ABICHE ODUGBO

SUSTAINABLE WATER SUPPLY MANAGEMENT STRATEGIES IN LAGOS, NIGERIA

UNIVERSIDADE DO ALGARVE
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Master in Urban Water Cycle

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Declaration of authorship of the work

I hereby declare to be the author of this work, which is original and unpublished. Authors and works consulted are properly cited in the text and included in the reference list.

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(Abiche Odugbo)

To my beloved late brother, Andrew Omaga Odugbo,
I dedicate this work to your memory.

You embarked on your own dissertation journey with unwavering determination and passion yet were sadly called home in October of last year before you could complete it. Your resilience, brilliance, and unyielding spirit remain a guiding light in my life.

It is with profound love, enduring pride, and deep sorrow that I dedicate this work to you. May your legacy continue to shine through the pursuit of knowledge and the dreams you so deeply cherished.

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RESUMO

Esta dissertação analisa os desafios da governação da água na cidade de Lagos, Nigéria, uma das megacidades que mais rapidamente cresce no mundo. Inserida num contexto de urbanização acelerada, pressão demográfica e infraestrutura deficiente, a investigação tem como principal objetivo compreender as falhas estruturais e institucionais que dificultam o acesso equitativo e sustentável à água potável na cidade. A pesquisa parte da constatação de que menos de 10% da população de Lagos tem acesso a água tratada para consumo humano, sendo a maior parte da população dependente de fontes informais e, muitas vezes, inseguras.

A dissertação está estruturada em cinco objetivos específicos: (1) analisar as estruturas atuais de governação da água, identificando os principais atores e as suas interações; (2) avaliar as políticas públicas e os regulamentos existentes, com especial atenção à abordagem de Gestão Integrada dos Recursos Hídricos (IWRM); (3) investigar o papel das inovações sociais e tecnológicas na mitigação das desigualdades no acesso à água; (4) propor recomendações para melhorar a sustentabilidade da governação da água, com enfoque em populações marginalizadas; e (5) contribuir para o debate global sobre governação urbana da água, com ênfase em adaptação climática e justiça hídrica no Sul Global.

Metodologicamente, a investigação assenta numa abordagem qualitativa, com base na análise documental, observação de campo e 14 entrevistas semiestruturadas a representantes de entidades públicas (nomeadamente a Lagos Water Corporation – LWC e a Lagos State Water Regulatory Commission – LASWARCO), organizações não governamentais, agências internacionais e membros da comunidade. Os dados recolhidos foram analisados tematicamente, permitindo identificar padrões de disfunção institucional, desigualdade socioespacial e ausência de estratégias de adaptação às alterações climáticas.

Entre os principais resultados, destaca-se o profundo desfasamento entre a procura e a oferta de água, acentuado pela existência de um elevado volume de "água não faturada", ou seja, perdas físicas e comerciais de água estimadas em mais de 50%. A infraestrutura de tratamento é obsoleta e insuficiente, com infraestruturas como a de Adiyan a operar abaixo da capacidade.

A governação da água em Lagos é caracterizada por fragmentação institucional, fraca coordenação entre os atores e ausência de responsabilização efetiva. A proliferação de fontes informais de abastecimento (vendedores privados, poços e perfurações ilegais) contribui para

a insegurança hídrica e expõe a população a riscos sanitários elevados, particularmente em bairros informais e periféricos.

A análise identificou ainda um fraco cumprimento das normas de qualidade da água, com uma supervisão regulatória ineficaz, especialmente no setor informal. O problema do saneamento, diretamente interligado com a qualidade da água, é outro desafio crítico. Cerca de 76% da população não dispõe de acesso adequado a infraestruturas de saneamento, o que agrava a contaminação das fontes hídricas e compromete a saúde pública.

A dimensão tecnológica surge como um campo promissor, mas ainda incipiente. Foram identificados projetos-piloto de sensores IoT para deteção de fugas e de soluções móveis para faturação e monitorização do consumo, bem como experiências com plantas solares de tratamento. No entanto, a escalabilidade destas inovações é limitada por constrangimentos financeiros, falta de capacitação técnica e desigualdades no acesso a tecnologias digitais. As entrevistas revelaram ainda uma desconfiança generalizada face à LWC, especialmente entre comunidades marginalizadas, que percecionam a entidade como ineficaz e alheia às suas necessidades.

Apesar do modelo analítico utilizado incluir a resiliência climática como dimensão relevante da governação sustentável da água, este tema não emergiu de forma significativa nos dados empíricos. A ausência de estratégias explícitas de adaptação climática nos discursos institucionais e comunitários evidencia um fosso entre os riscos ambientais crescentes e a capacidade de resposta planeada, sinalizando uma área prioritária para investigação e intervenção futura.

Na discussão, argumenta-se que os problemas de Lagos não decorrem apenas de escassez física de água, mas sobretudo de falhas estruturais na governação, de desigualdades socioeconómicas persistentes e de modelos de desenvolvimento que negligenciam a inclusão e a sustentabilidade. A má coordenação entre agências, a fragmentação das responsabilidades e a ausência de políticas integradas comprometem seriamente os esforços para alcançar os Objetivos de Desenvolvimento Sustentável, em particular o ODS 6 – Água potável e saneamento para todos.

A investigação contribui para o conhecimento académico e prático ao oferecer um diagnóstico aprofundado dos obstáculos à governação da água numa megacidade africana, e ao propor caminhos para a reforma institucional, o fortalecimento da regulação, o investimento em infraestrutura resiliente e o envolvimento ativo das comunidades locais. Propõe-se ainda a criação de parcerias público-comunitárias como estratégia de promoção da equidade, e a incorporação de soluções tecnológicas adaptadas ao contexto social e económico de Lagos.

As limitações do estudo incluem a representatividade geográfica reduzida, centrada em áreas como Ikoyi, Ajegunle e Ojota, e o uso exclusivo de métodos qualitativos, que podem estar sujeitos a enviesamentos discursivos. Além disso, a dificuldade de acesso a dados atualizados e fiáveis sobre infraestrutura e fontes informais de água limitou a abrangência da análise.

Para trabalhos futuros, sugere-se aprofundar a investigação sobre mecanismos de financiamento sustentável para infraestruturas hídricas, avaliar a eficácia das inovações tecnológicas em contextos de escassez e desigualdade, e explorar estratégias de governação mais integradas e participativas. Será também essencial estudar os impactos da crise climática nos sistemas urbanos de água, nomeadamente em termos de planeamento da resiliência e da justiça hídrica.

Em termos de impacto nas políticas públicas, a dissertação oferece recomendações concretas para reformar a governação da água em Lagos. Estas incluem o reforço da capacidade regulatória da LASWARCO, a expansão do investimento em infraestruturas sustentáveis, a implementação de tecnologias adaptadas e acessíveis, e a criação de mecanismos de participação cidadã que incluam as vozes das comunidades mais vulneráveis. Estes contributos podem informar os decisores públicos e apoiar iniciativas em curso de planeamento estratégico, nomeadamente o Lagos Water Supply Master Plan, contribuindo para uma abordagem mais equitativa, resiliente e centrada nas necessidades da população.

Palavras Chave: Lagos (Nigéria); Governação Urbana da Água; Megacidades; Infraestruturas Hídricas; Acesso à Água; Inovação Tecnológica.

ABSTRACT

Urban water provision in Lagos, Nigeria, is hampered by a widening gap between supply capacity and rapidly growing demand, compounded by non-revenue water losses and fragmented institutional oversight.

This study employs a qualitative case-study methodology underpinned by methodological triangulation, integrating semi-structured interviews with fourteen key stakeholders, a systematic review of policy and institutional documents, and direct field observations in three urban districts to capture a multidimensional portrait of governance arrangements, service-delivery shortfalls, and community-level coping strategies.

Findings reveal that existing treatment and distribution systems operate at roughly seventy-five per cent of design capacity, while nearly forty per cent of treated water is lost through leaks, illegal connections, and metering failures. Formal public schemes largely favour middle- and high-income areas, prompting low-income communities to rely on informal vendors and collective borehole initiatives that often incur higher costs and quality risks. Pilot adoption of smart meters, pressure-monitoring sensors, and decentralized solar-powered treatment units shows promise but remains constrained by funding shortfalls and limited technical capacity.

The study concludes that strengthening policy coherence, enhancing institutional coordination, and scaling appropriate technological innovations together with active community engagement are essential to improve equity, efficiency, and sustainability in Lagos's urban water sector.

Keywords: Lagos (Nigeria); Urban Water Governance; Megacities; Water Infrastructure; Water Access; Technological Innovation.

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IoT	Internet of Things
IWRM	Integrated Water Resources Management
LASWARCO	Lagos State Water Regulatory Commission
LWC	Lagos Water Corporation
MDG	Million Gallons per Day
NGO	Non-Governmental Organization
NRW	Non-Revenue Water
PPP	Public-Private Partnership
SDG	Sustainable Development Goals
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization

LIST OF SYMBOLS

Symbol	Term
MGD	Million Gallons per Day
m^3	Cubic metre
%	Percentage
km^2	Squares Kilometres

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INTRODUCTION

1.1 EXPLORATORY STUDY

The water crisis in Lagos results from limited water resources and governance, infrastructure constraints, and socio-political contexts contributing to a lack of water governance. Water management in Lagos is inefficient, with outdated infrastructure, opaque governance, and a lack of political will to implement long-term options. Lagos' urban water systems (water supply, sanitation, and wastewater) are based on outdated infrastructure that is not prepared to accommodate the increasing demands that accompany a rapidly growing population (Balogun et al., 2017). Moreover, the water management system in Lagos is fragmented, and different actors, including government, non-government organizations, and private sector organizations, will work on water issues without coordination and with no overall strategy for sustainable water management.

The water resources within the city are threatened by untreated industrial effluents and chemical runoff from farmland laden with agrochemicals and the lack of adequate wastewater treatment (Gutiérrez & Glückler, 2022). For potable water, groundwater resources are over-extracted and polluted, and saltwater intrusion occurs (Olabode & Comte, 2024). As a result, millions of Lagosians will rely on worsening water access and be exposed to poor sanitation, contaminated water, and increased health hazards.

The primary problem addressed by this dissertation is the gap between water demand and supply in Lagos. The dissertation aims to formulate sustainable water supply management strategies to alleviate the principal challenges in governance, infrastructure, and technology while also building local populations into the governance process.

1.2 OBJECTIVES AND CHARACTERISTICS OF THE DISSERTATION

The primary objective of this dissertation is to critically analyse the water governance challenges in Lagos, Nigeria, focusing on the complex interplay between policy frameworks, stakeholder involvement, and infrastructure challenges. The study aims to propose sustainable and innovative water management strategies that address the core issues of water supply, pollution, access disparities, and governance inefficiencies in the context of rapid urbanization and climate change.

Specifically, the dissertation specific objectives are:

1. Analyse Lagos's current water governance structures, identifying key stakeholders' roles and interactions (government agencies, private sector, NGOs, and local communities) in water resource management.
2. Assess the strengths and weaknesses of water policies and regulations, including strategic arrangements such as IWRM, and identify the gaps in institutional structures governing water in the city.
3. Investigate the possible social innovations for water management, such as community-based solutions, innovative technology, and public-private partnerships, that can augment addressing issues such as inequities in the accessibility to water, pollution and wastewater.
4. Provide evidence-based suggestions for enhancing sustainability of water governance through infrastructure improvement, new policies development, and institutional re-making for community agency. Strategies will include suggestions for improving water access and quality, primarily for marginalized populations and those living in informal settlements.
5. Enter the global dialogue on urban water governance by contributing lessons learned from Lagos’s water governance conundrums to other rapidly urbanizing areas of the Global South, particularly related to resilience, climate adaptation, and access, as well as equity in urban water.

Thus, this dissertation engages the intersection of social innovation, environmental sustainability, and urban governance to reflect on a usable framework for sustainable water management in Lagos. The research will showcase scalable, adaptable solutions to address the

best global practices and local context, ultimately producing alternatives for other cities with similar water governance dilemmas.

1.3 CONTEXT OF THE WORK

Lagos, Nigeria, is currently one of the fastest-growing urban centres in the world with a population of over 24 million projected by 2050 (UN-Habitat, 2018). It is expected to soon be one of the largest megacities in the Global South and achieving the first place in 2010 (Hoornweg & Pope, 2016). Besides its population, one striking factor with Lagos is its abundance of water resources through the Atlantic Ocean, major rivers, and aquifers, and yet the city has considerable water governance challenges (Olabode & Comte, 2024). Lagos's water management systems are under-resourced due to rapid urbanization and the present demand for water due to poorly developed infrastructure, poor sanitation, unregulated extraction of groundwater, and contaminated water (Dano et al., 2020).

Access to water in Lagos is inequitable. With a considerable portion of the city comprising low-wealth communities and informal settlements, the urban poor experience severe inequalities in secure access to water. Moreover, informal water systems (non-permitted systems), including unregulated boreholes, water vendors, and unsafe public taps, put the urban poor at risk of waterborne diseases and sicknesses (Shiru et al., 2020). Roughly 40% of Lagos's residents lack access to safe drinking water and sanitation services (World Bank, 2021). This situation exemplifies the importance of equitable practices in Lagos' water management approaches so that cities can actively address the water access issues across groups of varying wealth status (Adeoti et al., 2023).

Additionally, inadequate wastewater treatment services and associated pollution of water bodies add to water management difficulties in the city. Domestic and industrial wastewater is discharged to the Lagos lagoon and its tributaries, as well as other key water bodies, and even normally available clean water supply is limited (Gutiérrez & Glückler, 2022). Pollution worsens already impaired access to fresh water for vulnerable populations living in informal settlements, where access to water is limited and available water quality is unmonitored (Raimi et al., 2019). The rapid urbanization of cities like Lagos and climate change impacts are expected to worsen this scenario. The United Nations (2020) notes that climate change is expected to accelerate flooding and drought events, amplifying the pressure on water supply systems already stressed by urbanization. Climate change will also have

impacts from rising sea levels that threaten coastal aquifers, ultimately leading to a risk of saltwater intrusion and freshwater loss in the future of Lagos (Olabode & Comte, 2024).

