

ENSURING SUSTAINABLE WATER
SUPPLY
IN
LAGOS, NIGERIA

Judith Afooma Jideonwo

May 18, 2014

Primary Reader: Tom Daniels
Secondary Reader: Stan Laskowski

Dedication

Dedicated to the 783 million people who still lack access
to clean and safe drinking water.

Acknowledgements

I want to take the time to thank the following individuals for their support during the process of writing this capstone:

I am grateful to Mrs. Aderonke Odeneye from Lagos State Safety Commission; Dr. Bola Balogun from Lagos Water Corporation; Mr. Adefemi Afolabi from Lagos State Waste Management Office; and Engineer Shabi Adebola, Mr. Adebodun Sewanu and Dr. Sanuth Hassan from the Lagos State Environmental Protection Agency, for giving me the opportunity to interview them and providing me with valuable information for my capstone.

I would like to express my gratitude to Professor Thomas Daniels and Professor Stan Laskowski, my advisors for my capstone. I thank you for helping me develop a personal passion for sustainable water planning and management through your classes. I have really enjoyed working with you over the past year. Thank you for reading my lengthy drafts and for your unwavering support of my capstone. Your patience, motivation and knowledge provided guidance that helped me through the research and writing of this capstone. I could not have imagined having better advisors for my capstone.

I thank my friends who have encouraged me from the beginning of this process. Your daily encouragement and sense of excitement in all my accomplishments kept me going.

Thank you to my family for always being my biggest cheerleaders. My academics and personal pursuits over the past years would never have been possible without your guidance and trust. Thank you for shaping me into the person I have become today.

Finally, I thank God for granting me this amazing opportunity to attend the University of Pennsylvania. I thank God for the wisdom and perseverance that he has been bestowed upon me during this capstone. Nothing is made possible without You and I thank You for giving me the mental strength to remain dedicated through out the last two years.

Abstract

Lagos, the fastest growing city in Africa is currently facing a water management crisis. Due to poor planning, lack of adequate infrastructure, insufficient funds, and a poor governance and regulatory framework, there is a vast demand gap of 330 MGD. As such, only 10% of the population in Lagos is being served by the public water utility, Lagos Water Corporation. The rest of the population gain access to water either from private boreholes or from informal private sector participants such as water vendors. This situation is further worsened by certain factors such as rapid population growth, corruption, climate change, unreliable electricity, inadequate enforcement, and water leakages and theft that cause 60% unaccounted-for-water losses. As a result, citizens experience water shortages, water pollution, inadequate sanitation and wastewater treatment, and water injustice and inequality. There have been several governmental and external efforts to resolve the crisis, however they have all been fruitless due to poor implementation, inefficient enforcement, inadequate financing and lacking water governance. The Lagos Water Supply Master Plan aims to cover the demand gap by 2020 and improve water supply through extensive infrastructure development, however this plan is non-comprehensive and one-dimensional. Lagos needs a water supply plan that includes plans and strategies to address all the gaps and challenges that the Lagos water supply system faces. It is my goal to create a plan that would incorporate demand-side management, reduce waste and unaccounted water losses, ensure improved service delivery, restructure regulatory and governance frameworks, enhance reinvestment, and increase access to potable water.

This professional report will delve into the water supply crisis facing Lagos State. I will explore the geographical and political conditions in the city; explain the causes and illustrate the factors that exacerbate the water supply issues; define the barriers to resolution; and explore the efforts made by the state to resolve the water supply crisis. I will assess the effectiveness of these efforts and by highlighting the gaps and challenges faced, I aim to illustrate the importance of effective planning and management to ensure a sustainable water supply system. I hope to provide planning and management strategies that could rectify the severe water supply issues that Lagos is facing and if implemented would ensure a sustainable water supply system in Lagos.

Table of Contents

Dedication.....	ii
Acknowledgements.....	iii
Abstract.....	iv
Introduction.....	1
History of Water Supply in Lagos.....	7
Governance & Regulatory Framework.....	12
<u>Lagos Water Agencies for Water Supply and Quality.....</u>	12
Regulatory.....	12
Monitoring.....	13
Water Supply & Quality.....	14
Environmental Compliance.....	15
Wastewater Management.....	16
Other Agencies.....	17
<u>Lagos State Water Regulations.....</u>	18
The Present & Future Water Supply Issues.....	21
Elements of the Water Supply Crisis.....	27
<u>Unreliable Water Supply.....</u>	27
<u>Inadequate Wastewater Treatment & Sewerage System.....</u>	30
<u>Water Pollution.....</u>	34
<u>Water Injustice & Inequity.....</u>	37
<u>Challenges.....</u>	39
Poor Water Infrastructure and Utility Performance.....	39
Poor Planning.....	42
Bad Governance & Lack of Political Will.....	44
Unreliable Electricity.....	45
Lack of Funds.....	46
Research Methodology.....	47
<u>Research Question.....</u>	48
Sub-Questions.....	48

<u>Materials & Methods</u>	48
<u>Analysis & Results of Questionnaire</u>	52
Questionnaire Results.....	52
Discussion	56
<u>Main Findings from the Questionnaire</u>	56
<u>SWOT Analysis for Lagos Water Sector</u>	58
Factors That Exacerbate the Water Crisis	61
<u>Population Growth</u>	61
<u>Migration & Urbanization</u>	62
<u>Climate Change</u>	62
<u>Corruption</u>	63
<u>Restrictions & Redundancy of State Water Authorities</u>	64
<u>Violence</u>	64
<u>Inefficient Water Tariff System</u>	65
Current Governmental Efforts to Ensure a Long-Term Reliable	
Water Supply	66
Lagos State Water Supply Master Plan (2010-2020)	79
Assessment of Lagos Water Sector Efforts & Plans to Ensure	
Sustainable Drinking Water Supply	82
<u>Non-Comprehensive, Incongruent & Insufficient Master Plan</u>	82
<u>Institutional & Regulatory Challenges</u>	85
<u>Weak Strategies That Fail To Target Critical Problems, Deficient</u>	
<u>Monitoring and Evaluation</u>	87
<u>Disabling Environment</u>	88
<u>Absence of Community Participation</u>	88
The Viability of Water Privatization in Lagos	89
<u>Types of Water Privatization</u>	91
<u>Possible Benefits of Privatizing the Lagos Water Sector</u>	94
<u>Possible Concerns & Issues in Privatizing the Lagos Water Sector</u>	95
Efficiency or Profit.....	95

