and nutrient management. The systematic review approach was employed due to its strength in accumulating existing knowledge from various sources based on an explicit and reproducible protocol. The review aimed to determine the governance models for implementing the principles of the Circular economy to urban water and nutrient management.

In an attempt to obtain pertinent literature, an extensive search was carried out on major academic databases, such as Scopus, Web of Science, ScienceDirect, PubMed, and Google Scholar, as indicated in Fig. 3. The research strategy utilized the application of the following keywords: "governance models," "Circular economy," ‘’Ghana,’’ "urban water," and "nutrient management." The application of Boolean operators was utilized to enhance the search parameters' specificity. Only English-language articles were included, and the search was limited to publications from 2018 to 2025 to encompass both older and newer perspectives. The selection criteria for the studies targeted research that had investigated the governance models for implementing the principles of the

Circular economy to urban water and nutrient management. The review incorporated peer-reviewed articles, scholarly books, organizational reports, and empirical case studies. Nonetheless, opinion articles, non-academic literature, research that did not meet the general themes, and duplicate articles were not included in the review.

Following the identification of qualifying studies, data were extracted with the assistance of a structured coding scheme. This included the recording of details about each study's author(s), publication year, research objectives, methodology, key findings, and its applicability to the Ghanaian or African green infrastructure experience. This was followed by a thematic synthesis of the data that was extracted. The findings were always classified under one broad dimension: Governance Models for Implementing Circular Economy Principles, including State-Regulated Governance, Collaborative and Multi-Stakeholder Governance, Public-Private Partnerships and Hybrid Models, Community and Participatory Governance, and Adaptive and Flexible Governance.

Although the systematic review approach guarantees some degree of academicity and comprehensiveness, some limitations were realized. Most notably, there was the risk of publication bias as a result of the restriction of grey literature and non-English sources. Secondly, even though there is increased interest in urban water and nutrients in Ghana, studies specific to Ghana remain scarce. This gap highlights the necessity for more localized studies exploring the intricate link between governance model, circular principles, urban water, and nutrient management in Ghanaian Cities. Yet the methodological approach taken in this research offers a solid foundation for syntheses of current knowledge and formulating insights that are relevant to both scholars and policymakers. It also enables the identification of key themes and evidence gaps that can guide future research and urban water and nutrient management initiatives.

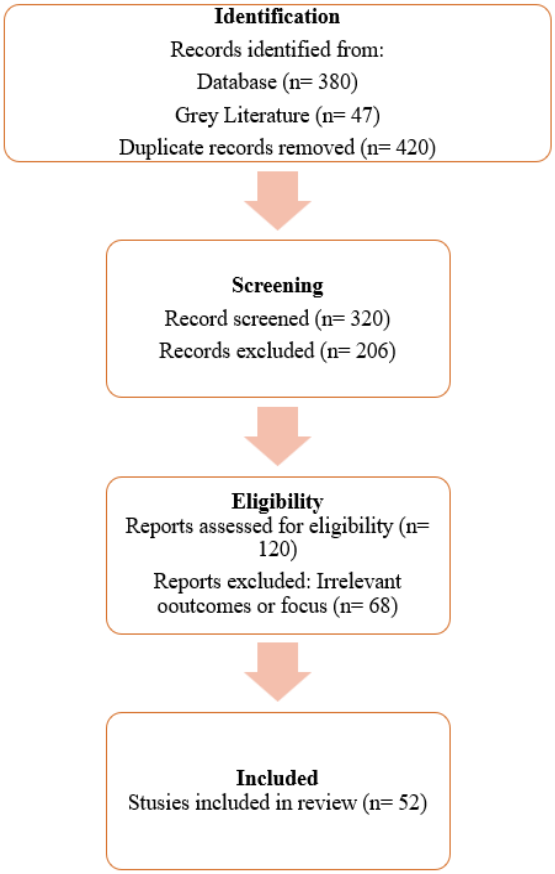

Fig. 3. PRISMA Flow Diagram
Source: Authors' construct

3.1 Contextual Focus on Ghana

Ghana, as shown in Fig. 4, is a West African nation known for its rich cultural heritage, democratic stability, and diverse ecological zones. Bordered by Côte d'Ivoire to the west, Burkina Faso to the north, Togo to the east, and the Gulf of Guinea to the south, Ghana spans approximately 238,535 square kilometers and has a population exceeding 33 million as of 2025 (World Bank, 2025). Ghana provides a compelling context for examining governance models for implementing circular economy principles in urban water and nutrient management. The country has experienced rapid urbanization over the last three decades, with more than 56% of its population currently living in urban areas, particularly in Accra, Kumasi, Sekondi-Takoradi, and Tamale (Ghana Statistical Service, 2021). This urban expansion has placed enormous pressure on basic services, especially water supply, sanitation, and solid waste management, creating significant challenges in ensuring environmental sustainability and public health (Owusu, 2022).