Tackling these challenges requires an integrated water governance model, encompassing technological advances, policy reforms, and community involvement. Integrated Water Resources Management (IWRM) is one of the most discussed visions for enhancing urban water management. IWRM is premised on sustainable water use, participative decision-making and efficient water resources management (Majahana et al., 2025). Lagos may benefit from the adoption of the IWRM tool, which has demonstrated potential in cities with a similar context, such as Cape Town, Pune, and São Paulo (Mirumachi & Hurlbert, 2022). Boosting water in Lagos, these examples could be adapted for Lagos to drive up water access and sustainability – through public-private partnerships and community-led solutions.

1.4 ORGANIZATION OF THE WORK

The dissertation is organized into five comprehensive chapters, each contributing to analysing water governance challenges in Lagos, Nigeria. The chapters are outlined as follows:

Chapter 1 introduces the research problem, outlining the challenges of water governance in Lagos. It presents the objectives of the dissertation, providing a clear framework for the study. Additionally, this chapter offers an overview of the research methodology, which combines qualitative and quantitative approaches to explore water management issues, governance structures, and the roles of various stakeholders.

Chapter 2 presents a detailed literature review of international literature on urban water governance and focuses on key theoretical frameworks and best practice models that shed light on cities like Lagos. The review highlights governance modalities, policy structures, and technological solutions for urban water systems, focusing on rapidly urbanizing megacities. Social innovations in water management are also addressed in the chapter, and key lessons are drawn from the experience of cities such as Cape Town, São Paulo, and Pune, where similarly severe urban water crises are in progress.

Chapter 3 sets out the research design and methodology applied to examine the water governance challenges in Lagos. In this sense, this chapter details the definition of typologies

of stakeholders to interview, formulation of data collection, and analytical strategies adopted to obtain insights into the major players in the water governance architecture of Lagos.

Chapter 4 provides a case study approach to studying the water governance system in Lagos. Results of interviews and observations are analysed and presented to depict the hidden governance gaps and challenges in water management. It also locates the position of important players like the government, NGO, and the community. This chapter discusses the policy implications of the results and proposes policy options to enhance both the sustainability and equity of water systems in Lagos.

Chapter 5 outlines the principal findings of the thesis and presents the conclusion with recommendations for improving water governance in Lagos. The recommendations cluster around the idea of policy reform and both technical and social innovation that could improve water access, enhance the quality of water supply, and promote water sustainability. The chapter ends by discussing the research implications for other cities in the Global South, focusing on possible ways of upscaling and outscaling the proposed solutions.

2

LITERATURE REVIEW

2.1 URBAN WATER MANAGEMENT IN RAPIDLY GROWING MEGACITIES

This literature review aims to synthesize key challenges and responses in urban water management, particularly in rapidly growing megacities of the Global South. It focuses on governance models, integrated resource management, technological innovations, pollution control, and climate adaptation, drawing on case studies worldwide. The goal is to extract actionable lessons and identify gaps that may inform future strategies for Lagos. The literature review studies varied issues, such as the nature of water governance, climate change effects on urban water resources, new technologies, and IWRM principles used in urban areas. It takes a sampling of case studies and theoretical frameworks used in both the Global North and South to provide a more reliable overview of the global perspective. This work is framed around cities worldwide, emphasizing complementary challenges facing cities, identifying gaps in current practices, and developing strategies for improved water governance and sustainability. Ultimately, it strives to identify relevant directions for how cities, especially in the Global South, can begin to build more meticulous, equitable, and sustainable urban water management systems.

Urban water management has become one of the major challenges of the 21st century, particularly in developing world megacities that are rapidly growing. All over the world, urbanization, industrialization, and climate change are compounding pressures on urban water systems and water frameworks; in the cities of the Global South, this is paired with many

significant issues related to water supply, water quality, and governance (Albrecht et al., 2018). A current example is Lagos, a dynamic and diverse megacity in Nigeria and Africa's largest city, facing multiple social and environmental challenges surrounding water management (Olabode & Comte, 2024). Further, it has been indicated that Lagos may become the third largest city in the world by 2050, with an estimated 24 million residents (Olabode & Comte, 2024); yet, with population growth, facing water crises every day, with barriers within its water management framework to adequately supply people with access to safe, reliable, water, and adequate sanitation.

Lagos has abundant natural water resources, such as the Lagos Lagoon Ogun. The natural water amenities, including the Lagos Lagoon, Ogun River, and aquifers, greatly contrast the dislocation of contamination, inefficiencies, and dreadful state of water systems that currently dominate practice. Such water systems impede cities from achieving universal access to safe, adequate, and sustainable water services (Adeoti et al., 2023). The challenges associated with the negligence and misuse of water infrastructure, the contamination of natural water amenities, over-extraction, and lack of regulation have stunted the city of Lagos from efficiently supplying clean water.

Despite natural resource abundance, rapidly urbanizing cities like Lagos face severe governance and infrastructure challenges that compromise equitable access to water. These challenges are revisited in detail in subsequent sections on governance, IWRM, and technology.

2.2 URBAN WATER GOVERNANCE IN DEVELOPING COUNTRIES

Urban water governance entails the processes associated with urban areas supplying their populations with safe, clean, and affordable water. It encompasses the institutions, policies, and management systems controlling urban water supply, quality, and access (Imonikhe et al., 2018). Water governance is crucial to overcoming the many challenges that cities face, including water shortages, pollution, and aging structures (Elias & Omojola, 2015). In developing countries, poorly coordinated policies, weak institutions, and a lack of investments leave urban water governance systems unable to combat challenges and their interrelatedness (Abolarin, Chinade, & Abdulsamad, 2024).

Cities such as Cape Town, Mexico City, and São Paulo have enacted water governance models based on collaboration between government actors, private sector actors, and civil society. While specific to certain geographies, these practices can be useful when examining

Lagos as a city moving forward, as advancing development from the repercussions of climate change and rapid urban growth can offer water scarcity solutions.

In Cape Town, the 2018 water crisis brought through a series of practices towards water demand management, such as with supporting smart meters, rainwater harvesting, and desalination projects (Wehn et al., 2021). Like Cape Town, Mexico City has a complex set of water supply and governance issues based on over-extraction of groundwater, pollution, and fragmented governance systems (Zhao & Boll, 2022). Mexico City has adopted smart water grid technology and new public-private partnerships as solutions for improving the water distribution process and reducing leaks. While specific to that context, the solutions found in Mexico City may provide useful lessons for Lagos, which similarly does not possess the current infrastructure or the water governance apparatus for efficient management of water supplies. The review provides examples from across the globe of integrating best practices to offer recommendations that are mindful of context to improve water governance, building from innovative technologies and approaches for participatory decision-making for sustainable and equitable water governance that works for all actors involved.

The conditions in Lagos provide an example of these frequently encountered challenges. The water supply system of Lagos State and the City of Lagos relies on a complex allocation of responsibilities from Federal, State, and Local Government agencies. However, the lack of coordination and synergy between the agencies has negatively impacted service delivery, like the lack of access to water experienced by many low-income communities (Olabode & Comte, 2024). Additionally, governance in Lagos is very much dependent on the social-political environment surrounding the governance of water resources. Political influence, poor regulation, and a lack of transparency in the management of water resources serve as obstacles to efficient water governance (Abolarin et al., 2024). In addition, Lagos Water Corporation (LWC), the agency responsible for the water supply, has not kept up with the growing water demand, largely due to limited resources, antiquated infrastructure, and little political will (Olabode & Comte, 2024). In addition, the water resources in Lagos are increasingly threatened by the pollution caused by industrial, agricultural, and domestic users that lead to pollution of surface and groundwater, draining safe water off the market (Adeoti et al., 2023).

The failure of many governance systems to provide adequate polls and access to decision-making processes by local communities has compounded the problem (Mabhaudhi

et al., 2019). Community engagement is important in achieving and sustaining successful interventions; however, governance arrangements in city contexts like Lagos rarely include this vital input into their water supply (Gutiérrez & Glückler, 2022). Local participation in governance is key to achieving equalized water management systems to reach marginalized communities.

Multi-level governance is a core theme of effective water governance that promotes coordination and collaboration among governmental actors across multiple levels, private sector actors and civil society. This model gains traction in several global cities with water governance challenges (Wehn et al., 2021). For example, Cape Town and South Africa has had successful experiences integrating multi-level governance models, including local community involvement, to mitigate their water crisis during extreme drought. Likewise, Mexico City has incorporated multi-level governance as a framework to govern its complex urban water system, coordinating between local authorities, national-level agencies, and private stakeholders (Wang et al., 2024).

In Lagos, governance failures stem from institutional fragmentation and lack of community involvement. Drawing lessons from cities like Cape Town and Mexico City, Lagos could benefit from multi-level governance approaches and participatory water management frameworks. However, adaptation requires consideration of political context, local capacities, and trust between stakeholders.

2.3 INTEGRATED WATER RESOURCES MANAGEMENT

The concept of IWRM was developed by the Global Water Partnership (2000) and promotes the coordinated development of water, land, and related resources to maximize economic and social welfare equitably, without compromising the sustainability of vital ecosystems. IWRM is broadly regarded as a holistic and sustainable way to manage water resources. It takes an integrated and coordinated approach to managing water resources to consider the needs of every possible water user (domestic, agricultural, industrial, and environmental), as well as social equity and environmental sustainability (Gutiérrez & Glückler, 2022). IWRM separates the management of water resources and land and allied resources, typically in services, to encourage stakeholder involvement, negotiation, and decision-making. IWRM incorporates internationally recognized principles and good practices to maximize findings for the ideal sustainable outcome for everyone involved; that is, viable or sustainable options and actions

in times of persistent water shortage and preparation for climate resilience for stakeholders equitably (Adeoti et al., 2023).

Using the principles of IWRM provides a way to address specific water management-related issues facing the city, such as water scarcity, pollution, and misallocation of resources. IWRM provides efficient utilization of water sources across a host of sectoral uses and only allows for the wastage of water that is ongoing across the generality of water uses. Formal recognition that all forms of water are finite and must be well-conserved and utilized where either option is viable to ensure sustainable outcomes is a prerogative of intention under the practice of IWRM (Isukuru et al., 2024). However, some major challenges (e.g., fragmentation of water management duties, lack of stakeholder and institutional coordination, and ill-equipped institutional capacity) undermine the efficacy of IWRM.

A more robust governance structure is necessary for IWRM to be effective. This will help provide accountability, transparency, and more integrated water management with urban development planning. Also, local communities must have a stronger role in consultation and decision-making in water governance because community participation in water management policy recommendations is crucial to collective equity (Gusikit & Lar, 2014). Local authorities must build on environmental stressors such as pollution and over-extraction of groundwater that could contribute to efficiencies with sustainable water use.

There have been successful implementations of IWRM frameworks in urban settings worldwide that can provide insight into cities like Lagos. For example, the water demand management strategies in Cape Town, South Africa (as part of its Integrated Water Management) have been the driving force behind balancing urban water supply and demand in the city. Notably, during the 2018 water crisis, Cape Town developed integrated water management approaches that included their public awareness campaign on water-saving strategies and technologies, smart water metering, and water-saving devices to assuage the worst drought the city has faced in recorded history (Wang et al., 2024). To this end, Mexico City has also worked through IWRM strategies, including rainwater harvesting, wastewater treatment, and public-private partnerships, to provide better water security in a city with substantial water shortages, ultimately from over-extraction (Abolarin et al., 2024).

Despite its promise, IWRM often faces implementation gaps in cities like Lagos due to fragmented institutional mandates, weak enforcement, and lack of data integration. Lessons

from Cape Town and Mexico City reveal that IWRM can be effective when embedded within broader governance reforms and citizen engagement strategies.

2.4 Technological Innovations and Pollution Control in Urban Water Systems

Technological innovations are increasingly central to the effective management of urban water systems, particularly in rapidly growing megacities with ageing infrastructure and significant maintenance backlogs (Abolarin et al., 2023). In cities like Lagos, such innovations have the potential to enhance water supply reliability, improve water quality, reduce losses, and build resilience in the face of climate change (Ipinnaiye & Olaniyan, 2023).

One such innovation is Managed Aquifer Recharge (MAR), including intentional recharge using surface water. This approach has been deployed in various water-stressed contexts—including Algeria, Canada, and the United States—to augment groundwater resources (Olabode & Comte, 2024). In Lagos, where over-extraction and groundwater contamination present pressing concerns, MAR represents a promising strategy for sustainable water resource management. However, it remains challenged by the need for continuous monitoring and effective system oversight (Abolarin et al., 2023).

Equally promising are smart water grids, which employ sensor networks, data analytics, and real-time monitoring systems to optimise water distribution, detect leakages, and manage water quality (Faivre et al., 2017). These technologies support demand-side efficiency and facilitate adaptive and resilient water systems. The case of Singapore illustrates the potential of smart grids to reduce losses and operational costs while enhancing service delivery (Wang et al., 2024). Similarly, Cape Town has adopted real-time monitoring technologies to manage demand effectively, especially during periods of drought (Abolarin et al., 2024). In Lagos, where outdated infrastructure and operational inefficiencies persist, smart grid systems could enable a shift towards more equitable and efficient water distribution, especially for underserved populations.