Economic Good or Human Right.....	96
Water Pricing.....	96
Impact on Employment.....	97
<u>Case Studies: Privatization of Water in Sub-Saharan Africa.....</u>	<u>98</u>
<u>Critical Factors for Successful Water Privatization in Lagos.....</u>	<u>98</u>
Planning.....	99
Contract Type.....	100
Regulation.....	101
Full Cost Recovery.....	102
Social Dimension.....	103
Public Support.....	104
The New Water Supply Plan.....	105
<u>Inventory & Analysis.....</u>	<u>105</u>
<u>Goals.....</u>	<u>106</u>
<u>Objectives.....</u>	<u>106</u>
<u>Strategies.....</u>	<u>109</u>
<i>Governance</i>	
Water Governance Restructuring.....	109
Stronger Enforcements & Requirements for Effective Implementation.....	117
Public Education & Participation.....	118
<i>Infrastructure & Planning</i>	
Sustainable & Integrated Planning.....	119
Smart Growth Infrastructure Development.....	121
Reduction of Unaccounted-For-Water Losses.....	124
Coordinated Infrastructure Development in Growth & Peri- Urban Areas.....	126
<i>Quality</i>	
Development of Water Protection Plans & Initiatives.....	131

<i>Sustainability</i>	
Coastal Zone & Flood Management.....	135
Sustainable Water Supply Projects.....	135
Promotion of Water Conservation Initiatives.....	136
Improving Groundwater Resource Management.....	137
Encourage Wastewater Reuse & Recycling.....	139
<i>Management</i>	
Privatization of Water.....	141
Integrated Water Resources Management.....	143
Water Pricing & Audit System.....	144
Targets & Performance Measurements.....	145
Timeline	147
Conclusion	151
Appendices	153
Appendix 1: Functions of Lagos Water Corporation.....	153
Appendix 2: Notes From Interviews.....	154
Bibliography	164

List of Tables

Table 1: Lagos Water Sources.....	6
Table 2: Results From Questionnaire.....	54
Table 3: Monthly Production at LWC Waterworks in 2010.....	69
Table 4: Demand Gap Estimates: Short, Medium, Long Term.....	80
Table 5: Infrastructure Development Projects in Master Plan.....	123
Table 6: Proposed Infrastructure Development in New Plan.....	128
Table 7: Details of Project Plans in Master Plan (2010-2020).....	129

List of Figures

Figure 1: Population of Lagos (2006-2020).....	2
Figure 2: Map of Lagos, Nigeria.....	3
Figure 3: Map of Lagos, Nigeria.....	4
Figure 4: Lagos Water Resources.....	5
Figure 5: Water Pipes in Sewers.....	24
Figure 6: Pure Water.....	26
Figure 7: Mairuwas.....	28
Figure 8: Girls Walking for Water.....	29
Figure 9: Polluted & Blocked Canal.....	32
Figure 10: Blocked Drainage.....	33
Figure 11: Dumping by the Lagos Lagoon.....	35
Figure 12: Makoko Slum.....	36
Figure 13: Water Leaking From Burst Pipe.....	38
Figure 14: Water Tankers.....	39
Figure 15: Drinking Water Sources in Lagos.....	53
Figure 16: Water Sources for Other Purposes in Lagos.....	53
Figure 17: Borehole at Lekki Waterworks.....	71
Figure 18: Polluted Water Body in Lagos.....	77
Figure 19: Projected Demand & Supply.....	81
Figure 20: Proposed Water Governance Structure.....	114
Figure 21: Summary of Cost Implications.....	122

Acronyms

GDP – Gross Domestic Product
IFC - International Finance Corporation
IMF – International Monetary Fund
IWRM - Integrated Water Resource Management
LAHA - Lagos State House of Assembly
LASEMA - Lagos State Environmental Management Agency
LASEPA - Lagos State Environmental Protection Agency
LMDGP - Lagos Metropolitan Development & Governance Project
LSDQAL - Lagos State Drug Quality Assurance Laboratory
LSWMO - Lagos State Waste Management Office
LWC - Lagos State Water Corporation
LWRC - Lagos State Regulatory Commission
MGD – Million Gallons Per Day
MOE - Ministry of Environment
MOH - Ministry of Health
NAFDAC – National Agency for Food & Drug Administration & Control
NGN – Nigerian Naira
NGO – Non-Governmental Organization
NSDQW - Nigerian Standard for Drinking Water Quality
ODI - Overseas Development Institute
PHCN – Power Holding Company of Nigeria
PPP - Public-Private Partnerships
UFW - Unaccounted-for Water
UNDP – United Nations Development Programme
UNEP – United Nations Environment Programme
UNIDO – United Nations Industrial Development Organization
WHO – World Health Organization

Introduction

Lagos is the largest city in Africa with a population that doubled over the last 15 years to 20.19 million in 2012.¹ It is both a city and a state and is the main commercial center in Nigeria, with more than 70 percent of the nation's industries and economic activities.² At its present annual growth rate of 5%, Lagos state will be the third largest mega-city in the world by 2015 after Tokyo and Mumbai (See Figure 1).³ The size and growth rate of Lagos means that the demand for basic needs such as water is growing very rapidly.

Lagos, located on the southwest coast of Nigeria, is made up of Lagos Island, the original city, the Mainland, which is comprised of rapidly growing settlements, and an additional group of islands, including Ikoyi, Eko Atlantic, Iddo and Victoria Island (See Figure 2). These islands are connected to the mainland by several bridges. Lagos state has an area of about 1,341 square miles (3,400km²) of which half is water.⁴

The metropolitan area of Lagos, the main focus of this paper, is 385.9 square miles (999.6km²); water bodies including wetlands constitute over 22% of the total landmass in the Lagos metropolitan area.

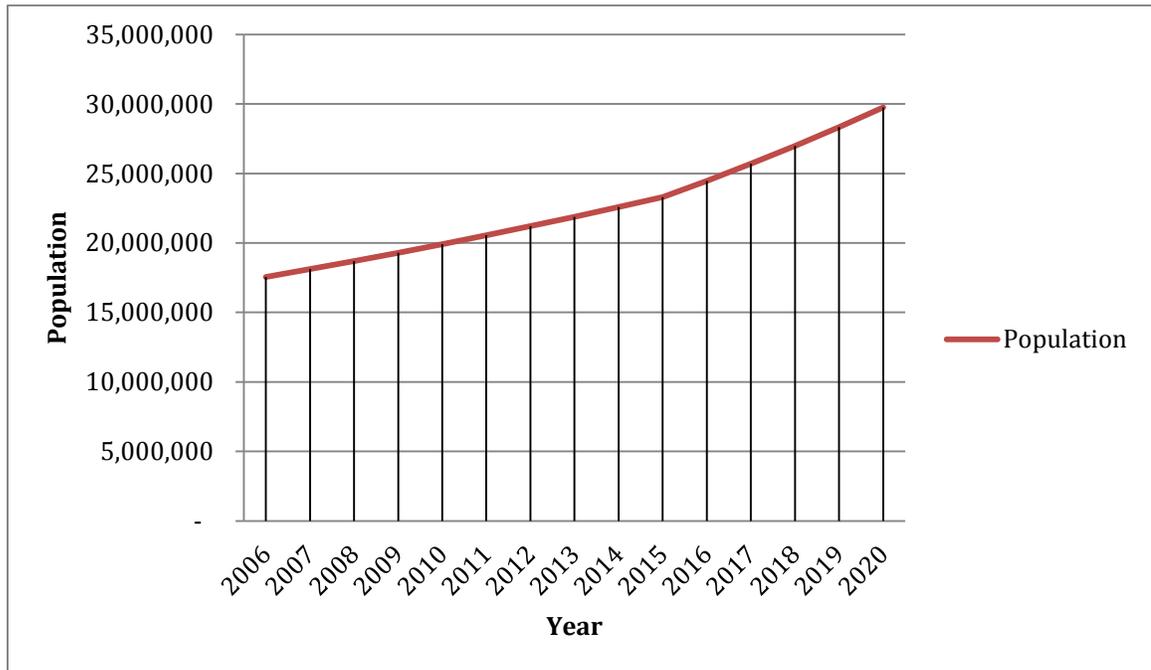
¹ LWC. Lagos Water Corporation (LWC). Lagos, Nigeria. *Lagos Water Supply Master Plan*. By Lagos Water Corporation. 2010.