Urban water management in Ghana is characterized by increasing demand, intermittent supply, and infrastructure deficits. Ghana Water Company Limited is responsible for urban water provision; however, capacity limitations and high levels of non-revenue water constrain efficiency and equitable access (Tetra Tech & USAID, 2024). In addition, wastewater treatment is extremely limited, with less than 10% of wastewater in urban areas receiving any form of treatment before disposal (Amenfia, E. 2020). Untreated effluents are often discharged directly into rivers and streams, contributing to water pollution and threatening ecosystems and human health.

Nutrient management is also underdeveloped, despite the significant potential for recovery from organic waste and fecal sludge. Urban centers in Ghana generate large volumes of organic waste, yet most of it is disposed of in open dumpsites or landfills, with minimal reuse or recycling (Boadi & Kuitunen, 2019). Where reuse occurs, it is largely informal, such as the use of untreated wastewater for irrigating vegetables in Accra and Kumasi, which poses health risks while simultaneously highlighting opportunities for nutrient recovery (Darko et al., 2025). Recent initiatives, such as resource recovery and reuse projects supported by international organizations, show the potential for composting, biogas production, and treated wastewater irrigation, but these remain limited in scope and require stronger governance frameworks for scaling up (Otoo & Drechsel, 2018).

Ghana has, however, begun to integrate circular economy principles into its national development strategies. The National Plastics Management Policy (Government of Ghana, 2020) and the Circular Economy Roadmap and Action Plan (MESTI, 2023) provide explicit policy directions aimed at reducing waste and promoting resource recovery. Initiatives like the Circular Bio Economy Innovation Hub (IWMI, 2024) and the Waste Recovery Platform (Waste Recovery Platform, 2022) demonstrate growing recognition of the need for multi-stakeholder governance in operationalizing circular economy practices. Despite these advances, governance fragmentation, weak enforcement, and limited financing continue to undermine effective implementation (Agyei et al., 2023).

In this context, Ghana serves as an appropriate case study for exploring governance models for the circular economy in water and nutrient management. The combination of rapid urban growth, underdeveloped infrastructure, and emerging circular economy initiatives presents both challenges and opportunities for policy innovation. Understanding how governance frameworks can be designed and strengthened to support resource recovery and sustainable urban management is critical for Ghana's transition towards circularity.

Fig. 4. Map of the Study Area
Source: Tengan & Aigbavboa (2021)

4. FINDINGS AND ANALYSIS

The governance of circular economy principles in water and nutrient management depends on how institutions, policies, and stakeholders interact to shape implementation outcomes. Different governance approaches are being adopted in Ghana and elsewhere in Sub-Saharan Africa, each offering unique strengths and facing particular challenges. To illustrate these variations, Tables 1, 2, 3, 4, and 5 summarize the key contributions of different authors and institutions under each governance model, thereby providing a comparative understanding of how governance models influence circular economy practices.

The literature largely confirms that state regulation provides legitimacy and structure for the implementation of circular economy principles. The United Nations Environment Programme (2023) emphasizes the critical role of national governments in aligning circular economy transitions with sustainable development goals. This is consistent with the Government of Ghana (2020), which introduced the National Plastics Management Policy as a key framework for shifting away from linear waste practices. The Ministry of Environment, Science, Technology, and Innovation (2023) further advanced this agenda by developing a Circular Economy Roadmap to guide implementation in collaboration with academia and civil society. While these frameworks highlight the strengths of state regulation, Agyei et al. (2023) argue that weak enforcement and inadequate financing remain major barriers to effective implementation. This contrast reveals a gap between the formal policy frameworks that exist on paper and the actual practices in implementation. Although there is consensus on the importance of state-regulated governance, the evidence shows that the model in Ghana is undermined by resource and institutional constraints.