Innovations in wastewater treatment technologies also offer significant contributions to urban water sustainability. Advanced systems such as Membrane Bioreactors (MBRs) and Advanced Oxidation Processes (AOPs) have the capacity to treat wastewater to standards suitable for non-potable reuse in agriculture, industrial processes, and municipal applications (Zhao & Boll, 2022). In Lagos, ineffective wastewater management has severely impacted

water bodies such as the Lagos Lagoon, contributing to environmental degradation and public health risks (Adeoti et al., 2023). The adoption of these advanced treatment technologies would enhance reuse potential, reduce contamination, and mitigate the environmental footprint of urban wastewater.

Despite these technological opportunities, water quality degradation remains one of the most pressing challenges in Lagos. Although the city possesses significant freshwater resources, their availability and safety are undermined by contamination from urban runoff, industrial effluents, limited sanitation infrastructure, and institutional fragmentation (Isukuru et al., 2024). A large share of the population depends on informal water sources, including self-supplied boreholes and water vendors, which are often unregulated and linked to recurrent outbreaks of waterborne diseases such as cholera and typhoid (Olabode & Comte, 2024).

The uncontrolled discharge of untreated or poorly treated wastewater into surface water bodies—including the Lagos Lagoon and the Ogun River—further exacerbates pollution. These discharges introduce nitrates, heavy metals, pharmaceuticals, and other pollutants into the environment (Adeoti, Kandasamy, & Vigneswaran, 2023). Lagos has limited wastewater treatment capacity, with only approximately 10% of effluent being treated before disposal (AfDB, UNEP & GRID-Arendal, 2020), severely undermining efforts toward water quality improvement.

In addition to centralised systems, decentralised wastewater management approaches offer underutilised yet viable solutions. These include the treatment and reuse of wastewater near its point of generation, which can be particularly beneficial in informal settlements lacking piped sewer infrastructure (Gutiérrez & Glückler, 2022). Decentralised systems provide greater flexibility and adaptability, enabling communities to respond to localised needs and enhancing the overall resilience of urban water systems (Mabhaudhi et al., 2019).

Nonetheless, the implementation of these technological innovations often encounters substantial barriers. High capital investment costs, elevated operational and maintenance demands, and a shortage of skilled labour limit their adoption in cities like Lagos. For instance, Mexico City—a similarly water-stressed metropolis—has faced significant challenges in deploying cost-effective water recycling technologies due to limited financial and technical capacity (Wang et al., 2024).

Beyond technological interventions, addressing water pollution in Lagos requires comprehensive pollution control strategies, particularly upstream or source-control measures.

At present, the city lacks robust mechanisms to monitor industrial waste discharges, and most industries do not routinely conduct environmental impact assessments or comply with effluent discharge standards. Weak enforcement, regulatory overlap, and political inertia continue to hinder progress. There is an urgent need to strengthen oversight mechanisms, particularly through institutions such as the National Environmental Standards and Regulations Enforcement Agency (NESREA), and ensure compliance with national regulations (Abolarin, Chinade, & Abdulsamad, 2024).

In this context, community-based monitoring and citizen science have emerged as valuable complements to formal regulation. These approaches can address gaps in environmental information and promote greater transparency, especially in contexts where institutional enforcement is weak and informal practices are widespread (When et al., 2021). Citizen engagement in pollution monitoring may also foster greater public trust and empower communities to take part in co-governance initiatives.

In sum, technological innovation and pollution control are indispensable components of sustainable urban water management. However, their success is contingent upon robust governance frameworks, adequate institutional capacity, and long-term investment in human and financial resources. In Lagos, integrating these solutions will require a systemic approach that aligns technical advancements with inclusive, participatory, and context-sensitive governance.

The experiences of other global cities provide useful benchmarks for addressing water governance, infrastructure, and quality issues in Lagos. The table below summarizes selected international cases, highlighting their key challenges, implemented solutions, and transferable lessons for the Lagos context.

Table 1.1 - International Case Studies in Urban Water Governance: Lessons for Lagos

City	Key Challenges	Implemented Solutions	Lessons for Lagos
Cape Town	Severe drought (2015–2018), risk of 'Day Zero', water scarcity	Demand-side management, public campaigns, smart metering, rainwater harvesting, desalination (Wang et al., 2024; Abolarin et al., 2024)	Multilevel governance and strong citizen engagement can enhance resilience

México City	Groundwater over-extraction, high leakage rates, fragmented governance	Smart water grid, public-private partnerships, wastewater reuse (Isukuru et al., 2024)	Integrated technological and institutional solutions can improve distribution and efficiency
Singapore	Limited freshwater sources, dependence on imports, climate vulnerability	Smart water systems, full water recycling, real-time monitoring (Wang et al., 2024)	Technological innovation and system integration are critical for long-term sustainability
São Paulo	Water scarcity during dry seasons, urban runoff pollution	Rainwater harvesting incentives, stormwater reuse, regulatory reforms	Decentralised infrastructure and financial incentives promote adaptive urban responses
Bangalore	Seasonal water shortages, informal settlements, pollution	Mandatory rainwater harvesting in buildings, local reuse initiatives	Simple, scalable solutions can support water access in rapidly urbanising contexts

Source: Own Elaboration

Yet, even the most advanced technological and governance interventions are increasingly challenged by the accelerating impacts of climate change. Extreme weather events, sea-level rise, and changing rainfall patterns are placing additional strain on already fragile urban water systems, especially in coastal megacities such as Lagos. As such, the next section explores how climate change intersects with urban water sustainability, highlighting the urgent need for adaptive and integrated responses to preserve water security in a rapidly evolving environmental context.

2.5 CLIMATE CHANGE AND WATER SUSTAINABILITY

Climate change is expected to cause extreme disruptions to urban water systems, one of the biggest challenges facing sustainable urban water resources management in the 21st century. The impacts of climate change are observable in cities like Lagos, where extreme weather events affecting water supply and quality will arise from seasonal flooding, droughts, and sea level rise (Balogun et al., 2017). As climate-related disruptions worsen, the quantity and quality of water resources will be increasingly compromised, prompting the urgency of adaptation strategies to preserve the viability of urban water systems. Lagos is particularly vulnerable due to its geographical location, risks from sea level rise, and high population growth, which can threaten the city's climate resilience (Adeoti et al., 2023).

To achieve Sustainable Development Goal 6 (Clean Water and Sanitation) set out under the 2030 Agenda for Sustainable Development, Lagos must integrate climate adaptation strategies into water policies, urban planning, and infrastructure development (United Nations Environment Programme, 2024). Climate change impacts on water resources require a multi-faceted response to impact, including climate-resilient urban water management practices to ensure access to water and improved water quality while building climate resilience in urban settings.

Climate variability and demographic change have put additional pressure on the existing water resources and infrastructure. Flooding in the rainy season can overwhelm the city's drainage system. This can result in severe public health and environmental disasters. Vulnerable communities, specifically communities in informal settlements, are most exposed to stormwater runoff risks, and the runoff is often contaminated with sewage, solid waste, and chemicals. The dry season is also becoming longer and more intense, compressing the dry season access to freshwater supply and increasing competition for drinking water among drinking water users (Olabode & Comte, 2024). In addition, groundwater extraction, which is unsustainable in many areas, is further reducing access to safe water, and saltwater intrusion, related to rising sea levels, is introducing salt and other pollutants to coastal aquifers (Adeoti et al., 2023).

To address the issue of sustainable water management in the context of climate change, both demand-side and supply-side interventions are needed. On the demand side, water efficiency must be prioritized across all sectors. Public awareness campaigns, water metering, and water-efficient technologies, such as low-flow faucets, toilets, and smart water meters, can significantly reduce per capita water consumption (Raimondi et al., 2023). For example, Cape Town, South Africa, successfully reduced daily water consumption from 1,200 million liters to 500 million liters during the 2017–2018 drought through comprehensive water-saving initiatives (Wang et al., 2024). Lagos can adopt similar strategies, focusing on behavioural changes and regulatory measures to manage water demand and ensure long-term sustainability.

Diversifying water sources will be critical on the supply side of sustainable water management. Non-conventional water supply options, including rainwater harvesting (RWH), stormwater reuse, and desalination, can augment the urban water system's conventional surface and groundwater sources. RWH is an effective and low-cost decentralized solution to

supply fresh water while reducing demands on municipal infrastructure and providing water supply options for irrigation, industrial processes, and sanitation (Raimondi et al., 2023). Rainwater harvesting programs in cities like Bangalore, India, and São Paulo, Brazil, provide success stories for RWH in meeting urban water supply challenges through private and commercial system installations with added financial incentives that capture and reuse stormwater (Abubakar, 2019). Based on these successes, Lagos could follow suit by implementing similar financial incentives for RWH as long-term solutions for the challenges of urban water supply changes.

Addressing water sustainability and climatic uncertainty challenges also require climate-resilient governance that supports and provides opportunities for sustainable water management. Interventions must focus on institutional arrangements to support inter-agency coordination, stakeholder engagement, and adaptive policy management. Integrated climate adaptation and water management require collaborative governance with external actors across water, health, housing, and disaster management sectors. For example, the Netherlands uses adaptive delta management that integrates climate forecasting, risk assessments, and long-term infrastructure planning to holistically develop approaches to address the threats posed by climate change (When et al., 2017; Wang et al., 2024).

For Lagos, enhancing water sustainability under climate uncertainty requires integrated adaptation policies that combine behavioural change, diversified supply strategies, and risk-based planning. Yet, such adaptation must align with institutional capabilities and prioritize social equity to avoid reinforcing existing vulnerabilities.

The literature reviewed highlights the multidimensional nature of urban water management in rapidly expanding cities, particularly in contexts marked by institutional fragility, socio-spatial inequalities, and environmental pressures. Central themes include the limitations of fragmented governance structures, the uneven implementation of integrated water management frameworks, the role of technological innovation under conditions of infrastructural deficit, and the challenges of ensuring water quality and pollution control in informal and under-regulated settings. Climate change further intensifies these dynamics, exposing systemic vulnerabilities and reinforcing the need for adaptive, context-specific responses. These interconnected dimensions point to the importance of approaches that account for local realities, socio-political dynamics, and the situated experiences of those involved in water governance.

3

METHODOLOGY

3.1 RESEARCH DESIGN

The aim of this research is to understand how different actors involved in the water sector in Lagos perceive and deal with the challenges of ensuring a sustainable and safe water supply. The study focuses on identifying the main governance and infrastructural constraints, as well as the responses developed at institutional, technical, and community levels. Particular attention is given to the way these actors interpret their roles, navigate overlapping responsibilities, and engage with broader environmental and urban pressures.

This study adopts a qualitative case study design to examine sustainable water supply management in Lagos, Nigeria. Given the multidimensional nature of water governance and infrastructure challenges in large urban centres, a qualitative approach was selected to explore how key actors interpret, negotiate, and respond to water-related issues in their specific institutional and socio-environmental contexts. The approach is particularly suited to understanding the complex interplay between structural, political, and ecological factors that shape urban water systems.

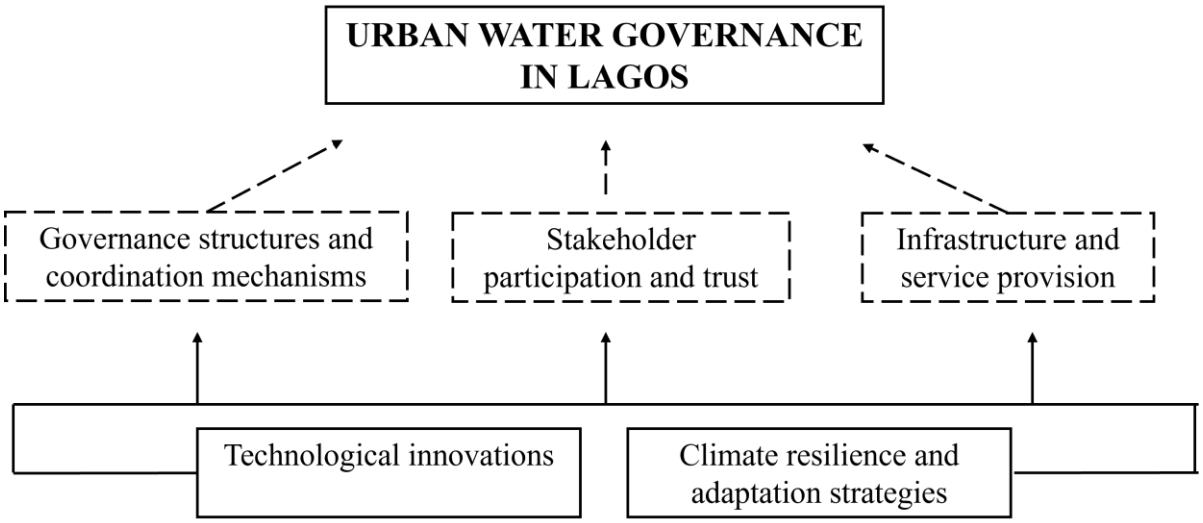
Following Yin (2018), case study research is appropriate when investigating contemporary phenomena within their real-life context, particularly when the boundaries between phenomenon and context are not clearly delineated. A single-case embedded design was adopted to allow for the analysis of multiple stakeholder perspectives and thematic dimensions within the bounded context of Lagos. The city of Lagos represents a critical case due to its rapid urban expansion, infrastructural deficits, institutional fragmentation, and

exposure to environmental stressors such as flooding and sea level rise. The embedded design enabled the exploration of these dynamics across different institutional, community, and technical actors involved in the governance of urban water.

This research follows an interpretivist epistemological orientation, recognising that water governance challenges are socially constructed and that contextual issues are best understood through the lived experiences and interpretations of the relevant stakeholders (Gusikit & Lar, 2014). The emphasis lies on meaning-making and contextual understanding, rather than on statistical generalisation. Accordingly, the qualitative methodological approach was selected to allow for in-depth engagement with the local realities and the complexity of governance processes.

To guide the empirical investigation, a simple analytical model was developed, grounded in the literature reviewed in Chapter Two and aligned with the research objectives.