² Irin News. "Lagos: Crisis of Management." *Irin News*. Web. 09 Apr. 2014.

³ LWC. *Lagos Water Supply Master Plan, 2010*.

⁴ Fasona, Mayowa, Ademola Omojola, and Nenna Amogu. *Sustainable Water Management Solutions for Large Cities. Sustainable Water Management for 49 - 57*. Wallingford, Oxfordshire, UK: IAHS, 2005.

Figure 1: Population of Lagos (2006 – 2020)



Source: Lagos Bureau of Statistics¹

Though the metropolitan area is a third of the state land area, over 87% of Lagosians reside in this area.² Lagos is a state surrounded by water. As a result, residents assume that it would be easy to provide potable water. Quite the contrary, the waters in the lagoon and ocean surrounding Lagos are not fit for human consumption and the large expanse of water around Lagos is not potable.

¹ Lagos State (2011) Digest of Statistics, 2011. Lagos Bureau of Statistics. Web. 09 Apr. 2014.

² LRDC. Lagos Research & Development Council (LRDC). *Research Brief. November 2013.* Issue brief. *Innovate Lagos.* Web. 09 Apr. 2014.

Figure 2: Map of Lagos, Nigeria



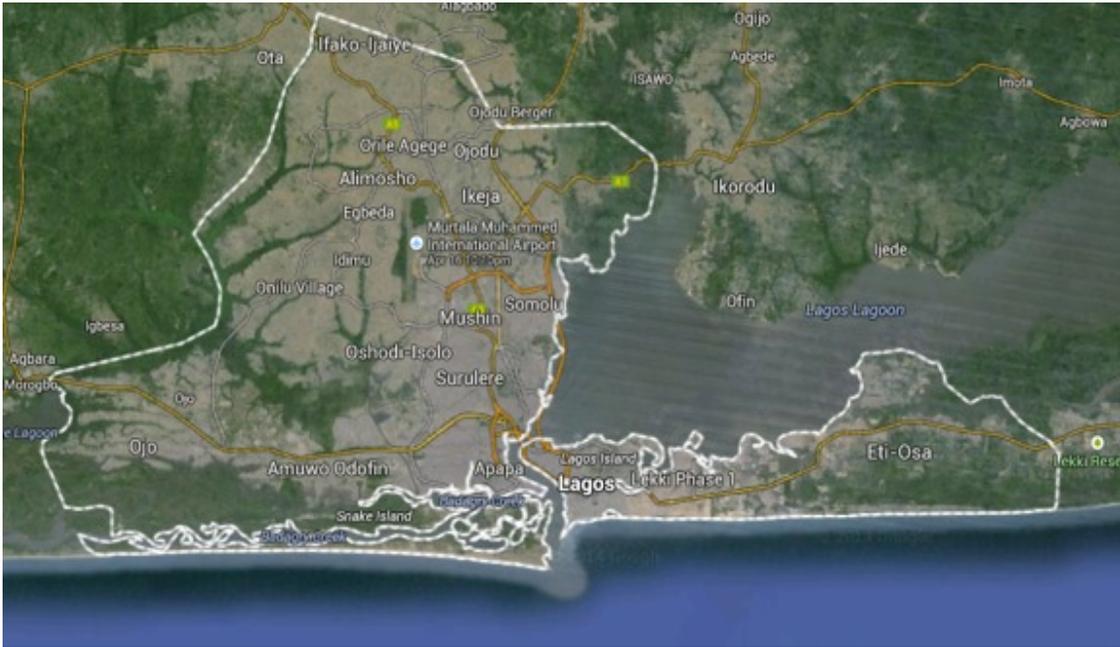
Source: Google Maps

“All the water bodies in Lagos, both fresh and brackish surface water and groundwater are polluted,” stated the Engr. Shabi Adebola, the General manager of LASEPA during my interview with him. Therefore, water sourced or supplied in Lagos needs treatment prior to consumption, as there is a lack of water source protection. However, the results from my questionnaire illustrate that only 48% of consumers treat their water before consumption.

Lagos is littoral to the Atlantic Ocean and its topography consists of lying coastal beaches, extensive inland lagoons, marshes, creeks and mangrove wetlands at elevations of 0 to 2 meters, and upland areas with moderately drained soils and an elevation range of 2 to 50 meters above sea level (See Figure 3).¹

¹ Fasona, Mayowa, Ademola Omojola, and Nenna Amogu. *Sustainable Water Management Solutions for Large Cities. Sustainable Water Management for* 49 - 57. Wallingford, Oxfordshire, UK: IAHS, 2005.

Figure 3: Map of Lagos, Nigeria



Source: Google Earth

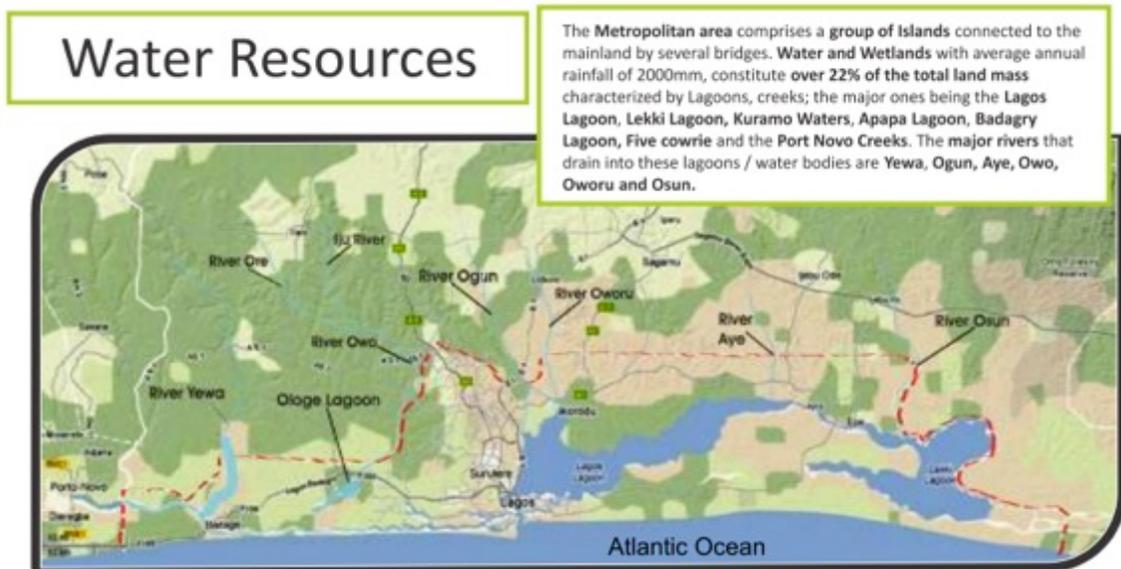
The major rivers that drain into the lagoons and water bodies are the Yewa River, Osun River, Owo River, Aye River, Oworu River and most significantly, Ogun river which yields 461MGD (See Figure 4).¹ Brackish water sources include Ologe Lagoon, Lekki Lagoon, Badagry Creek, and Lagos Lagoon, which the Ogun River discharges into (See Table 1).²