There is strong agreement among scholars and institutions that multi-stakeholder collaboration enhances innovation and knowledge sharing in circular economy governance. Wan (2025) provides a theoretical foundation for collaborative governance, showing that such models promote inclusivity and innovation. This is confirmed by evidence from the Circular Bio-Economy Innovation Hub established by the International Water Management Institute (2024) and the Ghana Waste Recovery Platform (2022). Both initiatives demonstrate how partnerships among ministries, research institutions, businesses, and civil society create capacity for resource recovery and recycling. The Ghana Climate Innovation Centre (2025) adds that resource recovery projects in Ghana require not only technical expertise but also community acceptance, reinforcing the case for multi-stakeholder collaboration. However, Wan (2025) also notes that sustaining partnerships is difficult when the interests of diverse actors are not easily aligned. Thus, while collaboration is widely celebrated as necessary for effective governance, its long-term stability is questioned. This highlights the confirmation of collaboration as a strength but also the challenge of balancing diverse stakeholder priorities.

Research consistently shows that Public-Private Partnerships and hybrid governance arrangements mobilize resources and improve efficiency in implementing circular economy practices. Gyamfi et al. (2024) provide evidence from waste-to-energy projects in Accra, demonstrating that such partnerships can convert municipal waste into compost and energy. Similarly, the Go Circular Project reported by Citi Newsroom (2025) illustrates how hybrid arrangements that involve state actors, private companies, and civil society contribute to scaling recycling and waste reduction efforts. Otoo and Drechsel (2018) also confirm through comparative case studies that such models can successfully mobilize investment and innovation in resource recovery. Nevertheless, Alidu (2018) cautions that Public-Private Partnerships in Ghana often arise from political convenience and may not achieve efficiency if not transparently managed. This presents a contradiction: on the one hand, partnerships are shown to provide practical solutions to waste and resource challenges; on the other, they can be undermined by political influence and profit-oriented motives. The literature, therefore, reflects a balance between optimism about the capacity of hybrid governance models and concern about their risks.

The evidence strongly confirms that community-based governance enhances legitimacy, inclusivity, and social acceptance of circular economy practices. Asare et al. (2024) show that participatory approaches in Ghana's informal waste sector increase community involvement and strengthen the role of grassroots actors. This aligns with the Ghana Waste Recovery Platform (2022), which connects informal waste pickers to formal recycling enterprises, creating economic benefits for local communities. Similarly, the

Table 1. State-Regulated Governance

Author(s)	Objectives	Methodology	Key Findings	Relevance
Agyei et al. (2023)	To examine pathways towards a circular economy in Ghana through waste transfer stations and informal waste collectors.	Case study analysis in an edited volume.	Found that state regulation aids institutionalization of waste reuse but faces weak enforcement and limited financing.	Shows challenges in applying state-led governance in Ghana.
Government of Ghana (2020)	To provide a framework for plastics management in Ghana.	Policy document.	Established the National Plastics Management Policy to transition away from linear waste systems.	Foundation for state regulation in Ghana's circular economy initiatives.
Ministry of Environment, Science, Technology and Innovation (MESTI) (2023)	To develop a roadmap and action plan for the circular economy transition.	Strategic policy roadmap.	Provides a structured implementation plan for waste reuse, wastewater treatment, and nutrient recovery.	Strengthens state-regulated governance by aligning national stakeholders.
United Nations Environment Programme (2023)	To outline governance and policy pathways for the global circular economy.	International policy report.	Emphasizes the role of state regulation in legitimizing and aligning CE with development goals.	Offers international reference that supports Ghana's state-regulated governance.

Source: Authors' Construct

Table 2. Collaborative and Multi-Stakeholder Governance

Author(s)	Objectives	Methodology	Key Findings	Relevance
Ghana Climate Innovation Centre (2025)	To assess innovations and policy reforms for waste management in Ghana's circular economy.	Policy paper and applied research.	Identified resource recovery projects requiring technical expertise, innovation, and social acceptance.	Supports collaborative governance by linking innovation and multi-stakeholder engagement.
International Water Management Institute (IWMI) (2024)	To establish a Circular Bio-Economy Innovation Hub for waste valorization and nutrient recovery.	Institutional initiative/case study.	Demonstrated success of co-ownership models involving ministries, research institutions, and businesses.	Illustrates collaborative governance in practice through capacity building.
Waste Recovery Platform (2022)	To provide an overview of Ghana's waste recovery platform.	Platform description and institutional report.	Fosters dialogue and business linkages across multiple sectors, supporting small enterprises.	A key example of collaborative and multi-stakeholder governance in Ghana.