Figure 3.1 - Analytical Model



Source: Own Elaboration

This analytical model outlines five interrelated dimensions that shape the governance of urban water systems in Lagos. The first dimension refers to governance structures and coordination mechanisms, encompassing the institutional configuration of water-related agencies, their mandates, and the degree of cooperation or fragmentation between them. It considers how responsibilities are distributed and how coordination, or lack thereof, influences the effectiveness of water management. The second-dimension addresses stakeholder participation and trust, focusing on the formal and informal processes through which different actors, governmental, non-governmental, and community-based, are involved in water

governance. It also reflects on the levels of trust, mistrust, and legitimacy associated with these interactions and institutions.

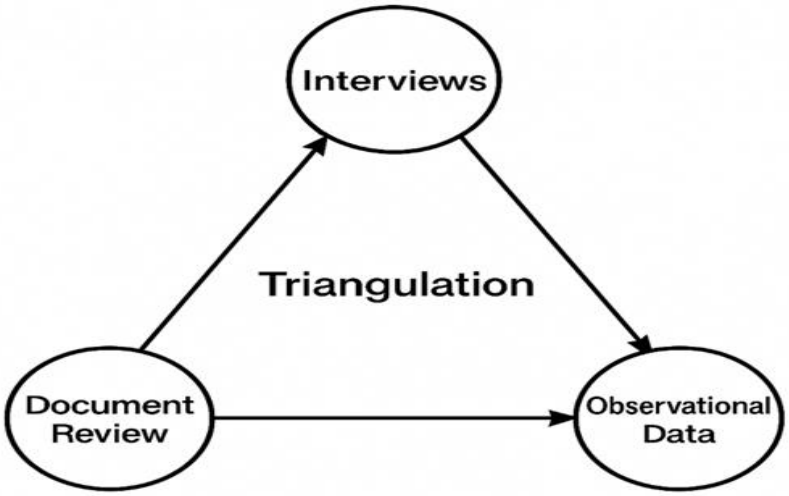
The third dimension concerns infrastructure and service provision. This includes the physical condition of water infrastructure, the quality and continuity of services, and the spatial inequalities in access to water and sanitation across different neighbourhoods. The fourth dimension focuses on technological innovations, exploring how new and existing technologies, such as smart water grids, decentralised treatment systems, or rainwater harvesting, are introduced, adapted, or resisted within the urban water system. It also considers the socio-technical and financial constraints that shape the uptake of such technologies.

Finally, the fifth dimension relates to climate resilience and adaptation strategies. It captures how institutions and communities perceive and respond to environmental stressors such as flooding, droughts, or sea level rise. This includes both proactive and reactive strategies, the integration of climate concerns into planning, and the capacity to build adaptive water systems under conditions of uncertainty. Taken together, these five dimensions offer a coherent lens through which to examine how water governance unfolds in Lagos, helping to make sense of the interactions between institutions, social actors, and the broader environmental context.

3.2 DATA COLLECTION METHODS

To ensure methodological rigor, the study employed triangulation by integrating semi-structured interviews, systematic document review, and direct field observations. Semi-structured interviews with officials of the Lagos Water Corporation, representatives of the Lagos State Water Regulatory Commission, Ministry of Environment staff, community leaders, and development-agency experts yielded in-depth insights into governance arrangements, infrastructure challenges, and adaptation strategies. The document review encompassed Nigeria's national water policy, Lagos State Water Law, institutional reports, and technical publications to contextualize and triangulate interview data. Field observations in three purposively selected urban districts captured the condition of water infrastructure, informal access points, and resident water-collection practices. Data from each method was coded and compared to identify convergent and divergent themes, thereby strengthening the credibility of findings and providing a comprehensive understanding of water governance in Lagos.

Figure 3.2 - Triangulation of Data Collection Methods



Source: Own Elaboration

This combination of data collection methods was designed to respond directly to the research aim of understanding how sustainable water governance is structured and experienced in Lagos. Semi-structured interviews enabled the exploration of institutional perspectives and stakeholder narratives; document analysis grounded these views within existing legal and policy frameworks; and field observations revealed the everyday realities of infrastructure access and coping strategies in diverse neighbourhoods.

To explore the individual perceptions of the actors involved, semi-structured interviews were used as the primary data collection technique. Interviews are one of the most widely used methods in qualitative research. A semi-structured interview is an instrument in which the researcher follows a set of guiding questions organised in an interview guide or protocol, while maintaining the flexibility to alter the sequence of questions and to pose additional questions where necessary in order to further explore the interviewee's responses (Bryman., 2012).

The main purpose of a semi-structured interview is to enable the researcher to understand how respondents perceive specific dimensions of the research, while also allowing for flexibility in the flow of conversation (Kvale, 1996). This flexibility is achieved through the way the questions are formulated. The construction of questions should leave room for alternative lines of inquiry that may emerge during the data collection process—this is, in fact, one of the core principles of qualitative research.

Semi-structured interviews allowed for flexibility in exploring emergent themes while maintaining structural consistency across interviews (Adeoti, Kandasamy, & Vigneswaran, 2023). The interview script was designed to gather data on governance issues, infrastructure, stakeholder engagement, technological innovations, and climate adaptation strategies for accessing water in urban domestic settings (cf. Appendix).

Relevant policy documents, institutional reports, legal frameworks, and technical papers were reviewed to triangulate interview data. These documents included Nigeria's national water policies, Lagos State's Water Law, the Sanitation and Wastewater Atlas of Africa (AfDB, UNEP, & GRID-Arendal, 2020), and reports on the status of the IWRM implementation plan (United Nations Environment Programme, 2024). The document reviews helped contextualize stakeholder views by framing them within the broader institutional and policy frameworks governing water and sanitation in Lagos.

Observations were conducted in selected urban districts to understand how residents experience accessing water, the condition of water infrastructure, and the sanitation environments present. These observations provided valuable evidence of infrastructural poverty, informal water access points, and how communities cope with these challenges (Isukuru et al., 2024). Field notes from observations also highlighted the spatial distribution of water access and revealed critical gaps in service provision across different neighbourhoods.

3.3 SAMPLING STRATEGY AND DATA ANALYSIS

The study employed purposive sampling to ensure that all major stakeholder categories in Lagos's water sector were represented. A total of 14 participants were selected on the basis of their professional role, sector influence and ability to shed light on governance, infrastructure and community coping strategies. Data collection continued until theoretical saturation was reached - that is, the point at which no new conceptual insights were emerging from additional interviews, and the core analytical categories were sufficiently developed (Guest et al., 2006). Interviews were conducted in English, lasted between forty-five and seventy-five minutes, and took place at either participants' offices or community meeting points. Table 3.1 summarizes the professional background, demographic characteristics, duration of work experience and interview length for each participant.

Table 3.1 - Profile of Interview Participants

Participant	Profession	Gender	Age (years)	Work Experience (years)	Interview Duration (minutes)
P1	Lagos Water Corporation Engineer	F	45	20	31
P2	Lagos Water Corporation Manager	M	50	25	47
P3	Lagos Water Corporation Senior Technician	M	38	15	34
P4	Community Development Association Chair	F	42	10	27
P5	Community Development Association Secretary	M	35	8	34
P6	Community Development Association Member	F	29	5	45
P7	Community Youth Leader	M	31	6	38
P8	WaterAid Nigeria Programme Officer	F	36	12	32
P9	Environmental Rights Action Advocate	M	48	18	39
P10	Private Borehole Driller	M	40	15	29
P11	Private Borehole Driller	M	33	8	24
P12	University of Lagos Lecturer (Civil Engineering)	F	52	22	48
P13	Nigerian Institute for Oceanography & Marine Research Scientist	M	44	20	34
P14	Federal Ministry of Water Resources Liaison Officer	F	47	23	42

Source: Own elaboration.

Snowball sampling was also employed to identify additional participants through referrals, especially for reaching stakeholders in informal communities often excluded from formal data-gathering efforts. This technique was particularly useful in accessing hard-to-reach populations (Arimoro & Musa, 2020).

Following the transcription of the interviews, the data analysis process was initiated using NVivo Qualitative Data Analysis Software (QSR International Pty Ltd., version 11.1, 2015). A combined approach was employed: a directed content analysis based on categories informed

by the literature review (Hsieh & Shannon, 2005), alongside a conventional content analysis approach that allowed for the emergence of open codes grounded in the data itself (Bardin, 2008).

The identification of themes was carried out through a coding process, which is widely recognised as a key step in qualitative data analysis (Bryman, 2012). Coding serves both to interpret the meaning of the data and to reduce its complexity. The analysis also included an exploratory count of the frequency of references assigned to each category, to gauge the relative salience of themes (Namey et al., 2008). While frequency counts can be skewed (particularly if certain respondents repeat the same idea) this metric can still offer a useful indication of how widely certain topics were raised. To assess thematic prevalence, relative frequencies (the proportion of specific references to total references per category or subgroup) were used to highlight variations across interviewee profiles (Namey et al., 2008).

Nonetheless, these frequency indicators must be interpreted with caution. They are not intended to serve as precise quantitative measures of preferences or behaviours, but rather as exploratory suggestions within the broader qualitative analysis. This mixed deductive–inductive approach ensured that the analysis was both systematically structured and grounded in participants lived experiences.

3.4 ETHICAL CONSIDERATIONS

This study followed standard ethical research procedures, ensuring all ethical considerations were made throughout the research. Before data collection began, ethical approval was obtained from the relevant ethical review board. Informed consent was sought from all participants, who were also assured confidentiality through anonymizing data. Although pseudonyms were used when reporting findings to further protect participant identities, participants granted consent to share their information at unidentifiable levels. The research was particularly aware of ethical considerations including marginalized voices, especially those who live in informal settlements that experience heightened water insecurity while often being excluded from prominent policies (Isukuru et al., 2024). In that way, the study tried to include culturally appropriate languages and environments for interviews, allowing the researcher to be flexible and supportive to build trust and open exchange of ideas with some of the official stakeholder respondents who participated in this study.

Protocols were strictly adhered to for the storage of data, including all digital recordings, transcripts, and data analysis files, with access to the data limited to research team members. Participants were allowed to withdraw from study participation at any time without penalty. Finally, this research study also stressed transparency of research and voluntary consent of all participants, ensuring that they fully understood the purpose and nature of the research before they agreed to participate.

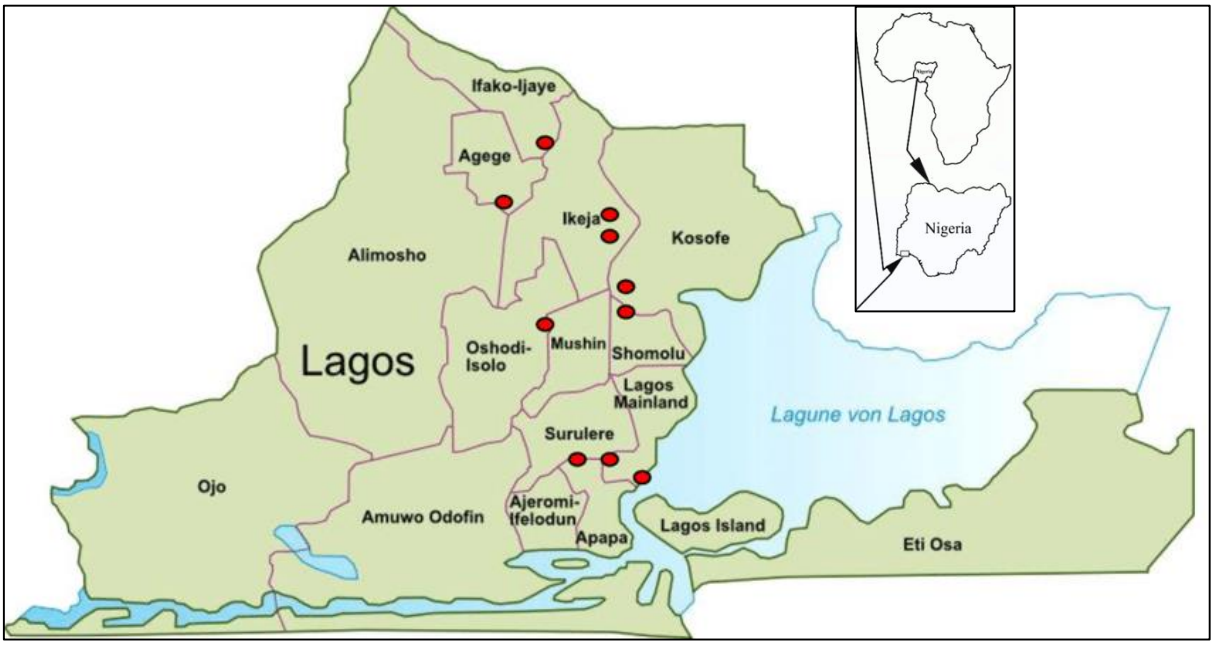
4

CASE STUDY

4.1 CONTEXTUALIZATION

Located in southwestern Nigeria, Lagos lies on the Gulf of Guinea along the Atlantic coast of West Africa (Figure 4.1). The city borders Ogun State to the north and east and is separated from the Republic of Benin by a narrow western corridor.

Figure 4.1 - Lagos (Nigeria) Map



Source: Adapted from Lawal & Iwajomo (2020) and Fajemila et al. (2022).

It is characterised by a low-lying topography interspersed with lagoons, creeks, and barrier islands, including Lagos Island, Victoria Island, and Ikoyi, which are connected to the

mainland through a network of bridges and causeways. The presence of extensive wetlands and proximity to the Atlantic Ocean have historically shaped Lagos's urban morphology while simultaneously exposing it to coastal and fluvial hazards, such as flooding, erosion, and saltwater intrusion (Oteri & Ayeni, 2013).