Lagos is also blessed with abundant groundwater from the Coastal Plain Sands Aquifer that gets amply recharged as Lagos experiences an average annual rainfall of about 2 meters. With the rapid population growth rate of Lagos, the LWC has not been able to meet the growing demand of water.

¹ LWC. *Lagos Water Supply Master Plan, 2010.*

² LWC. *Lagos Water Supply Master Plan, 2010.*

Figure 4: Lagos Water Resources



Source: Lagos Water Supply Master Plan, 2010

This has resulted in residents looking to the most readily accessible source, groundwater. This has led to unplanned and uncontrolled groundwater exploitation with siting of boreholes by both skilled and unskilled technicians with varying degrees of success.¹ Because Lagos is adjacent to the Atlantic Ocean, over extraction of groundwater leads to high risks of saltwater intrusion.

¹ Longe, E. O. "Groundwater Resources Potential in the Coastal Plain Sands Aquifers, Lagos, Nigeria." *Research Journal of Environmental and Earth Sciences* 3.1 (2011): 1-7. Maxwell Scientific Organization. Web. 9 Apr. 2014.

Table 1: Lagos Water Sources

Fresh Water Sources	
<i>Source</i>	<i>Safe Yield¹</i>
Ogun River	460.8 MGD
Osun River	45.6 MGD
Yewa River	41.6 MGD
Owo River	28 MGD
Aye River	18.4 MGD
Oworu River	20.8 MGD
Brackish Water Sources	
<i>Source</i>	<i>Surface Area</i>
Lagos Lagoon	500 sq.km
Lekki Lagoon	300 sq.km
Badagry Creek	200 sq.km
Ologe Lagoon	64.sq.km

Source: Lagos Water Supply Plan, 2010²

The total annual GDP for Lagos State in 2012 was approximately \$32 billion, enough to allocate funds for sustainable water management and ensure a long-term reliable water supply in the city, however the funding allocation to the water supply sector was low and as such many chronic water

¹ Safe Yield is how much water is allowed to be withdrawn without harm to the environment or future production

² LWC. *Lagos Water Supply Master Plan, 2010.*

problems still exist.¹ The crumbling infrastructure, pipes burst by residents in search for water, and the shortage of man power and funding to repair these leakages has led to a 60% rate of unaccounted for water, i.e., 60% of the 210MGD produced by the LWC is lost. In addition to poor infrastructure, the lack of a proper sewage network infects the public water supply, and safe drinking water is not available for the residents of Lagos. As a result, a regular water supply has been described as a 'distant dream', one that would only be achieved through divine intervention.² The lack of adequate or reliable supply from the government has resulted in a proliferation of boreholes surrounded by neighboring septic tanks and blocked sewer pipes through which sewage drains out into the environment.

History of Water Supply in Lagos

The search for water in Lagos began in 1901 by the colonialists who searched as far as Iju, a suburb on the outskirts of Lagos, where water was flowing in from the Ogun River.³ It was from Iju that the colonialists started bringing the water supply to Lagos areas, mainly Ikoyi and Obalende. The first waterworks, Iju Waterworks, was built in 1910 with a capacity of 2.42MGD, drawing raw water from spring water trenches within the Iju hills.⁴ The

¹ Lagos (2010). "Lagos Gross Domestic Product Survey 2010." Lagos Bureau of Statistics. Web. 09 Apr. 2014.

² Irin News. "Lagos: Crisis of Management." *Irin News*. Web. 09 Apr. 2014.

³ LWC. *Lagos Water Supply Master Plan, 2010*.

⁴ LWC. *Lagos Water Supply Master Plan, 2010*.

waterworks was then designed and commissioned to serve the residential reservation of the colonial administrators living in Ikoyi. Lagos was seen to have an advanced modern water supply system at the time as other surrounding communities were still tapping water from springs, rivers, hand-dug wells, and rainwater, and the plants in Lagos offered treated water, with pollutant removal and disinfection, to its residents. In 1943, the plant upgraded its capacity to 6MGD to serve Lagos Island, Apapa, and Ebutte-Metta and later in 1954 to 11MGD, expanding coverage to residential and industrial areas of Ikeja, Ikorodu Road and east of the Metropolis.¹

Additional abstraction investments were developed at Akute, contiguous to the Ogun River, the major source of surface raw water available to the Lagos metropolis. With the increasing demand of the residents and the growth of the industrial sector, the production and distribution potential became overstretched. The supply of water to Lagos had been a Federal responsibility under the Federal Ministry of Works and for 66 years federal authorities took care of the establishment of waterworks and distribution channels for Lagos. The responsibility was transferred to Lagos State in 1967 when the state was created. The state set up a Water Board to carry out the various duties in this respect and in 1980 created the Lagos Water Corporation.²

Rapid population growth in Lagos has posed a heavy burden on the public water system and there has been there has been a continuous need to

¹ LWC. *Lagos Water Supply Master Plan, 2010.*

² LWC. *Lagos Water Supply Master Plan, 2010.*

expand the Lagos water supply and distribution capacities. Since 1910, the main concern of the authorities managing water supply to Lagos has always been how to increase the supply of water due to the ever-increasing population of Lagos and the role of Lagos as a commercial nerve center of the nation's economy. The supply from Iju was no longer enough to meet the demands of Lagosians and a second waterworks had to be constructed at Ishasi in 1977, deriving its source from the Owo River.¹ It had a capacity of 4MGD. This waterworks was developed primarily to meet the water requirements of the residents of Festival Village, now called Festac, during the All Black and African Festival of Arts and Culture, and also served the west of the metropolis including Ishasi and Satellite Town.² Although the Iju Waterworks was expanded in 1973 to 35MGD, it had to be further upgraded in order to reduce the gap between the water demand and water supply. This was done between 1982 and 1985 to achieve a 45MGD production target.³ This modernization of the Iju waterworks was also to boost pressure into the existing mains with 10 additional mini waterworks with a total capacity of 26.4MGD.⁴ Mini waterworks are waterworks that can provide water supply up to 3MGD. The mini-waterworks were designed to feed directly into the networks laid in their various locations to supply potable water in these areas. Along with the installations of the mini-waterworks, additional