Author(s)	Objectives	Methodology	Key Findings	Relevance
Wan, C. K. (2025)	To explore collaborative platforms as stakeholder governance models in circular economy ecosystems.	Conceptual and case study analysis in an edited book.	Finds that stakeholder-inclusive governance enhances knowledge sharing and innovation.	Provides a theoretical foundation for collaborative models relevant to Ghana's context.

Source: Authors' Construct

Table 3. Public-Private Partnerships and Hybrid Models

Author(s)	Objectives	Methodology	Key Findings	Relevance
Alidu, S. (2018)	To examine the efficacy of Public-Private Partnerships (PPPs) in Ghana.	Policy and institutional analysis.	Found that PPPs are often politically driven and may fail to achieve efficiency if not transparently managed.	Provides context for understanding the limitations of PPP governance in circular economy projects.
Citi Newsroom (2025)	To report on the outcomes of the Go Circular Project in Ghana.	Development partner project review/report.	Demonstrated how international collaborations foster hybrid governance by bringing together state, private, and civil actors.	Illustrates the potential of hybrid governance in scaling circular economy practices.
Gyamfi et al. (2024)	To assess hybrid waste-to-energy solutions within a circular economy framework in Ghana.	Case study analysis of Accra waste-to-energy projects.	Showed how municipal waste can be converted into compost and energy through hybrid models.	Provides empirical evidence for the viability of hybrid PPP projects in Ghana.
Otoo, M., & Drechsel, P. (2018)	To analyze business models for energy, nutrient, and water reuse in low- and middle-income countries.	Comparative case studies across countries.	Demonstrated that PPP and hybrid models mobilize resources effectively but need safeguards to protect public interest.	Provides comparative insights that strengthen Ghana's hybrid circular economy models.

Source: Authors' Construct

Table 4. Community and Participatory Governance

Author(s)	Objectives	Methodology	Key Findings	Relevance
African Circular Business Alliance (2024)	To promote the circular economy and business collaboration across Africa.	Institutional initiative and advocacy platform.	Shows that participatory governance enhances social acceptance and integrates local knowledge.	Provides a continental framework that validates Ghana's participatory approaches.
Asare et al. (2024)	To examine community engagement in Ghana's	Case study analysis of informal waste	Found that participatory models improve legitimacy and community	Demonstrates the role of grassroots actors in Ghana's

Author(s)	Objectives	Methodology	Key Findings	Relevance
	informal waste sector.	practices.	inclusion in circular economy value chains.	circular economy governance.
Darko et al. (2025)	To assess wastewater quality for irrigation in Ghana's Central Region.	Field-based assessment and lab analysis.	Showed that informal wastewater use supports urban agriculture but raises safety concerns.	Highlights how informal and community practices shape circular resource use.
Owusu, G. (2022)	To analyze urbanization and sanitation infrastructure challenges in Ghana.	Policy and institutional review.	Identified capacity gaps, financing issues, and weak alignment between local practices and national regulations.	Explains constraints facing participatory governance when scaling into formal structures.
Waste Recovery Platform (2022)	To link informal waste pickers with formal recycling enterprises.	Institutional initiative and programmatic report.	Enabled communities to benefit economically from waste recovery and recycling.	A practical example of participatory governance in Ghana's circular economy.

Source: Authors' Construct

Table 5. Adaptive and Flexible Governance

Author(s)	Objectives	Methodology	Key Findings	Relevance
Frijns et al. (2023)	To provide a roadmap for addressing governance and societal challenges in adopting circular water solutions.	Policy roadmap/report under NextGen project.	Demonstrated that adaptive governance supports wider uptake of circular solutions through flexible mechanisms.	Provides practical guidance for integrating adaptive governance in water sector transitions.
International Water Management Institute (IWMI) (2024)	To establish the Circular Bio-Economy Innovation Hub.	Institutional case study/initiative.	Showed how adaptive models evolve by blending state oversight with collaborative and private-sector roles.	Illustrates adaptive governance in action within Ghana.
Panda et al. (2025)	To develop a governance and regulatory framework for the circular economy.	Conceptual framework and review.	Found that adaptive governance blends regulatory, market, and participatory tools for effectiveness.	Offers theoretical support for adaptive frameworks relevant to Ghana's context.
Rangoni Gargano et al. (2023)	To propose a governance model for measuring territorial circularity.	Conceptual and analytical model development.	Developed the Territory Circularity Index as a flexible governance tool.	Provides assessment tools that can support adaptive governance in Ghana.