Historically, Lagos originated as a Yoruba fishing village and evolved under Portuguese and then British colonial influence. Annexed by the British in 1861, it became a critical node in regional maritime trade and served as Nigeria's capital until 1991 (Oteri & Ayeni, 2013). While it no longer holds political capital status, Lagos remains the country's most significant economic and demographic centre. As of 2020, its metropolitan population was estimated to exceed 20 million inhabitants, positioning it among the world's fastest-growing megacities (UN-Habitat, 2020). The city contributes approximately 30% of Nigeria's GDP and is home to some of the country's largest industrial zones, financial institutions, and the Port of Lagos, actually one of the busiest in Africa (World Bank, 2021).

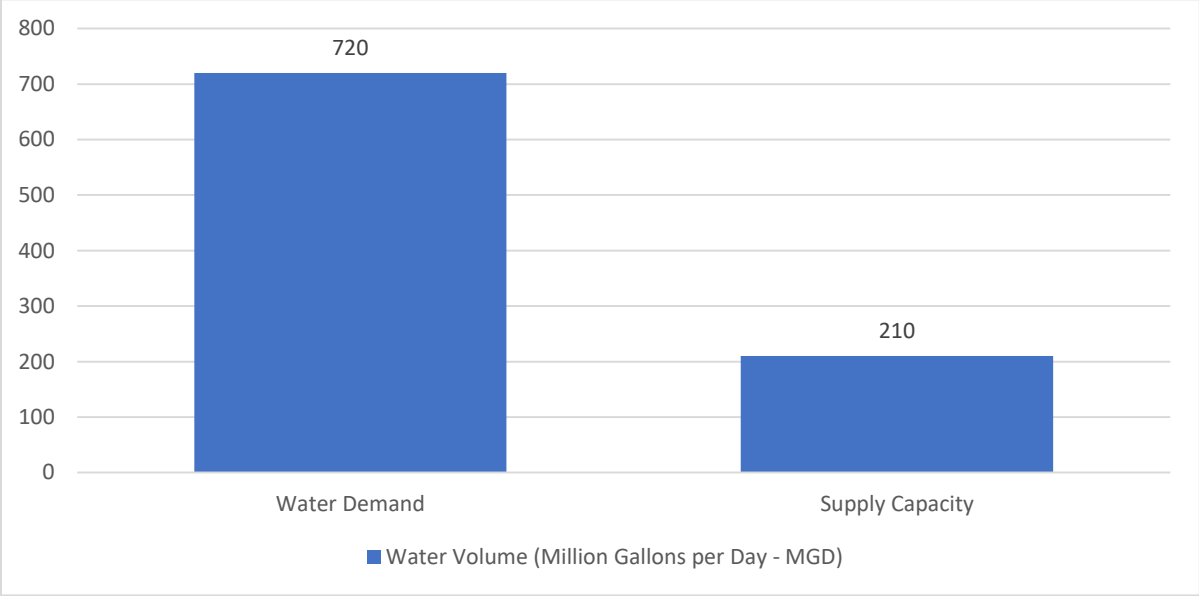
Despite its economic centrality, Lagos exemplifies the challenges of urbanisation in the Global South. The city's growth has occurred largely in the absence of coordinated urban planning, producing acute spatial and social inequalities. A significant proportion of the population lives in informal settlements, often without secure tenure or access to basic services. Urban infrastructure, particularly water, sanitation, and transportation systems, has not kept pace with demographic expansion, and institutional fragmentation hampers effective service delivery. These structural vulnerabilities are compounded by climate-related risks, including sea-level rise and increasingly erratic rainfall patterns, which threaten infrastructure and public health, particularly in low-income areas (Adeoti et al., 2023).

These multidimensional pressures expose the limits of existing governance structures and highlight the critical role of essential services, especially water supply, in mediating urban inequality and vulnerability. Access to clean and affordable water is not only a fundamental right but also a determinant of broader health, economic, and environmental outcomes. In a city like Lagos, where informal systems often substitute for formal provision, the water sector becomes a lens through which to understand both institutional shortcomings and everyday practices of adaptation and resilience among residents.

The water supply system in Lagos is marked by a profound structural imbalance between growing demand and limited supply capacity (figure 4.2). Current estimates place the daily water requirement for the city at approximately 720 million gallons per day (MGD),

while the Lagos State Water Corporation (LWC) operates with a production capacity of only 210 MGD (LWC, 2022). For reference a MGD is 3,785.41 m³/day. This means that less than one-third of the daily needs of the population are met by the formal system. The implications of this deficit are intensified by the city's demographic expansion, with Lagos projected to surpass 24 million inhabitants by 2030, further exacerbating pressures on already overstretched infrastructure (UN-Habitat, 2020).

Figure 4.2 - Comparison of Water vs Supply Capacity in Lagos in 2022



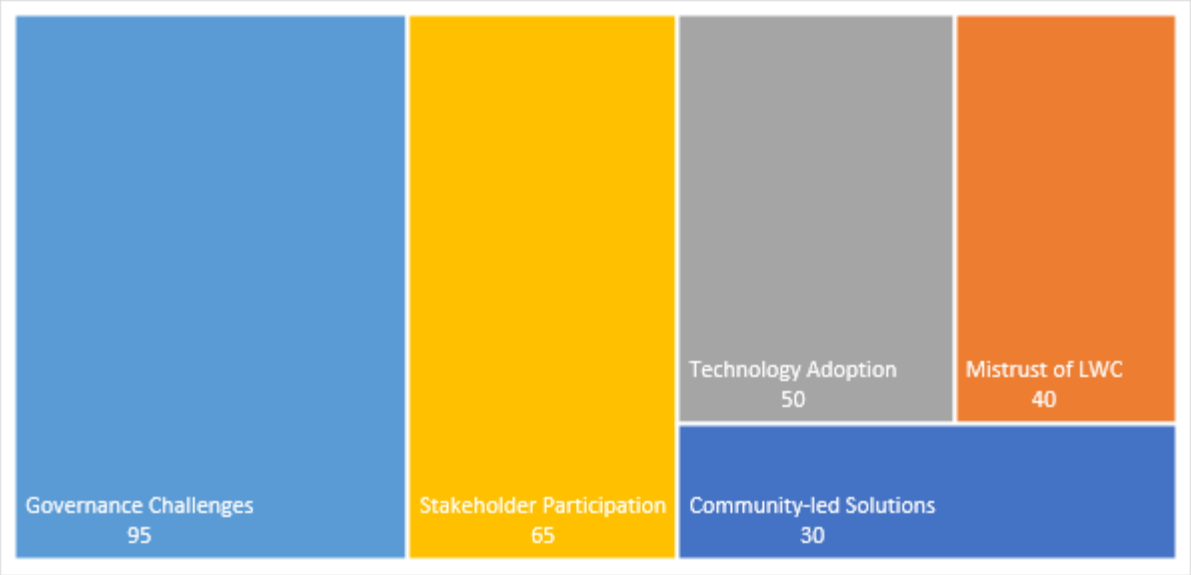
Source: Own Elaboration based on data by LWC, 2022

The structural mismatch between water supply and demand in Lagos highlights more than a technical shortfall; it reflects deeper systemic issues rooted in the city's mode of urbanisation. The strain on water infrastructure is emblematic of broader development challenges in rapidly expanding cities of the Global South, where formal systems are routinely outpaced by population growth and spatial transformation. In this context, water provision emerges not only as a logistical concern but also as a terrain of urban inequality, where access is shaped by geography, income, and institutional reach. Understanding the persistence of these deficits requires attention to the governance landscape that underpins infrastructure delivery. Lagos presents a complex assemblage of actors, mandates, and regulatory frameworks, often operating in parallel or at cross-purposes.

To further examine the thematic prominence of key issues raised by participants, a visualisation technique was employed to synthesise the results of the interview analysis. The figure below presents a tree map, which illustrates the relative frequency of major themes

coded from the interview transcripts. This graphical representation uses nested rectangles to convey the number of references associated with each theme, allowing for a comparative visualisation of the topics that emerged most strongly across the dataset. Each block is sized in proportion to the volume of coded material, thereby reflecting the perceived importance of each dimension as articulated by the interviewees.

Figure 4. 3 - Key Challenges in Urban Water Management in Lagos



Source: Own Elaboration

As shown in the tree map, governance challenges clearly dominate the discussion, with 95 coded references, underscoring the centrality of institutional fragmentation, weak regulatory enforcement, and coordination failures in shaping the water management landscape in Lagos. The theme of stakeholder participation (65 references) also featured prominently, pointing to both aspirations for inclusive governance and persistent barriers to meaningful engagement. Technology adoption (50 references) and mistrust of the Lagos Water Corporation (LWC) (40 references) reveal the tensions between innovation and institutional credibility in the current system. Finally, while community-led solutions (30 references) were the least frequently mentioned, they nonetheless represent important adaptive practices, particularly in underserved areas where formal services are absent or unreliable. These findings serve as an analytical entry point for a more detailed exploration presented in the following sections.

4.2 GOVERNANCE CHALLENGES

The analysis of interview data revealed that governance-related issues are widely perceived as the most pressing obstacle to sustainable and equitable water provision in Lagos. These findings underscore the systemic nature of governance failures in shaping access, equity, and resilience in the urban water sector.

Analysis of interview transcripts, policy documents and field observations reveals that Lagos's water-treatment and distribution infrastructure operates at approximately seventy-five per cent of its design capacity. Non-revenue water losses, driven by pipeline leaks, illegal connections and metering failures, account for nearly forty per cent of treated output. Fragmented institutional mandates and overlapping regulatory responsibilities further constrain timely decision-making and resource allocation. One of the most prominent themes that emerged from the interviews was the fragmentation of governance structures. A participant from the Lagos Water Corporation (LWC) highlighted the challenges posed by the overlapping responsibilities of different agencies:

> *"There's a lot of overlap between the responsibilities of various agencies in Lagos, and this fragmentation complicates water management efforts"* (Interviewee #3, May 08, 2024).

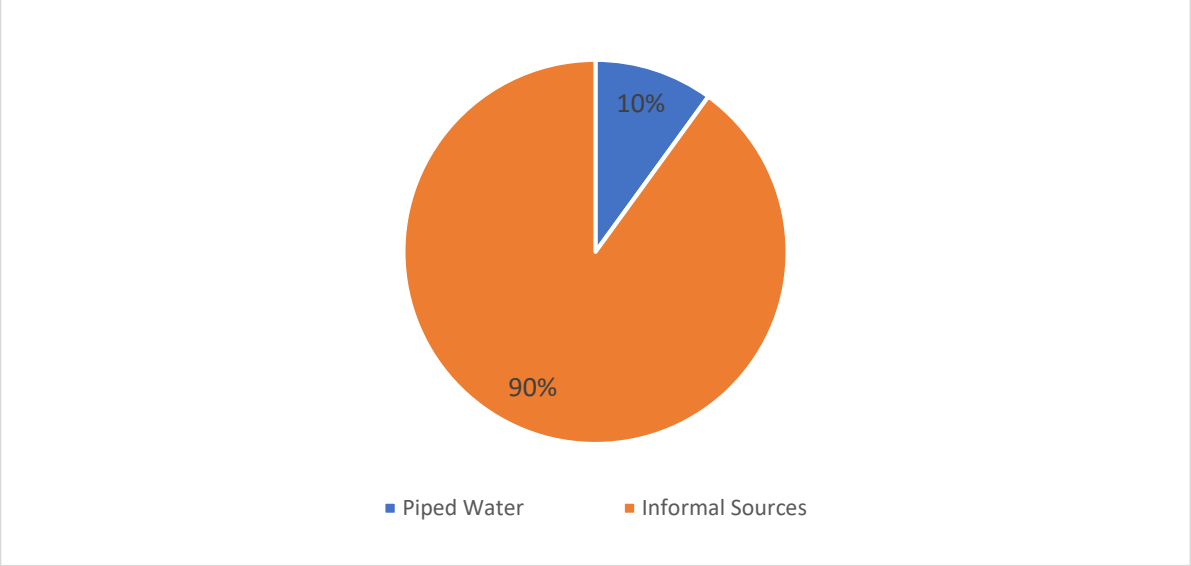
This concern aligns with prior research (Abolarin et al., 2024), which identifies inter-agency coordination failures as a central obstacle to effective water governance in Lagos. For example, conflicting directives between the Lagos Water Regulatory Commission and the Ministry of Environment have delayed critical maintenance and expansion projects. These governance shortfalls contribute to frequent service interruptions, inequitable access across urban districts and deteriorating water quality in peripheral settlements.

On further analysis of access to public water, it can be seen that there are high levels of differences where only 10 per cent of the city population has piped water (figure 4.4). Most tenants, especially those in the informal settlements and underserved communities, use alternative water supplies in the form of individuals own boreholes, water sellers, and the risking taps.

These alternative sources relieve some pressure but are not guaranteed to produce water of good quality and reliability and are usually very costly. This dependency on the informal water systems is the direct result of poor coverage of the formal supply system, and

thus, much of the population is exposed to waterborne illnesses and other health problems. The information highlights the necessity of structural reforms of how water is managed in order to make that resource available to everyone in the population on a fair basis, especially people living in disadvantaged groups.