¹ LWC. *Lagos Water Supply Master Plan, 2010.*

² LWC. *Lagos Water Supply Master Plan, 2010.*

³ LWC. *Lagos Water Supply Master Plan, 2010.*

⁴ LWC. *Lagos Water Supply Master Plan, 2010.*

tertiary distribution networks have been laid on a continuing basis, to improve access to consumers.¹

Despite previous expansion, the population continued to grow, so the state government had to consider additional water supply expansion schemes. These included the construction of Adiyari Waterworks in three phases to supply 70MGD per phase, the expansion of Ishasi Waterworks to 35MGD and the expansion of primary, secondary, and tertiary distribution networks.² Due to the expanding responsibilities and work to be done, the Lagos State Water Management Board was created in August 1980 to operate and maintain the existing water supply systems and eradicate the pail system of sewage disposal; the water supply department of the Ministry of the Environment and Physical Planning continued to handle the capital projects for new construction.³ The expansion projects involved huge costs; international commercial banks and external funding agencies were invited to assist with providing loan facilities. Two French commercial banks funded the construction of Adiyari Waterworks Phase 1 and the laying of the primary trunk mains, while the World Bank opted to fund the transmission and distribution systems, including rehabilitation works, institutional development, administrative infrastructure, and technical support services.⁴ To enter into an agreement with the World Bank, and also because of the size

¹ LWC. *Lagos Water Supply Master Plan, 2010.*

² LWC. *Lagos Water Supply Master Plan, 2010.*

³ LWC. *Lagos Water Supply Master Plan, 2010.*

⁴ LWC. *Lagos Water Supply Master Plan, 2010.*

of the new project to be placed on the existing system, especially the pipelines, the Water Corporation was upgraded to the category of a parastatal in 1985, meaning it was given some political authority as it was serving the state indirectly; the Lagos Water Corporation was re-designated as the Lagos State Water Corporation, with expanded functions to implement capital projects.¹

During the project appraisal, a study was carried out on the organization and management study of the LWC. The report recommended re-organizing the LWC for more efficient and effective services delivery. The report showed that in 1985, despite all the expansion projects, only 47% of the people living in the metropolis were served with potable water at reduced level of service.²

To date, the LWC supply system includes 3 major waterworks, Iju, Ishasi and Adiyari, with a total capacity of 119MGD; 48 mini and micro waterworks with a total capacity of 91MGD; and a 12.15MW Independent Power Plant for Iju, Adiyari and Akute, to address unreliable electricity needed for production. This boosts the level of service from 21.6% to 57.2%.³

¹ LWC. *Lagos Water Supply Master Plan, 2010.*

² LWC. *Lagos Water Supply Master Plan, 2010.*

³ LWC. *Lagos Water Supply Master Plan, 2010.*

Governance & Regulatory Framework

Lagos Water Agencies for Water Supply and Quality

1. Regulatory

- *Lagos State Regulatory Commission (LWRC)*: The Water Sector Law of 2004 established the Lagos State Water Regulatory Commission (LRWC) to ensure that water and sewage functions are carried out in the state and to ensure that operators in the sector secure reasonable returns on their capital investments to finance proper implementation.¹ The LWRC's operations commenced in 2012. The LWRC regulates the water sector including public water supply and packaged water producers, and issues borehole licenses for industrial users of groundwater.² The LWRC is a relatively new agency and is not charged with the responsibility of ensuring enforcement or implementation or providing an enabling environment. The LWRC is responsible in ensuring fair returns on investment and consumers get fair price for quality water service. The LWRC also settles disputes between consumers and service providers (Balogun). The state government has a central PPP office attached to the governor's office that is responsible for creating an enabling environment by enacting laws and policies (Balogun).

¹ LWRC. Lagos Water Regulatory Commission (LWRC). *Lagos State Water Sector Law, Law No. 14*. 2004. Web. 09 Apr. 2014.

² Interview with Dr. Balogun from LWC

2. Monitoring

- *Lagos State Drug Quality Assurance Laboratory (LSDQAL)*: The Lagos State Drug Quality Assurance Laboratory (LSDQAL) is the monitoring body for quality of drinking water from pipe borne water. The quality assurance unit of the Lagos State Water Corporation (LWC) has to send reports on water quality to measure if they conform to national standards set by the LSDQAL (Balogun). How effective the process is, how the information is utilized and how much weight the reports carries is uncertain (Balogun).
- *Lagos State Environmental Protection Agency (LASEPA)*: The Lagos State Environmental Protection Agency (LASEPA) was created out of the Pollution Control Unit of the department of environment, sewage and water in the Ministry of Physical Planning in 1996. LASEPA is the monitoring agency for Lagos water bodies, in respect to wastewater, solid and liquid waste disposal, groundwater, and environmental issues in the state. It also determines permissible pollution levels, collects baseline data, and reviews and recommends requirements for liquid waste management in Lagos.¹
- *Ministry of Environment (MOE)*: The Ministry of Environment (MOE) was established in 1979. The MOE was separated from the Ministry of

¹ LWRC. Lagos Water Regulatory Commission (LWRC). *Lagos State Water Sector Law, Law No. 14*. 2004. Web. 09 Apr. 2014.

Physical Planning and became a full-fledged ministry in 2003.¹ The primary mandate of the MOE is to secure a cleaner, healthier, and sustainable environment. The agency also has monitoring and regulatory functions in relations to installation of any pollution control, waste treatment and disposal system.

3. Water Supply and Quality

- *Lagos State Water Corporation (LWC):* The Lagos State Water Corporation (LWC) was established under the Lagos State Water Sector Law in 2004.² The LWC is an operator of the state government and is the water agency responsible for providing potable water to the Lagos metropolis and is ensuring that water supplied to any premises is of good quality and conforms to the Nigerian Standard for Drinking Water Quality (NSDQW) for potable water.³ The LWC priorities are to increase production, increase access to water and to undertake a PPP program to improve service quality. (See Appendix 1 for functions of the LWC).
- LASEPA is in charge of water source protection and water pollution. The main responsibility of LASEPA is to protect and safeguard Lagos

¹ LWRC. Lagos Water Regulatory Commission (LWRC). *Lagos State Water Sector Law, Law No. 14.* 2004. Web. 09 Apr. 2014.

² LWRC. Lagos Water Regulatory Commission (LWRC). *Lagos State Water Sector Law, Law No. 14.* 2004. Web. 09 Apr. 2014.

³ LWRC. Lagos Water Regulatory Commission (LWRC). *Lagos State Water Sector Law, Law No. 14.* 2004. Web. 09 Apr. 2014.

water bodies, both groundwater and surface water.¹ The goals of LASEPA are to ensure environmental sustainability and reduce pollution load of the state.