Source: Authors' Construct

African Circular Business Alliance (2024) emphasizes that participatory approaches across Africa ensure local knowledge is integrated into circular economy practices. At the same time, Darko et al. (2025) highlight the risks associated with informal wastewater use in urban agriculture. While such practices sustain livelihoods, they present health and environmental concerns. Owusu (2022) further critiques the limited capacity of participatory approaches to align with national regulatory frameworks, noting financial and technical constraints. These perspectives reveal a confirmation of the importance of community governance at the local level, but also a contradiction when such practices are scaled to align with formal systems.

The literature confirms that adaptive governance is essential in addressing the complexity of urban resource management, particularly in contexts with limited institutional capacity. Frijns et al (2023) argue that adaptive governance mechanisms allow governments to respond flexibly to societal and governance challenges, thereby supporting wider adoption of circular water solutions. This perspective is supported by the International Water Management Institute (2024), which demonstrates through the Circular Bio-Economy Innovation Hub that adaptive governance can integrate state oversight with collaborative, community, and private-sector participation. At the conceptual level, Panda et al. (2025) emphasize that adaptive governance requires the integration of regulatory, market-based, and participatory instruments. Rangoni Gargano et al. (2023) complement this argument by proposing the Territory Circularity Index as a flexible governance tool for assessment and monitoring. The two perspectives differ slightly: Panda and colleagues focus on the systemic integration of governance tools, while Rangoni et al. (2023) highlight the importance of measurement and evaluation. Together, they confirm that adaptive governance requires both flexibility in design and continuous monitoring to respond to emerging challenges.

5. CONCLUSION AND RECOMMENDA-TIONS

This study has examined the different governance models shaping the implementation of circular economy principles in water and nutrient management in Ghana. The evidence shows that governance remains the central driver of how effectively circular economy strategies are designed, institutionalized, and sustained. Across the models analyzed, it is clear that no single governance approach is sufficient; rather, each offers strengths and weaknesses that together highlight the need for integrated and context-sensitive strategies.

State-regulated governance has laid the foundation for Ghana's transition, particularly through instruments such as the National Plastics Management Policy and the Circular Economy Roadmap. However, the effectiveness of these frameworks continues to be undermined by weak enforcement and inadequate financing. It is therefore recommended that the Government of Ghana strengthen enforcement by allocating dedicated financial resources and building monitoring capacity within local government agencies, ensuring that policies move beyond symbolic adoption to actual implementation.

Collaborative and multi-stakeholder governance models have proven effective in fostering innovation and building capacity, as demonstrated by the Circular Bio-Economy Innovation Hub and the Waste Recovery Platform. Yet, sustaining such partnerships remains a challenge. To address this, stakeholder platforms should institutionalize long-term financing mechanisms, such as waste management levies earmarked to support cross-sectoral initiatives, so that collaboration is not dependent on short-term donor projects.

Public-Private Partnerships and hybrid governance arrangements have demonstrated success in mobilizing investment, particularly in waste-to-energy projects in Accra. Nonetheless, the risk of politically driven contracts and profit-oriented motives cannot be overlooked. To safeguard public interests, the Ministry of Environment, Science, Technology, and Innovation should mandate transparent contracting processes, with clauses that ensure affordability and environmental compliance, while also requiring regular audits of private operators engaged in waste-to-energy and recycling projects.

Community and participatory governance approaches remain indispensable, particularly in contexts where informal actors play a dominant role in waste collection and resource recovery. However, safety and integration with national systems present challenges. It is recommended that municipal authorities formally recognize and

certify community-based waste and water reuse practices, providing technical training and basic protective equipment for waste pickers and urban farmers, while also integrating them into national reporting and monitoring frameworks. This would improve both the efficiency and safety of grassroots circular economy practices.

Finally, adaptive and flexible governance has emerged as the most promising model for addressing Ghana's institutional and infrastructural limitations. Adaptive frameworks allow governance systems to evolve in response to emerging challenges and opportunities. To strengthen this approach, it is recommended that the Ministry of Environment, Science, Technology, and Innovation integrate adaptive monitoring tools, such as the Territory Circularity Index, into its Circular Economy Roadmap, ensuring that progress is continuously measured and policies are adjusted accordingly.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

The author (s) hereby declare that no generative AI technologies, such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators, have been used during the writing or editing of this manuscript.