Figure 4.4 - Water Access Distributions



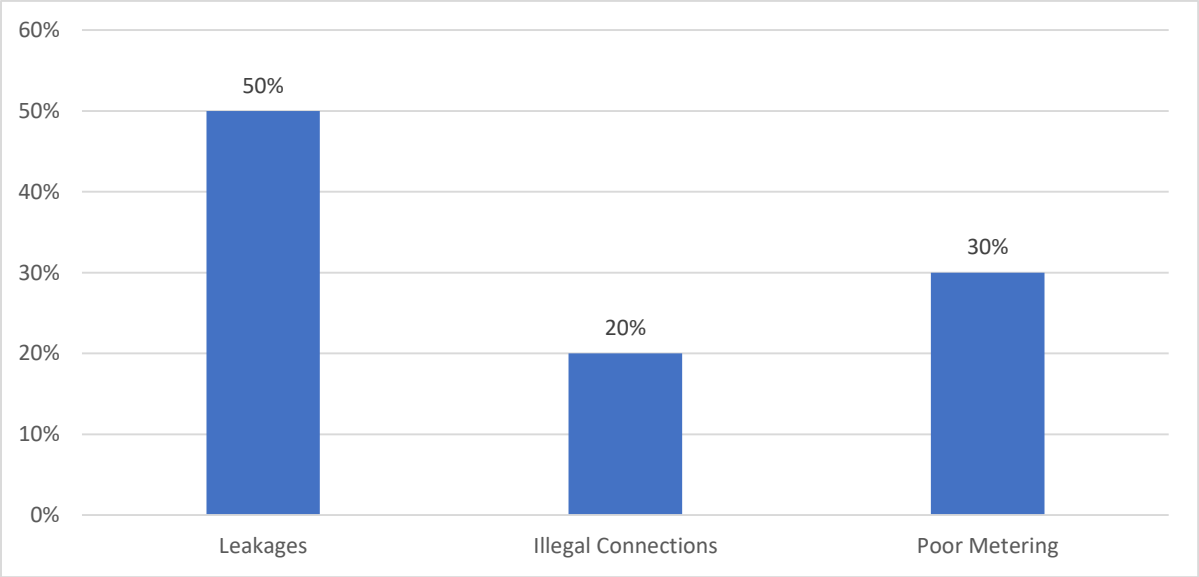
Source: Own Elaboration

In addition to the issue of limited access, non-revenue water (NRW) emerges as a significant challenge. The portion of water produced but not metered by the consumers is estimated to be more than 50 per cent in Lagos. The resulting level of water loss is quite substantial and could be explained by the combination of problems, such as illegal connections, experimental age infrastructure, and ineffective metering systems. Interviews conducted with the Lagos State Water Regulatory Commission (LASWARCO) officials showed that the absence of substantial monitoring and ineffective enforcement creates a good environment where illegal connections are widespread. This means that the city cannot account for a huge percentage of its water production, increasing the burden on the limited resources already available to satisfy the demand. Such water management waste increases the difficulties of having stable and fair water provision for the people.

The sanitation predicament in Lagos is also troubling. The number of people in the city enjoying good sanitation facilities is about 24%, with a huge number lacking good waste disposal or sewage functions. Sanitation is the key problem in informal settlements, where sanitation facilities are minimal, and waste disposal mechanisms are open and not regulated.

Besides increasing water pollution, the scenario is dangerous to people, where raw sewage is most often drained in bodies of water like the Lagos Lagoon and other rivers. The inadequate provision of sanitation services worsens the management issues of water, leading to a general deterioration of the water quality in the city.

Figure 4.5 - Non-Revenue Water Breakdown in Lagos



Source: Own Elaboration

Water quality in Lagos is also a major concern, especially in the informal water source serviced areas. Although the Lagos State Water Regulatory Commission undertakes regular checks and inspections on water quality and quality, enforcement of standards on water quality in the city remains poor. Most citizens, especially those living in underserved regions, have complaints that they are using untreated water drawn out of privately dug holes or buying untreated water from hawkers who are not licensed to provide such services, which is extremely dangerous to people. This situation is also worsened by the absence of a complete water quality surveillance mechanism where most inhabitants are not informed of the probable threats of using untreated water. Such a scenario brings into consideration more stringent regulations and the need to invest more in water quality assurance to ensure the health security of the population.

These findings illustrate a persistent pattern of infrastructural underinvestment and institutional fragmentation that shapes the governance of water in Lagos. Rather than reflecting isolated technical problems, the challenges identified by interviewees point to deeper structural deficiencies, including overlapping mandates, weak enforcement capacity,

and limited institutional accountability. In the absence of an effective and coherent regulatory framework, water provision has become increasingly reliant on informal arrangements that escape public oversight and often reproduce existing inequalities in access, cost, and quality.

The interview data also reveal widespread concerns regarding the lack of coordinated leadership, the proliferation of institutional actors with conflicting responsibilities, and the exclusion of citizens from decision-making processes. This was strongly echoed by a community leader:

> *"The government doesn't consult with the people when making decisions on water, and we're the ones who are directly affected"* (Interviewee #7, May 12, 2025).

These governance deficits not only undermine the effectiveness of infrastructure development but also erode public trust and reinforce the vulnerability of already marginalized communities. As such, addressing the water crisis in Lagos requires more than technical fixes. Instead, it highlights the need for integrated and participatory governance reforms that recognize the interdependence of social, institutional, and environmental factors.

4.3 STAKEHOLDERS' PARTICIPATION AND TRUST

Stakeholder engagement patterns differ markedly by income bracket. In middle- and high-income neighbourhoods, formal public water schemes deliver piped supplies two to three times per week on average. In contrast, fewer than thirty per cent of households in low-income areas receive piped water more than once weekly. Community leaders report reliance on informal vendors, collective borehole drilling and private tanker services to fill supply gaps. These coping strategies often incur per-litre costs up to three times higher than municipal tariffs and expose residents to unregulated water quality risks.

Interviews with development-agency experts underscore the need to integrate community voices into governance forums to better align service delivery with local priorities. However, the interviews revealed that community participation in water governance remains limited, particularly among low-income populations. Several stakeholders expressed concerns over the lack of inclusive decision-making processes. As one respondent from a local NGO noted:

> *"There is little to no involvement of the community in the decision-making processes regarding water access. The people*

> *who are most affected by these policies don't have a voice"* (Interviewee #5, May 12, 2024).

This finding aligns with the literature on participatory governance (Acey, 2018), which highlights the importance of engaging local communities in decision-making to ensure water governance is inclusive and responsive. The absence of participatory mechanisms not only reinforces existing inequalities but also contributes to growing mistrust in public institutions and service providers. In several interviews, participants expressed scepticism regarding authorities' ability or willingness to meet the needs of underserved communities, reinforcing their reliance on informal water solutions.

A related issue raised by several interviewees was the mistrust of the Lagos Water Corporation (LWC), especially among residents of informal settlements. Many expressed frustrations with the lack of transparency and perceived neglect by the LWC. As one community leader stated:

> *"People in our community don't trust the LWC because they've seen little improvement in service delivery, despite paying for water. The LWC doesn't seem to care about the people who live in informal areas like ours"* (Interviewee #8, May 14, 2025).

This mistrust is further compounded by the inequitable distribution of water, with wealthier neighbourhoods often receiving more reliable services (Abolarin et al., 2024). These perceptions of injustice undermine the legitimacy of public institutions and weaken the social contract between providers and citizens.

The limited inclusion of stakeholders in the planning and implementation of water infrastructure projects has broader implications for institutional trust and accountability. In contexts where communities are excluded from governance processes, public perceptions of neglect and marginalisation become widespread. These perceptions are particularly acute in informal settlements, where infrastructure deficits are most pronounced and where citizens report a persistent lack of communication from responsible agencies. As Cleaver (2012) argues, participatory processes that do not adequately redistribute voice and influence risk becoming symbolic, rather than transformative.

Moreover, the lack of transparency around project timelines and funding decisions further weakens trust. For example, delays in the implementation of the Lagos State Water

Supply Master Plan have led to frustration among stakeholders, who see repeated promises of improvement go unfulfilled. Some respondents suggested that such delays reflect deeper governance constraints, including political interference and inadequate inter-agency coordination, which hamper long-term planning and erode public confidence.

4.4 Infrastructure and Service Provision

In terms of infrastructure, the water treatment plant is a current facility that cannot serve an increasing number of people, and the coverage and capacity have huge gaps. For example, the Adiyan water treatment plant, whose operational capacity is at 70 MGD, is not working at full capacity because of a lack of funding and technicality. Even though new work has been done to rehabilitate the existing infrastructure to increase capacities of the existing infrastructure and build mini-water works as additional capacity, the entire system is still not satisfactory to serve the entire population of the city. Lagos State Water Supply Master Plan, which had an implementation period from 2010 to 2020 was expected to boost the water production capacity of the city to 745 MGD (Lagos State Water Corporation, 2011), has been facing delays and budgetary restraints and has also acted as a negative influence in holding the progression to achieve the projected objectives. Such delays show how difficult it can be to scale up infrastructure projects to serve the fast-growing megacity.

This situation is further complicated by the structural imbalance between water demand and formal supply. As noted earlier, the formal water system produces only 210 MGD against an estimated demand of 720 MGD (LWC, 2022), meaning that less than one-third of the population's needs are met. This persistent shortfall has led to the proliferation of informal and often unsafe alternatives such as private boreholes, tanker services, and water hawkers. These alternatives expose the infrastructural gaps more starkly in low-income and informal settlements, where residents lack both piped connections and safe storage options.

In addition to quantity, issues of water quality also stem from inadequate infrastructure. Weak metering systems and aging pipelines contribute to frequent service interruptions and water losses, while poorly maintained treatment facilities compromise the safety of the supply. The reliance on informal distribution systems – prompted by infrastructural underinvestment – results in significant health risks due to the absence of water quality controls.

Moreover, the lack of infrastructure to support effective sanitation further undermines water safety. As described in section 4.2, only 24% of the population has access to adequate sanitation, and raw sewage often ends up in surface water bodies such as the Lagos Lagoon.

This not only pollutes existing water sources but also adds pressure to already insufficient treatment facilities.

Taken together, these elements reveal how infrastructure and service provision are at the core of the water crisis in Lagos. Rather than isolated technical failures, they reflect systemic underinvestment, weak planning, and an inability to match supply systems to the pace and scale of urban growth. Addressing these challenges requires not only technical upgrades but also governance reforms that can ensure sustained investment, coordination, and equitable expansion of infrastructure across the city.

4.5 TECHNOLOGICAL INNOVATIONS

Technology is emerging in the quest to solve some of the water governance issues in Lagos. Internet of Things (IoT) based sensors are being trialed for real-time monitoring of water flow and use, to improve how much of that water is wasted from leaks. New mobile technologies are being developed so that customers can pay their bills and monitor their water usage, as a way to encourage customer engagement and reduce administrative costs. These technologies are promising about improving efficiency and operations, but their scalability is still a tricky issue, especially in low-income areas where access to mobile devices and internet connectivity may fall short. Equally, large capital costs could hinder their growth and uptake. Emerging pilot projects for solar-powered water treatment plants can also reduce the ecological damage done by the energy-dependent water treatment plants of the past. However, the transition into Lagos's water supply system is only beginning.

Another key theme discussed was the potential of technological innovations to address water management challenges in Lagos. A representative from an international development agency mentioned the promise of smart water systems to reduce inefficiencies in water distribution:

> *"Smart meters and sensors could significantly reduce our operational costs by identifying leaks and inefficiencies in the system before they become critical issues"* (Interviewee #2, May 7, 2025).

However, several interviewees also raised concerns about the high initial costs associated with adopting such technologies, especially in a city like Lagos, where funding for infrastructure is limited. One respondent from a community-based organization noted:

> *"The initial costs of installing these systems are too high for our city's budget, and there's not enough skilled labour to manage these technologies"* (Interviewee #4, May 9, 2025).

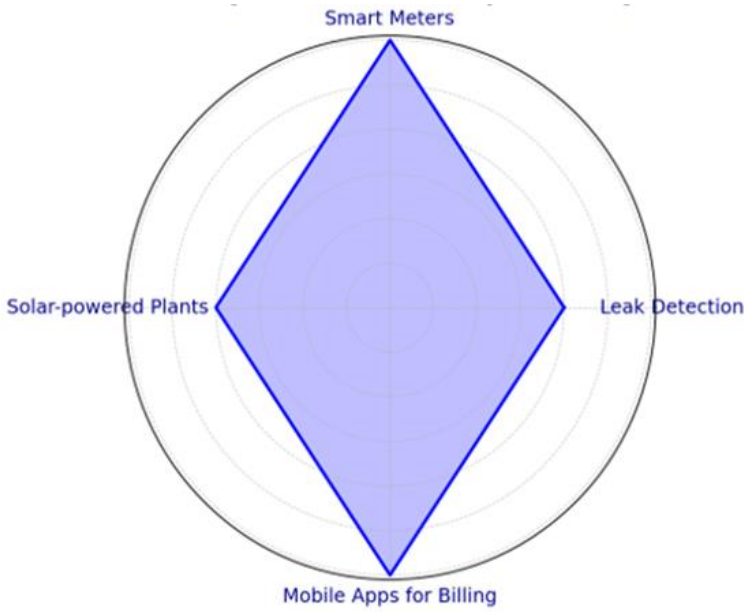
These concerns reflect broader structural constraints that limit the uptake of innovations, particularly in informal or underserved areas where institutional and technical capacities remain weak.

This challenge is echoed in the literature, where economic barriers and digital divides are often cited as critical obstacles to the implementation of technological solutions in urban water systems of the Global South (Raimondi et al., 2023). The uneven distribution of technological infrastructure and training reinforces spatial inequalities and risks creating a two-tiered system, where affluent areas benefit from innovation while poorer communities remain excluded.

Nonetheless, pilot projects have shown that innovation can contribute to long-term improvements when paired with institutional support and targeted capacity-building. To be successful, technological innovations must therefore be accompanied by strategies for local adaptation, affordability, and user training. Without these complementary measures, new technologies risk remaining isolated experiments with limited transformative potential.

The figure suggests a diamond with the main areas of technological innovation discussed in the interviews and document analysis. It highlights the relative emphasis on smart meters, leak detection, mobile applications for billing, and solar-powered treatment systems.

Figure 4.6 - Technological Innovation Adoption Diamond for Lagos



Source: Own Elaboration

While some of these technologies (particularly mobile and smart metering tools) are gaining traction, others remain at an early stage, especially in low-income areas. In this sense, the figure illustrates both the potential and the uneven adoption of innovations in Lagos's water sector.