4. Environmental Compliance

- LASEPA is thus charged with the responsibility of ensuring environmental compliance within the state. Before the establishment of LASEPA, all water bodies were highly polluted due to non-regulation of the activities that resulted in environmental pollution.² LASEPA, however, is currently only focused on ensuring environmental compliance amongst the industries and neglects the domestic and agricultural sectors. Currently, the industries are highly monitored to prevent additional pollution.³ LASEPA carries out advocacy and public awareness to prevent pollution, monitor sewer lines and administer fines, permits, incentives and policies to ensure compliance.
- The LWC in carrying out its functions and duties under this Law is meant to comply with existing environmental laws and regulations in the State. Water from surface sources is to be returned substantially undiminished in quality and not harmful to aquatic life.⁴ However, this

¹ Interview with Engr. Shabi Adebola from LASEPA

² Interview with Mr. Sewanu from LASEPA

³ Interview with Engr. Sanuth Hassan from LASEPA

⁴ LWRC. Lagos Water Regulatory Commission (LWRC). *Lagos State Water Sector Law, Law No. 14*. 2004. Web. 09 Apr. 2014.

is not the case. With the lack of proper drainage and sewage networks, water becomes polluted.

5. Wastewater Management

- *Lagos State Waste Management Office (LSWMO)*: The Lagos State Waste Management Office (LSWMO) is responsible for establishment of fundamental wastewater policy reforms that will address all wastewater management concerns in urban, semi-urban and rural areas of Lagos state (Obani).¹ Furthermore, the office is to carry out monitoring, supervision and regulation of all public and private wastewater infrastructures. It is also responsible for conducting research for the development and implementation of environmentally friendly technologies for wastewater management with emphasis on recovery and re-use. Services offered include consultancy services on wastewater matters; design, construction, operation and maintenance of wastewater treatment plant facilities; management of wastewater haulage trucks; evacuation and haulage of sewage; provision of public education and monitoring to ensure compliance on wastewater matters; operation and maintenance of wastewater treatment plant; design and construction of sewer grids as well as cleanup services for sewer pipes and manholes.

¹ Obani, Pedi. Lecture. REGULATING WASTEWATER MANAGEMENT IN LAGOS STATE. Lagos, Nigeria. 3 Oct. 2013. *LWRC*. Web. 09 Apr. 2014.

6. Other Agencies

- *The Office of Drainage Services*, within the Ministry of Environment, is in charge of storm water management. They create channelization to ensure that runoff water gets into the receiving bodies; the runoff is to be treated by LSWMO.¹
- LASEPA is responsible for coastal and flood zone management; the beach, the development, and the cleanup. The Ministry of Waterfront handles the infrastructure built in these areas.² There is no agency in charge of protecting the coastal zone areas.
- The Lagos State Environmental Management Agency (LASEMA) is in charge of emergency and drought management.³
- Office of Transformation sets targets and benchmarks for LASEPA and other water agencies.
- The Ministry of Health (MOH) is in charge of controlling waterborne diseases.

There is no central water body that governs all water agencies. Different water agencies take care of different aspects of water that inadvertently impact one another but they do not work together. As such, there is a lot of redundancy, confusion, inefficiency and waste of resources.

¹ Interview with Mr. Sewanu from LASEPA

² Interview with Mr. Sewanu from LASEPA

³ Interview with Mr. Sewanu from LASEPA

Lagos State Water Regulations

1. *Environmental Pollution Control Law (1989)*

Purpose: This law established the Environmental Pollution Control Advisory Committee to formulate policies, programs & guidelines for pollution control and a sub-committee to establish basic requirements for liquid waste management to complement Federal standards.

Activities: Entry & inspection; controlling industrial point source pollution; establish effluent discharge standards; control of siting of industries & waste dumpsites; establishment of the Pollution Discharge Charge fund; fines & penalties.

Agency: Ministry of Environment & Physical Planning through the Environmental Pollution Control & Sewage Department.

2. *Environmental Sanitation Enforcement Agency Law (1991)*

Purpose: Establishment of the Environmental Sanitation Enforcement Agency to enforce environmental sanitation and pollution laws.

Activities: Demolish any structure creating a public nuisance; impound or take custody of items found in prohibited places; fines and penalties.

Agency: Environmental Sanitation Enforcement Agency

3. *Lagos State Environmental Protection Agency Law (1996)*

Purpose: Establishment of the Lagos State Environmental Protection Agency (LASEPA) to make regulations on environmental standards

and waste management options, and the advisory committee on the environment.

Activities: Levy of annual environmental development charge in manufacturers; registration of practicing consultants on environmental management; prohibit of discharge of waste into the environment.

Agency: LASEPA

4. *Lagos Environmental Sanitation Law (2000)*

Purpose: Creates a duty for owners to clean and maintain drains; provide suitable holding for liquid waste and ensure regular evacuation and disposal; prohibits illegal disposal of liquid waste in water courses. This law empowers the LASEPA to carry out and enforce some of their activities.

Activities: Fines and penalties for non-compliance

5. *National Water Supply and Sanitation Policy (2000)*

Purpose: Approved in 2000, this policy encourages private sector participation and envisages institutional and policy reforms at the state level. However, little has happened in both respects. As of 2007, Lagos was one of the 4 states out the 37 that had begun to introduce public-private partnerships (PPP) in the form of service contracts; a form of PPP where the responsibility of the private sector is limited to operating infrastructure without performance incentives. While the government has a decentralization policy, little actual decentralization

has happened. The capacity of local governments to plan and carry out investments, or to operate and maintain systems, remains low despite efforts at capacity development. Furthermore, the national policy focuses more on water supply and neglects sanitation.

6. *Lagos State Water Sector Law (2004)*

Purpose: In 2004, the Lagos State Government enacted the Lagos State Water Sector Law without public notice. This legislation covers production, distribution and provides a regulatory framework for the governance, financing and management of water supply in Lagos and established the Lagos State Water Corporation (LWC) and the Lagos State Water Regulatory Commission (LWRC).¹ Public Private Partnership (PPP) is a policy thrust of this law. The Water Sector Law was passed to create an enabling environment for PPP.

Activities: Establishment of the LWC to maintain maps of waterworks and sewers; Establishment of a complaints center; establishment of the LWRC to regulate water and sewerage functions and ensure operators secure reasonable returns.

Agency: LWC, LWRC, LASEPA, Lagos State Drug Quality Assurance Laboratory

¹ LWRC. Lagos Water Regulatory Commission (LWRC). *Lagos State Water Sector Law, Law No. 14*. 2004. Web. 09 Apr. 2014.