ACKNOWLEDGEMENTS

We would like to express our appreciation to all those who were engaged in this paper.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Africa Circular. (2025). *Circular economy action plan and roadmap in Ghana.* https://africacircular.org/circular-economy-action-plan-and-roadmap-in-ghana/

African Circular Business Alliance. (2024). *About us.* https://acba.africa/about-us/

Agbo, C., Jeffrey, P., & Sule, M. N. (2025). Evaluation of failings in urban water supply and sanitation systems in Sub-Saharan Africa: A systematic review to inform future planning. *Journal of Water, Sanitation and Hygiene for Development, 15*(2), 148–165. https://doi.org/10.2166/washdev.2025.267

Agyei, K. D., Manteaw, B. O., Nyamekye, A. B., Enu, K. B., & Yeboah, T. (2023). Pathways towards a circular economy in Ghana: The contribution of waste transfer stations and informal waste collectors. In M. O. Erdiaw-Kwasie & G. M. M. Alam (Eds.), *Circular economy strategies and the UN Sustainable Development Goals* (pp. 345–368). Springer. https://doi.org/10.1007/978-981-99-3083-8_18

Ahenkan, A., Boon, E., Nordjo, E., & Akalibey, S. (2025). Advancing the transition to circular economy in Ghana: Prospects and challenges. *Environmental Development, 55,* 101229. https://doi.org/10.1016/j.envdev.2025.101229

Akter, M. M., Hosen, M. A., Gilroyed, B. H., Eti, S. A., Sarker, P., Kabir, M. M., & Mohinuzzaman, M. (2024). Nutrient recovery for fertilizer production and wastewater treatment for a circular economy. *ACS Sustainable Resource Management.* https://doi.org/10.1021/acssusresmgt.4c00016

Alidu, S. (2018). *Public private partnerships in Ghana: Interrogating the efficacy of a politically convenient practice.* Friedrich Ebert Stiftung Ghana. https://library.fes.de/pdf-files/bueros/ghana/16591.pdf

Amenfia, E. (2020). *Improving Ghana's urban water supply: Sector regulations, laws, policy and guidelines.* University of Cape Coast. https://ir.ucc.edu.gh/xmlui/bitstream/handle/123456789/6584/AMENFIA%2C%202020.pdf

Asare, W., Cobbina, S. J., & Tahiru, A.-W. (2024). A circular economy approach to addressing waste management challenges in Tamale's waste management system. *World, 5*(3), 659–682. https://doi.org/10.3390/world5030034

Boadi, K. O., & Kuitunen, M. (2019). Municipal solid waste management in the Accra Metropolitan Area, Ghana. *Environmentalist, 23*(3), 211–218. https://doi.org/10.1023/B:ENVR.0000017283.09117.20

Chakraborty, A., Maitra, M., Ray Chowdhury, B., & Dutta, C. (2023). Nutrient recovery and utilization from wastewater for soil-less agriculture. In *Biorefinery for water and wastewater treatment* (pp. 137–158). Springer. https://doi.org/10.1007/978-3-031-20822-5_7

Citi Newsroom. (2025). *Go Circular Project ends with a call to scale*

up plastic reduction in Ghana. https://citinewsroom.com/2025/06/go-circular-project-ends-with-call-to-scale-up-plastic-reduction-in-ghana/

Crovella, T., Paiano, A., Falciglia, P. P., Lagioia, G., & Ingrao, C. (2024). Wastewater recovery for sustainable agricultural systems in the circular economy: A systematic literature review of life cycle assessments. *Science of the Total Environment, 912,* 169310. https://doi.org/10.1016/j.scitotenv.2023.169310

Darko, R. O., Nsonowah, P. P., Owusu-Sekyere, J. D., & Nyameche, M. (2025). Assessment of wastewater quality for irrigation use in the Central Region of Ghana. *Discover Environment, 3,* Article 146. https://doi.org/10.1007/s44274-025-00271-1

Debrah, J. K., Teye, G. K., & Dinis, M. A. P. (2022). Barriers and challenges to waste management are hindering the circular economy in Sub-Saharan Africa. *Urban Science, 6*(3), 57. https://doi.org/10.3390/urbansci6030057