4.6 Climate Resilience and Adaptation Strategies

In the context of a rapidly urbanising coastal megacity such as Lagos, the resilience of water infrastructure to climate variability constitutes a critical dimension of sustainable governance. Rising temperatures, erratic rainfall patterns, sea-level rise and increasing frequency of flooding events pose direct threats to both water supply and water quality, particularly in low-lying and underserved areas. These environmental stressors interact with pre-existing infrastructural deficits and socio-spatial inequalities, amplifying the vulnerability of large segments of the urban population. As highlighted in previous sections, Lagos's water system is already under severe strain due to a structural mismatch between supply and demand, institutional fragmentation, and widespread reliance on informal coping mechanisms. In this context, addressing climate resilience cannot be separated from broader questions of equity, access, and infrastructural adequacy.

Despite this critical relevance, the empirical data collected through interviews and field observations suggest that climate change is not yet prominently integrated into local narratives

or strategic responses concerning water governance. Stakeholders tended to frame the challenges of water provision primarily in terms of technical capacity, institutional effectiveness, and service delivery gaps. While several participants acknowledged increased pressure on water infrastructure, explicit connections to climate-related risks or adaptation planning were largely absent from the discourse. This omission raises important questions about the extent to which long-term environmental vulnerabilities are recognised and addressed in planning and governance processes.

Although climate resilience and adaptation strategies are recognised in the analytical framework as a key dimension of sustainable water governance in rapidly urbanising contexts, this theme did not emerge strongly in the empirical data collected through interviews and field observations. While several interviewees alluded to infrastructural limitations and the increasing strain on water systems, there were no explicit references to climate-related adaptation measures or policies. This absence may reflect a gap in awareness, institutional prioritisation, or the framing of water governance challenges primarily in infrastructural and institutional terms. Future research could explore how climate adaptation is integrated, or neglected, in local governance agendas and how communities perceive and respond to climate-related risks in the context of water management.

4.7 DISCUSSION

The findings of the present research show that the water governance and management system in Lagos, Nigeria, faces several crucial challenges due to some of the issues related to rapid urbanization, infrastructural gaps, and socio-political issues in the city. On the one hand, Lagos is a megacity with a rapidly increasing population and high urbanization rates, which creates great challenges in satisfying the water demands of Lagos residents. The results of this study depict the existence of an acute difference that exposes the core problem of water shortage between the water demand daily and the capabilities of the Lagos State Water Corporation (LWC) in supplying water. The latter can be further complicated by infrastructure inefficiency manifested as outdated waterworks and mass non-revenue water, which hinders the improvement of water access and quality within this city.

The major outcome of this study is that there is a huge deficit in water supply in Lagos compared to water demand, with only 10 % of the population enjoying piped water. This concern has been adequately reflected in the available literature that has pointed out the structural injustices in the water increases in rapidly expanding urban cities. Equivalent

metropolises, such as those in the Global South, are faced with the issue of managing the challenge of water demand and supply. As an example, the case of Cape Town in terms of its water crisis experienced in the year 2018 showed how the failure of urban water governance could prompt significant shortages in a very short time (Wang et al., 2024). Similar to Cape Town, the water supply system in the city of Lagos is disintegrated and characterized by inequalities whereby the privileged communities have greater access to water distribution services than disadvantaged communities, especially informal settlements (Abolarin et al., 2024).

The water crisis in the city is further aggravated by the problem of NRW, which is estimated to be above 50 percent in Lagos. This statistic correlates with the results of other investigations stating that there are big water losses in cities with underdeveloped infrastructure and ineffective regulation systems. Trying to evaluate the state of water governance in developing cities, Gutierrez-Nava et al. (2024) point out that such inefficiencies (via leakage, illegal connections, or lack of proper metering leads to the fact that they play a decisive role in unequal access to water supply. In Lagos, the NRW is very extensive, and this reduces the ability of the water distribution network to serve the people efficiently. According to the officials of the Lagos State Water Regulatory Commission (LASWARCO), these inefficiencies cause high costs of operations and produce obstacles to expanding services to the underserved groups (Adeoti et al., 2023). Hence, future water governance strategies should focus on solving the problem of NRW through improved technologies for leak detection, enforcement of regulations, and upgrading the systems in Lagos.

The other prominent challenge, as indicated by the findings of this study, is sanitation in Lagos. Water contamination is linked to the low proportions of adequate sanitation service coverage, which in this case is 24 percent. This is a major problem in informal settlements because the residents do not have access to controlled sewer systems, and in most cases. As a result, many of the residents resort to using primitive sanitation processes. Sanitation infrastructure is necessary since it not only influences the well-being and health of citizens but also worsens the contamination of water resources. The available water sources in Lagos are already at a disadvantage because parts of the water bodies are used in untreated wastewater and industrial effluent; this causes water quality to keep degrading in the city. Research on urban water governance has revealed that in the other megacities (Mexico City), a lack of available infrastructure sanitation resulted in the contamination of the ground and surface

water (Isukuru et al., 2024). The key to improving the quality of water and minimizing the threat to the health of citizens in Lagos lies in dealing with these sanitation shortages.

The irregular application of water quality standards further complicates the situation. Although there are regulatory agencies such as LASWARCO that come to do inspections, there is not always adequate enforcement of these high standards, especially in the informal water systems. Several households are also dependent on non-treated water sources, including personalized boreholes and unmonitored water sellers that usually do not conform to the safety norms. The case exemplifies larger issues of governance and regulation most cities in the Global South struggle to solve. Low regulatory supervision and an informal water market are thus making adequate access to safe water very difficult due to market inefficiency, as observed by Olabode and Comte (2024). It would be important to increase regulatory structures and enforcement strategies in Lagos to ensure that all sources of water, especially those used in informal settlements, are acceptable in terms of health and safety.

The results of the water treatment infrastructure also show that the city is battling a shortage of resources and stale infrastructure. However, as there is a continuous attempt to increase the capacity and repair the water treatment plants, such as the Adiyan plant, there is still the need to increase the capacity, which is why the problem is not yet over. The same can be noted regarding other megacities, i.e., people in cities like Sao Paulo face water infrastructure problems as they cannot withstand the fast population growth rate (Singh et al., 2023). The Lagos Water Supply Master Plan targets to raise the production volume of 745 MGD in the city. However, these plans have been stalled by the program's unavailability and financial shortage. It has been lacking in taking proper investments in infrastructure on time, and the issues with the old facilities in Lagos highlight the need for massive changes and investments in the water supply system in Lagos.

Some potential to enhance operational efficiency lies with technological advances, including using IoT-based sensors to detect leaks and mobile applications to reduce water consumption. The scalability of these technologies is, however, a problem. Most low-income sites in Lagos cannot carry these innovations due to the lack of infrastructure to facilitate them, and the prices to maintain them are even prohibitive. Despite these predicaments, one can see potential in the opportunities presented by pilot projects such as solar-powered water treatment plants that can help diminish the aggregate effect of water systems that rely on common sources of energy. Such usages of technology, as demonstrated by cities such as Singapore,

can greatly help to enhance the systems governing water (Wang et al., 2024). Technology can, therefore, serve as a reference point for effectively managing water in Lagos; however, its successful deployment requires complementary investments in infrastructure and capacity building to ensure its effectiveness.

In addition to these opportunities, the study highlighted that technological innovation is not only a matter of infrastructure, but also of inclusivity. Interview data revealed concerns about the digital divide and affordability constraints, particularly in low-income areas, suggesting that a purely technical solution may exacerbate existing inequalities if not accompanied by capacity-building and institutional support.

Another theme that emerged in the analysis was related to participation and trust in water governance. While the findings suggest that certain communities, particularly wealthier neighbourhoods, have more access to formal supply, low-income residents often rely on informal providers and reported low levels of trust in official institutions. Mistrust towards the Lagos Water Corporation was especially pronounced in informal settlements, where service reliability is poor and communication with authorities is limited. This reflects broader governance gaps and the need for more inclusive, participatory decision-making processes that consider the voices of marginalised communities. Strengthening trust and stakeholder engagement will be crucial for future reforms and for increasing the legitimacy and effectiveness of water governance strategies in Lagos.

Finally, although climate resilience and adaptation strategies were included in the analytical framework, this dimension did not emerge prominently from the empirical findings. The lack of explicit references to climate adaptation in the interviews may reflect a gap in institutional awareness or in the prioritisation of climate-related risks within water governance agendas. However, the observed infrastructural stress, uneven distribution of services, and growing urban vulnerability all point to the urgency of integrating climate resilience into planning efforts. Future research and policy development should explore how climate risks are perceived at the local level and how adaptation strategies can be meaningfully incorporated into Lagos's long-term water governance agenda.

The socio-political contexts of the city aggravate the outlined challenges of water governance in the current research. The decentralized system and the presence of numerous agencies in water management also create inefficiencies, nondirectedness, and a lack of coordinated effort. According to Adeoti et al. (2023), effective water governance needs the

cooperation of the government, business, and civil society. In Lagos, failure to have a single governance system has affected water development in terms of supply and quality in a disordered manner. In solving this issue, the city's priority should be to introduce institutional reforms that encourage cooperation between the stakeholders and see that the management of water resources becomes much more coordinated and efficient.

5

CONCLUSIONS

5.1 ANALYSIS OF THE WORK DONE

This final chapter synthesizes key research findings on Lagos, Nigeria's water governance and infrastructure challenges. It revisits the study's objectives and reflects on the significance of the results, offering a comprehensive summary of the critical issues identified throughout the research process. Drawing upon the empirical data gathered and the discussions in earlier chapters, this chapter provides conclusive insights into the challenges facing Lagos's water governance system and offers recommendations for addressing these challenges. Furthermore, the study's limitations are acknowledged, and areas for future research are identified further to advance understanding and solutions in urban water governance.

The main objective of this dissertation was to discuss the burning problems of Lagos, Nigeria, one of the fastest-growing megacities, which had to resolve both the water shortage problem and the problem of inefficiency of the current water infrastructure. The study has met the set goals because it found important loopholes in the water governance of the city by finding out that there is a significant mismatch between water supply capacity and demand, which is worsened by the fact that the city has been experiencing urban sprawl. It is the synergy of empirical data gathering, the conducting of interviews with major stakeholders, and the examination of the water infrastructure adopted by Lagos that helped this research validate findings that show that not only are the water treatment plants sustained by Lagos poorly developed, but also that they are severely underutilized. The inefficiency is further exacerbated by the non-revenue water, poor sanitation, and limited access to clean water, especially in informal settlements.

The research methodology focused on sustainable urban water supply strategies in Lagos. The qualitative case study approach, which involved stakeholder interviews, document reviews, and field observations, provided an opportunity to better understand the city's water

governance environment. The research design employed purposive sampling and thematic analysis, presenting empirically grounded findings highlighting institutional weaknesses, community resilience, and opportunities to leverage technology to improve water governance.

The analysis indicated that the study objectives were achieved, as the proposed paper has given an in-depth description of the present state of water governance in Lagos. The study found that IoT, satellite technologies, innovative metering solutions, and leak detection systems have the potential to reduce inefficiencies in water management; however, their implementation is currently constrained by limited financial resources, technical expertise, and capacity. On the same note, it became evident that the availability of piped water is very minimal, especially to low-income earners who depend highly on what is referred to as informal sources of water, which is, more often than not, a threat to the health of the people of the community. The investigation has also shown that there is a necessity for more coordination among the stakeholders, according to which the responsibility of different state institutions and other private and local actors is shared. Thus, the governance is weak, and implementation of the necessary reform is not timely.

In line with Objective 1, the study provided a mapping of the actors involved in water governance, highlighting the fragmented and poorly coordinated interactions between governmental institutions, regulatory bodies, community organizations, and informal water vendors. It became evident that the absence of a harmonized institutional framework contributes significantly to service inequalities and hinders the formation of coherent water policies.

Concerning Objective 2, while formal regulatory instruments such as IWRM are mentioned in policy discourse, their practical application remains limited. The research identified weaknesses in enforcement mechanisms and a lack of institutional accountability, especially in informal areas. These insights confirm the importance of strengthening regulatory frameworks and improving institutional coherence in order to bridge the implementation gap.

The dissertation also touches on aspects related to Objective 3, particularly through its discussion of emerging technological solutions (e.g., smart metering, mobile apps) and pilot solar-powered plants. Although not fully explored, the research nonetheless highlighted the importance of aligning such innovations with broader social and infrastructural capacities. The potential role of community-based responses, particularly those that can be translated into

social innovations, though not a central theme of the fieldwork data, remains underexplored and presents a promising avenue for future research.

In relation to Objective 4, the study underlined the persistence of deep inequalities in water access, most notably in informal settlements. The insights gathered suggest that improvements in infrastructure must be accompanied by institutional reforms and greater community participation. This reinforces the need to embed equity concerns within the design and implementation of water strategies, as part of a transition to more sustainable governance models.

Finally, while the topic of climate resilience and adaptation (Objective 5) was not a prominent theme in the empirical data, the absence itself is revealing. The findings suggest that climate-related considerations are not yet integrated into local governance discourse or planning instruments. This points to a significant knowledge and policy gap, as climate change is expected to further exacerbate water stress in Lagos and similar cities. Future work should explore this intersection more systematically.

Through these findings, the research provides an exploratory framework that not only highlights the challenges faced by Lagos but also suggests actionable steps to improve the governance and infrastructure of the water supply system. However, the study also acknowledges several areas for future exploration, particularly in sustainable financing for infrastructure development, the scaling of technological innovations, and improvements in sanitation systems.

5.2 POLICY IMPLICATIONS

The findings of this dissertation carry significant implications for urban water policy in Lagos and, more broadly, for megacities in the Global South facing similar governance and infrastructural challenges. The identification of fragmented institutional responsibilities, weak regulatory enforcement, and limited access to safe water in informal settlements underscores the need for an integrated and inclusive water governance framework. Strengthening institutional coordination among state agencies, civil society, and private actors is essential to avoid overlaps and inefficiencies and to ensure coherent policy implementation.