7. *Nigerian Standard for Drinking Water Quality (NSDQW)*

Purpose: Drinking water quality standards are designed to promote the safety of the drinking water supplies and the protection of public health. The establishment of Nigerian Standard for Drinking Water Quality (NSDQW) is to ensure the protection of the consumers. It is expected that the Nigerian Standard for Drinking Water Quality will speed up the process of upgrading non-protected water systems and improving the management of all drinking water systems in the country. This standard sets parameters and maximum allowable limits in drinking water in Nigeria.¹ In addition to these standards, there are water quality assessments of water discharge by quality and destination performed by LASEPA. These assessments adhere to the Effluent Limitation Standards, which are stricter than national water quality standards, because of the peculiarity of Lagos state.²

Agency: LWC, LASEPA

The Present and Future Water Supply Issues

As with many fast-growing cities, the influx of so many people in Lagos and the proliferation of slums have put a tremendous strain on the government's ability to provide basic services. Traditionally, the provision of water supply in the state of Lagos has been regarded as a responsibility of

¹ Interview with Dr. Balogun from LWC

² Interview with Mr. Sewanu Adebodun

the government, through the Lagos State Water Corporation.¹ From Independence in 1960 until the 1980s, the Lagos state government provided potable water to communities that had water boards; the taps were flowing and all Lagosians had access to treated drinking water.² However, since then the situation has deteriorated and a reliable water supply of good quality water has been hard to find. Reasons for the change include: a rapidly increasing population, poor planning, insufficient funding, failing infrastructure, climate change and corruption. Those factors, coupled with the failure of the government to properly manage and implement goals and effective policies, have further exacerbated the water supply crisis.

The Lagos State Water Corporation is currently facing a demand gap of 330 million gallons per day (MGD).³ As such, majority of Lagosians are not connected to pipe borne water and bear the responsibility of gaining access to water. Residents have access to water through private boreholes and are also largely supplied by the private sector via private tankers, water carts, boreholes and wells; providing up to 70% of the water consumed. This in turn has created its own issues with regards to water purity standards, potential contamination from septic tanks or drains, higher delivery costs, and the ultimate impact on the state's groundwater levels from the improper tapping of groundwater reserves. Between 2010 and 2020, the demand of potable

¹ LWC. *Lagos State Water Supply Plan, 2010*

² Vanguard. "Water Crisis: As borehole becomes ticking timebomb?" *Vanguard* (Nigeria), May 29, 2012. Web. 09 Apr. 2014.

³ LWC. *Lagos State Water Supply Plan, 2010*

water is expected to grow from 600 to about 800 million gallons per day.¹ To meet this demand, investments of about \$2.5 billion² will be required in order to expand and improve the water supply. For now, the Lagos State Water Corporation aims to improve the water supply by focusing solely on expansion of infrastructure rather than also ensuring good service delivery. What good would additional plants do if residents cannot receive adequate and clean water due to leakages from burst pipes or water contamination from pipes laid in sewers (See Figure 5)?

The Lagos water sector has a huge opportunity to produce synergies but the system appears to be fractured, as there is limited cooperation and communication between different water agencies responsible for different aspects of water: wastewater, water supply or water quality. Due to the uncoordinated water supply and poor sewage system in Lagos, the city's water supply quality is compromised as a result of the insufficient wastewater treatment and sanitation services in Lagos. This situation promotes confusion and limits efficiency and progress because each agency's work vastly impacts the other. In addition, inadequate tariff structures for water supply in Lagos, low metering and collection rates result in limited funding for the expansion of coverage and as such create a high dependence on governmental support, allowing various opportunities for government interference.

¹ LWC. *Lagos State Water Supply Plan, 2010*

² LWC. *Lagos State Water Supply Plan, 2010*

Figure 5: Water Pipes in Sewers



Source: *Nigerian Journal*, 2011¹

Furthermore, there is a lack of effective policies and institutional capacities to create an enabling environment for a larger and safer water distribution system. A combination of difficult terrain and many years of economic crisis and misrule have turned Lagos into a governance nightmare.² A major restructuring of the water system in Lagos is needed to ensure reliable water supply to its citizens. The government needs to ensure proper planning, develop effective and targeted policies and strategies, appropriately utilize investment, encourage community participation, effectively manage

¹ Nigerian Journal. "Tackling Nigeria's Water Crisis." *Nigerian Journal* (2011). Web. 09 Apr. 2014.

² Irin News. "Lagos: Crisis of Management." *Irin News*. Web. 09 Apr. 2014.

implementation, and guarantee effective governance. By doing this, Lagos will be able to confront its challenges and climb out the water crisis.

The Lagos Water Corporation is not able to meet current demand. As a result, the informal private sector has expanded to cover this gap.

Unfortunately, the informal sector sells water at about 500% of the LWC tariff.¹ The results from my questionnaire show that the average price paid for water from other sources is 0.55 Naira per liter, which is 11 times that of the LWC tariff of 0.05 Naira per liter². Currently, the other sources of water provided by an informal private sector include mairuwas, water tankers, public boreholes, wells, and pure water. Among these options, the major source of drinking water is sachet water. My questionnaire results illustrate that about 63% of respondents who source their drinking water from the private sector use pure water as their source of drinking water. This sachet water, known locally as “pure water,” refers to commercially purified water sealed in small (16 oz.) plastic polyethylene pouches (See Figure 6). Produced by innumerable small and medium-sized manufacturers and sold throughout the city by street vendors under a variety of brand names, its packaged form widely engenders a perception that it is much better quality than piped water. In contrast, there are also views that some packaged water makers do not bother to treat it. In Lagos, NAFDAC compels manufacturers of packaged water to do tests at inception. It also warns consumers to beware of packaged

¹ LWC. *Lagos State Water Supply Plan, 2010*

² 1 Naira = \$0.0062, \$1 = 161.05 Naira

water that has spent some time on the shelves of retailers, especially if in the sun. However, there has been no enforcement as the agency fails to carry out checks on these products or perform periodic tests.¹ Mrs. Tanwa Koya, CEO of the LWRC states “there are homes with no water supply that depend on sachet water to cook, drink, and so on. Years back we conducted a water sample and the contaminants showed that water flowing in the gutter is cleaner than most of the sachet water. So boiling it is the best one can do, as I will not advise you to drink the sachet water directly without boiling”.² On the contrary, the results from my questionnaire show that out of the 26 respondents who drink pure water, only 10 treat their water.

Figure 6: Pure Water



¹ Oghifo, Bennett. "Getting Clean Water Into Homes." *ThisDay* [Lagos] 1 Feb. 2014: 49. Print.

² Oghifo, Bennett. "Getting Clean Water Into Homes." *ThisDay* [Lagos] 1 Feb. 2014: 49. Print.

Elements of the Water Supply Crisis

A) Unreliable Water Supply

Water supply to Lagos comes from surface and groundwater sources. The three main sources of fresh water are the Ogun, Otta-Ikosi and Owo rivers. The Ogun River is the major water source and it feeds 72 million gallons per day (MGD) and 45 MGD of water to the major waterworks of Adiyin and Iju respectively¹. The demand for water in Lagos is much larger than the production capacity of the LWC. The LWC has not been able to meet with the rising demands of water in Lagos over the years. Though the state is surrounded by water and experiences abundant rainfall, the taps, wells, and boreholes in some neighborhoods are either completely dry, sometimes for months on end, or produce only a dirty, odiferous liquid that is unfit for human consumption.² It is estimated that only about only 2.1 million of the state's 21 million population in Lagos have access to potable and safe water.³ The results from my questionnaire reiterate this finding, as only 9% of respondents had access to pipe borne water from the LWC. Those who lack access to water find potable water by either sinking boreholes and wells or patronizing water vendors, known as "mairuwas" who sell at exorbitant prices (See Figure 7). The price of the bought water from vendors in Lagos is

¹ LWC. *Lagos Water Supply Master Plan, 2010*

² Durham, Mark. "Report From Lagos: Water Crisis." *URBim*. April 17, 2012.