Farfán Chilicaus, G. C., Cruz Salinas, L. E., Silva León, P. M., Lizarzaburu Aguinaga, D. A., Vera Zelada, P., Vera Zelada, L. A., Luque Luque, E. O., Licapa Redolfo, R., & Ramos Farroñán, E. V. (2025). Circular economy and water sustainability: Systematic review of water management technologies and strategies (2018–2024). *Sustainability, 17*(14), 6544. https://doi.org/10.3390/su17146544

Fernandes, E., & Cunha Marques, R. (2023). Review of water reuse from a circular economy perspective. *Water, 15*(5), 848. https://doi.org/10.3390/w15050848

Fiskal, A., Deng, L., Michel, A., Eickenbusch, P., Han, X., Lagostina, L., Zhu, R., Sander, M., Schroth, M. H., Dubois, N., & Lever, M. A. (2019). Effects of eutrophication on sedimentary organic carbon cycling in five temperate lakes. *Biogeosciences, 16*(12), 3725–3743. https://doi.org/10.5194/bg-16-3725-2019

Frijns, J., Smith, H., & van Veen, M. (2023). *NextGen Deliverable D4.4: Roadmap to address governance and societal challenges to support wider uptake of circular solutions in the water sector.* https://nextgenwater.eu/wp-content/uploads/2023/04/D4.4-Roadmap-to-support-uptake-of-circular-water-solutions-1.pdf

Ghana Climate Innovation Centre. (2025). *Incubating Climate Innovation 2025 – Brochure.* Ashesi University. https://ghanacic.ashesi.edu.gh/wp-content/uploads/2025/06/Incubating-Climate-Innovation-2025-Brochure-.pdf

Ghana Statistical Service. (2021). *2021 Population and Housing Census: General report.* https://census2021.statsghana.gov.gh/

Government of Ghana. (2020). *National Plastics Management Policy.* Ministry of Environment, Science, Technology and Innovation (MESTI). https://mesti.gov.gh/wp-content/uploads/2021/02/Revised-National-Plastics-Management-Policy_-FINAL.pdf

Gyamfi, G. A., Narra, S., Mohammed, M., Boahemaa, B., Beguedou, E., Kemausuor, F., & Agyenim, F. B. (2024). Hybrid waste-to-energy solutions within a circular economy framework directed towards sustainable urban waste management in Ghana. *Sustainability, 16*(12), 4976. https://doi.org/10.3390/su16124976

Hamam, M., Pergamo, R., Manganiello, V., & Ferrigno, M. (2024). Agricultural wastewater reuse as a circular economy model: Future scenarios considering Reg. (EU) 2020/741. *Water, 16*(24), 3638. https://doi.org/10.3390/w16243638

International Water Management Institute (IWMI). (2024). *Circular Bio-Economy Innovation Hub.* https://cbeih.iwmi.org/

Jian, F. (2025). The global water crisis: Challenges and solutions for a sustainable future. *Hydrology: Current Research, 16*(1). https://www.hilarispublisher.com/open-access/the-global-water-crisis-challenges-and-solutions-for-a-sustainable-future.pdf

Keraita, B., Drechsel, P., & Konradsen, F. (2018). *Reducing exposure to faecal contamination in wastewater-irrigated urban vegetable farming in Ghana: Options for policymakers.* International Water Management Institute (IWMI). https://ageconsearch.umn.edu/record/359490/files/124.pdf

Kusi-Appiah, M., Murphy, R. J., & Liu, L. (2025). An analysis of municipal solid waste management in Ghana: A scoping review of challenges, opportunities, and technology options. *Sustainability, 17*(18), 8266. https://doi.org/10.3390/su17188266

Lasseur, N. M., Holstead, K., & Huitema, D. (2024). How is the governance of circular economy of water organized? A systematic review of the literature. *Ecology and Society, 30*(3), Article 36. https://doi.org/10.5751/ES-16390-300336

Lema, M. W. (2025). Wastewater crisis in East African cities: Challenges and emerging opportunities. *Discover Environment, 3,* Article 18. https://doi.org/10.1007/s44274-025-00206-w

Macura, B., Metson, G. S., McConville, J. R., & Harder, R. (2024). Recovery of plant nutrients from human excreta and domestic wastewater for reuse in agriculture: A systematic map and evidence platform. *Environmental Evidence, 13,* Article 21. https://doi.org/10.1186/s13750-024-00342-5

MESTI. (2023). *Circular economy roadmap and action plan.* Ministry of Environment, Science, Technology, and Innovation. https://thevaultznews.com/2023/03/03/mesti-develops-a-circular-economy-roadmap-and-action-plan-to-foster-strong-alignment-between-academia-and-the-civil-society/