The study also points to the urgent necessity of prioritizing investment in the rehabilitation and expansion of water infrastructure, particularly in underserved areas. Policies that support community engagement, transparency, and accountability, especially in relation

to the Lagos Water Corporation, could help rebuild public trust and enhance the legitimacy of water governance institutions. Moreover, while technological innovations such as smart meters and solar-powered treatment systems present potential benefits, their effective integration into policy requires supportive financing mechanisms, capacity-building strategies, and attention to digital inclusion.

Finally, the absence of explicit references to climate adaptation in the governance agenda, as revealed in this research, suggests that current policies may be underestimating the long-term risks posed by climate variability. Incorporating climate resilience into urban water planning should be a priority, particularly given the vulnerability of Lagos to flooding, rising temperatures, and infrastructure stress. Policymakers should therefore adopt a forward-looking approach that aligns water governance with broader sustainability and climate adaptation goals.

5.3 LIMITATIONS

It is important to acknowledge several limitations of this study. First, the study's geographical coverage was necessarily limited. Given the size and diversity of Lagos, it was not feasible to capture all communities and districts. The empirical data collection focused on selected areas such as Ajegunle, Ikoyi, and Ojota, which represent a range of socio-economic conditions, but do not fully reflect the experiences of residents in other parts of the city, particularly in peripheral or rural locations. As such, the generalizability of the findings is constrained, and future work would benefit from a broader and more representative sample across Lagos.

Second, access to reliable, up-to-date datasets posed challenges. While efforts were made to triangulate information, data on water production, treatment capacity, and non-revenue water were often outdated or incomplete. This reflects a broader issue common in rapidly urbanizing cities, where informal supply systems and limited institutional capacity hinder accurate data collection. Longitudinal and mixed-method approaches could strengthen data reliability and comparability in future studies.

Third, the research relied primarily on qualitative data from semi-structured interviews with representatives of LWC, LASWARCO, NGOs, and other stakeholders. While these interviews provided rich contextual insights into governance processes, they are subject to potential bias. Institutional actors may underreport challenges or strategically frame their accounts, while the voices of residents—especially those in informal settlements—remain underrepresented due

to their limited involvement in formal governance processes. Additionally, the intentional, non-random nature of the sampling restricts statistical generalizability. Instead, the study aims for analytic generalization, contributing to theory development and informing policy in other urban contexts (Banso et al., 2023).

Four, the researcher faced constraints in gaining access to some key stakeholders, particularly senior policymakers and business leaders, due to time and availability limitations. This restricted the breadth of perspectives, particularly in relation to regulatory enforcement and industry compliance with good practices (Abolarin et al., 2024).

Finally, while steps were taken to reduce researcher bias, including reflexivity and peer debriefing, the interpretive nature of qualitative research means the researcher's positionality may have shaped interpretations. These practices mitigate but cannot eliminate bias. Nonetheless, the methodological approach, framed within the study's conceptual framework, provides a robust foundation for interrogating the dynamics of water governance in Lagos and yields relevant implications for policy and practice concerning water security.

5.4 FUTURE WORK

While limited in many aspects, this dissertation has provided important insights on the challenges of water governance in Lagos, several areas require further investigation. One of the most immediate priorities is the rehabilitation and expansion of water infrastructure. This includes upgrading underperforming treatment plants, such as Adiyan and Iju, and investing in new facilities to increase production and improve coverage.

Another path for future research concerns alternative water supply technologies, such as desalination and wastewater reuse. These options could supplement the current system and provide greater resilience against future water scarcity, particularly in the context of climate change. Studies could explore the feasibility, costs, and environmental implications of these technologies in the Lagos context.

Technological innovation remains a promising, yet underutilized, area. While this study has identified the potential of IoT-based leak detection, smart metering, and mobile water consumption management tools, there is a clear need for further research on the cost-effectiveness, scalability, and institutional readiness for adopting such technologies in low-income urban settings. Particular attention should be paid to financing models and capacity-

building strategies that could support the gradual integration of these tools in Lagos's water infrastructure.

Governance challenges also merit deeper examination. The findings show that fragmented responsibilities and weak coordination among agencies hinder effective service delivery. Future research could investigate institutional reform options aimed at improving inter-agency collaboration and establishing clearer accountability frameworks. The potential of public-private partnerships (PPPs) as a mechanism for financing and co-managing water services also warrants further study, particularly in terms of their long-term sustainability and impact on equity.

Sanitation remains a critical issue requiring further attention. Future work should examine the public health consequences of inadequate sanitation in informal settlements and explore context-sensitive solutions to expand safe sanitation coverage. This includes evaluating community-based models for waste management and exploring how water and sanitation services can be better integrated into a unified service delivery framework.

Lastly, there is scope for comparative research that situates Lagos within broader discussions on urban water governance in the Global South. Cross-city studies could highlight shared challenges and promising practices in areas such as resilience, equity, stakeholder engagement, and adaptation to climate impacts. By contributing to these global dialogues, future research can strengthen both theoretical and practical approaches to sustainable urban water management.

The research developed throughout this dissertation has the potential to contribute meaningfully to the academic and professional discourse on urban water governance, particularly in the context of megacities in the Global South such as Lagos. Scientific production in applied fields such as water governance is only as effective as its dissemination. Beyond journal articles and academic conferences, impact depends on reaching the strategic stakeholders who can act upon the evidence produced. Building on the empirical and analytical insights of this study, the author intends to prepare a peer-reviewed article addressing the institutional, infrastructural, and social challenges to equitable water provision in Lagos. Participation in national and international conferences on urban development, sustainability, and infrastructure planning will provide further venues to share findings, gain feedback, and engage in comparative debates.

But equally important is ensuring that the results inform policy and practice. Efforts will therefore be made to communicate key messages directly to policymakers, regulators, and local organizations engaged in water governance in Lagos, particularly those there were already contacted for the study. Collaboration among these actors are crucial to incorporate the perspectives of underrepresented communities and support future reforms. In this way, the dissertation's impact may extend beyond its academic goal, contributing to practical solutions for water security and governance in Lagos.

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APPENDIX

APPENDIX 1. INTERVIEW SCRIPT

Semi-structured Interviewer Introduction:

Thank you for taking the time to speak with me. My name is Abiche Odugbo, and I am conducting research for my Master's dissertation at the University of Algarve (Portugal) on Sustainable Water Supply Management Strategies in Lagos. The purpose of this interview is to gain insights into the current practices, challenges, and opportunities in urban water governance from the perspective of key stakeholders like your organization/community.

Your responses will be treated with confidentiality and used solely for academic purposes. With your permission, I would like to record this interview for accuracy.

Section 1: Governance and Institutional Framework

1. Can you describe the current governance structure of water supply management in Lagos?
2. How does your organization/community coordinate with other agencies involved in water governance?
3. What are the main challenges you face in inter-agency collaboration?

Section 2: Community Engagement and Participation

4. How does your organization/community involve local communities in decision-making processes?
5. What mechanisms exist for public feedback or consultation on water-related policies?
6. How do you address concerns from communities, especially those in informal settlements?

Section 3: Technology and Innovation

7. What technologies has your organization/community adopted to improve water supply and distribution?
8. Are there plans to implement smart water systems (e.g., sensors, smart meters)?
9. What are the financial or technical barriers to adopting new technologies?

Section 4: Service Delivery and Equity

10. How does your organization/community ensure equitable distribution of water across different neighbourhoods?
11. What strategies are in place to improve delivery service in underserved areas?
12. How do you respond to public concerns about inconsistent water supply?

Section 5: Transparency and Trust

13. What steps has your organization/community taken to improve transparency and accountability?
14. How do you build trust with communities that have historically been underserved?
15. Are there any recent initiatives aimed at improving public perception of your organization/community?

Section 6: Sustainability and Future Planning

16. What long-term strategies are in place to ensure sustainable water supply in Lagos?
17. How does your organization/community plan to address the impacts of climate change on water resources?
18. What role do partnerships (local or international) play in your sustainability efforts?

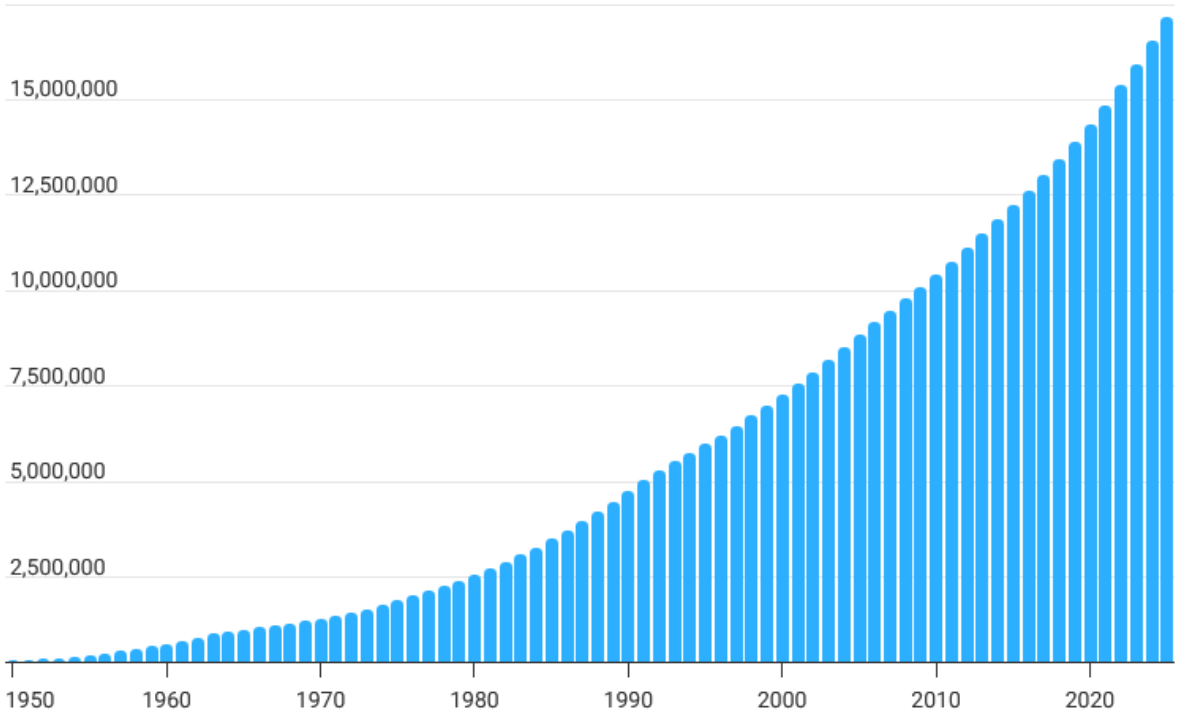
APPENDIX 2. POPULATION TRENDS

Table A2: Largest cities extrapolations (millions)

	City	2010 Pop.	City	2025 Pop.	City	2050 Pop.	City	2075 Pop.	City	2100 Pop.
1	Tokyo	36.094	Tokyo	36.4	Mumbai	42.404	Kinshasa	58.424	**Lagos**	**88.345**
2	Mexico City	20.117	Mumbai	26.385	Delhi	36.157	Mumbai	57.862	Kinshasa	83.494
3	Mumbai	20.072	Delhi	22.498	Dhaka	35.193	Lagos	57.195	Dar es Salaam	73.678
4	Beijing	19.61	Dhaka	22.015	Kinshasa	35	Delhi	49.338	Mumbai	67.24
5	São Paulo	19.582	São Paulo	21.428	Kolkata	33.042	Dhaka	46.219	Delhi	57.334
6	New York	19.441	Mexico City	21.009	**Lagos**	**32.63**	Kolkata	45.088	Khartoum	56.594
7	Delhi	17.015	New York	20.628	Tokyo	32.622	Karachi	43.374	Niamey	56.149
8	Shanghai	15.789	Kolkata	20.56	Karachi	31.696	Dar es Salaam	37.485	Dhaka	54.25
9	Kolkata	15.577	Shanghai	19.412	New York	24.769	Cairo	32.999	Kolkata	52.395
10	Dhaka	14.796	Karachi	19.095	Mexico City	24.329	Manila	32.749	Kabul	50.27
11	Buenos Aires	13.089	Kinshasa	16.762	Cairo	24.035	Kabul	32.672	Karachi	49.056
12	Karachi	13.052	**Lagos**	**15.796**	Manila	23.545	Khartoum	30.681	Nairobi	46.661
13	Los Angeles	12.773	Cairo	15.561	São Paulo	22.825	Tokyo	28.916	Lilongwe	41.379
14	Cairo	12.503	Manila	14.808	Shanghai	21.317	Nairobi	28.415	Blantyre	40.911
15	Rio de Janeiro	12.171	Beijing	14.545	Lahore	17.449	New York	27.924	Cairo	40.543
16	Manila	11.662	Buenos Aires	13.768	Kabul	17.091	Baghdad	24.388	Kampala	40.136
17	Moscow	11.514	Los Angeles	13.672	Los Angeles	16.416	Mexico City	24.178	Manila	39.959
18	Osaka-Kobe	11.337	Rio de Janeiro	13.413	Chennai	16.278	Lahore	23.878	Lusaka	37.741
19	Istanbul	10.823	Jakarta	12.363	Khartoum	15.995	Addis Ababa	23.709	Mogadishu	36.372
20	**Lagos**	**10.572**	Istanbul	12.102	Dar es Salaam	15.973	Chennai			

Source: Hoornweg and Pope (2016).

Figure A2: Lagos, Nigeria Metro Area Population (1950-2025)



Source: Macrotrends (n.d.), available at

https://www.macrotrends.net/global-metrics/cities/22007/lagos/population