Nyika, J., & Dinka, M. O. (2025). Wastewater generation and management patterns in Sub-Saharan Africa. In *The silent wastewater problem in Sub-Saharan Africa* (pp. 27–46). SpringerBriefs in Water Science and Technology. https://doi.org/10.1007/978-3-031-90143-0_2

Otoo, M., & Drechsel, P. (Eds.). (2018). *Resource recovery from waste: Business models for energy, nutrient and water reuse in low- and middle-income countries.* Routledge. https://doi.org/10.4324/9781315767134

Owusu, G. (2022). From informal settlements to environmentally sustainable urban development in Ghana. *Urban Governance and Sustainability, 3*(2), 145–162. https://link.springer.com/content/pdf/10.1007/s43545-022-00402-y.pdf

Panda, L. P., Rath, K. C., Rao, N. V. J., Samantra, C., & Muduli, K. (2025). Circular economy governance and regulatory framework. In *Information systems engineering and management* (Vol. 54, pp. 49–73). Springer. https://link.springer.com/chapter/10.1007/978-3-031-93654-8_3

Pausta, C. M., Kalbar, P., & Saroj, D. (2024). Life cycle assessment of nutrient recovery from domestic wastewaters for the sustainability of water resources and environmental benefits. *Research Square.* https://www.researchsquare.com/article/rs-3494851/v1

Peydayesh, M., & Mezzenga, R. (2024). The circular economy of water across the six continents. *Chemical Society Reviews, 53*(9), 4333–4348. https://doi.org/10.1039/D3CS00812F

Rangoni Gargano, E., Cornella, A., & Sacco, P. (2023). Governance model for a territory circularity index. *Sustainability, 15*(5), 4069. https://doi.org/10.3390/su15054069

Rebello, T. A., Chhipi-Shrestha, G., Hewage, K., & Sadiq, R. (2024). Sustainability assessment of applying the circular economy to urban water systems. In *Proceedings of the Canadian Society of Civil Engineering Annual Conference 2022* (pp. 1037–1051). Springer. https://link.springer.com/chapter/10.1007/978-3-031-35471-7_72

Sesay, R. E. V., & Fang, P. (2025). Circular economy in municipal solid waste management: Innovations and challenges for urban sustainability. *Journal of Environmental Protection, 16*(2), 35–65. https://doi.org/10.4236/jep.2025.162003

Tahiru, A.-W., Cobbina, S. J., & Asare, W. (2024). A circular economy approach to addressing waste management challenges in Tamale's waste management system. *World, 5*(3), 659–682. https://doi.org/10.3390/world5030034

Tengan, C., & Aigbavboa, C. (2021). A review of the Ghanaian construction industry and the practice of monitoring and evaluation. In C. Aigbavboa, W. L. Le Roux, & N. Mokhele (Eds.), *Construction project monitoring and evaluation: An integrated approach* (pp. 143–160). Springer. https://doi.org/10.1007/978-3-030-70213-7_11

Tetra Tech & USAID. (2024). *Improving water quality management, water equity, and non-revenue water in Ghana – Component 3 report.* https://washghana.org/wp-content/uploads/2024/06/ghana_buy-in_component_3_report_non-revenue_water_final_508.pdf

United Nations Environment Programme (UNEP). (2023). *Global circular economy strategy: Governance and policy pathways.* https://www.unep.org/resources/report/global-circular-economy-strategy

Wan, C. K. (2025). Collaborative platforms as stakeholder governance modes in circular economy ecosystems. In R. Zimmermann et al. (Eds.), *Human-centred technology management for a sustainable future* (pp. 47–65). Springer. https://doi.org/10.1007/978-3-031-72490-9_5

Waste Recovery Platform. (2022). *Ghana Waste Recovery Platform overview.* United Nations Development Programme (UNDP). https://ghanawasteplatform.org

World Bank. (2024). *Water in circular economy and resilience (WICER) framework.* https://thedocs.worldbank.org/en/doc/6843853c1a601b962242c40c9814f236-0320082024/original/Session-1-Overview-of-the-principles-of-circular-economy-and-resilience-in-the-water-sector.pdf

World Bank. (2025). *Ghana overview.* https://www.worldbank.org/en/country/ghana/overview

Peer-review history:
The peer review history for this paper can be accessed here:
https://pr.sdiarticle5.com/review-history/145989