³ Vanguard. "Water Crisis: As borehole becomes ticking timebomb?" *Vanguard* (Nigeria), May 29, 2012. Web. 09 Apr. 2014.

normally 4 to 10 times higher than the water got from piped water supplies.¹ Often, the quality of water bought by vendors is harmful and people get illnesses from consuming it. Persons who cannot afford them walk long distances, sometimes more than one kilometer, to fetch water from public taps or get cheaper water vendors.²

Figure 7: Mairuwas



My questionnaire results illustrate that the average distance traveled to gain access to water was 1.1 kilometers (See Figure 8). In some cases, desperate residents look for any burst water pipes to get water for their

¹ Aalto University: School of Engineering. *Case Study of Lagos*. 2009. Web. 9 Apr. 2014.

² Aalto University: School of Engineering. *Case Study of Lagos*. 2009. Web. 9 Apr. 2014.

domestic needs.¹ Some of the pipes are located in the gutters and refuse sites. These illegal connections through drains result in sewage intrusion when drains become full. This is often responsible for the foul smell and turbidity in pipe-borne water, which results in diseases such as typhoid, hepatitis, dysentery, and cholera.²

Figure 8: Girls Walking For Water



The reliability and quality of water supply is often not adequate and sometimes inhabitants have to survive without water for days. The water demand of Lagos State is 540 MGD, while the corporation is currently

¹ Akoni, Olasunkanmi, and Monsur Olowoapejo. "Lagos: Water, Water Everywhere, None to Drink." *Vanguard* (Nigeria), March 25, 2013. Web. 9 Apr. 2014.

² LWC. Lagos Water Corporation (LWC). *Water: Conserve and Use Wisely*. Lagos, Nigeria 2010. Web. 09 Apr. 2014.

operating at 210 MGD capacity (excluding unaccounted-for water losses), leaving a deficit of 330 MGD, about 60%.¹ Lagos Water Corporation has estimated that by 2020, the daily water demand of Lagos State would rise to 733 million gallons and it plans to close this gap by increasing water production to 745MGD.² The Lagos water sector needs massive financial investments and an improved infrastructure, but more importantly governmental restructuring and a more robust and integrated master plan to ensure sustainable water supply.

B) Inadequate Wastewater Treatment and Sewerage System

LASEPA is responsible for industrial wastewater while LSWMO is responsible for municipal wastewater.³ Only 5% of wastewater in Lagos is treated and the sewage and solid waste management systems of the state are poor. The only conventional sewerage system is in the metropolitan area of Victoria Island, the first commercial area in the state. While there are no major wastewater treatment facilities in the state, Lagos operates five smaller wastewater plants, at primary treatment levels, that serve only 40% of the Lagos metropolis.⁴ The state government has about 5-6 sewage treatment plants where the dislodgers take the waste. This doesn't serve the whole population and residents are averse to paying the cost to empty their

¹ LWC. *Lagos Water Supply Master Plan, 2010*.

² PM News. "World Water Day: Lagos Targets 733 Million Gallons Of Water In 2020." March 21, 2011. Web. 09 Apr. 2014.

³ Interview with Mr. Adefemi Afolabi from LSWMO

⁴ Interview with Mr. Adefemi Afolabi from LSWMO

septic tanks.¹ There is no closed sewerage system in Lagos. The sewerage system in Lagos consists of septic tanks, sewers, and canals. The wastewater from homes empties into the septic tank, the sludge settles while the wastewater leaves the tank and drains into the soil. The sludge is dislodged and taken from homes to discharge points by private sector participants. This is then treated chemically by the LSWMO. The treated water is then put back into water bodies.² But the system is flawed. The excess water is supposed to be captured by drainage or gutters, which flow into canals, that empty into water bodies. However, many residents are found to be reluctant to empty out their septic tanks, which causes pollution of the nearby groundwater. In addition, many gutters and canals in Lagos are blocked and as such this supposed “wastewater management system” in Lagos is ineffectual (See Figure 9). During my interview with Mr. Sewanu Adebodun of LASEPA, he stated that “The current design for the wastewater management and sewage is causing pollution, but it is not feasible currently to have a central sewage system. So the seepage is hoped to be filtered by the soil before it gets to the water body”. This is a very serious problem as there is a serious risk of pollution and contamination of water bodies.

Though about 70% of Lagos residents have access to adequate sanitation, there are still cases of open defecation especially in the riverine

¹ Interview with Mr. Adefemi Afolabi from LSWMO

² Interview with Mr. Adefemi Afolabi from LSWMO

areas and slums such as Makoko and Badiya.¹ Some of the population relies on pits and open sewers, or dispose of human wastes and garbage directly into surface waters. Likewise most of these sanitary toilets are water closets only by name. It is quite normal that water does not run in these toilets or water is wastewater from other households.²

Figure 9: Polluted & Blocked Canal



Due to inadequate sewerage, much of the excreta and sillage is disposed of by the drainage of rainwater through open ditches. During the dry season, when the flushing action of rainfall does not exist, drainage channels become blocked with solids, creating stagnant pond of contaminated

¹ Interview with Mr. Sewanu Adebodun from LASEPA

² Aalto University: School of Engineering. *Case Study of Lagos*. 2009. Web. 9 Apr. 2014.

water. Some people even use this water for household purposes (See Figure 10).¹ In 2010, the LSWMO set out a five-year sanitation plan, which includes a goal to improve wastewater treatment infrastructure, but this plan is being schedule and has yet to be implemented.²

Figure 10: Blocked Drainage



¹ United Nations (UN). *City Profiles: Lagos*. Web. 09 Apr. 2014

² Siemens. *Africa Green City Index: Lagos*. 2013. Web. 09 Apr. 2014.

C) Water Pollution

Lagos has often been referred to as the one of the dirtiest cities in the world¹ and LASEPA reports that all water bodies in Lagos, both surface and ground water, are polluted². Saltwater intrusion, human wastes, leachate from waste disposal sites, maritime and industrial waste, leakages from sewer lines and agricultural runoff all pose water quality challenges.³

Adebodun explains that the quality of water has been adversely affected by the rapid increase in population. With increased use of water, comes increases wastewater, which drains into canals that empty into water bodies. In addition, Lagos is particularly susceptible to water pollution because the water table is very high, sometimes only three meters from the surface and the relatively loose and easily permeable soil allows the infiltration of contaminants. Lagos lacks an effective waste collection service and has no central system for treating sewage and industrial effluent. Filling the vacuum are self-employed collectors who push carts through the streets, collecting rubbish from residents for a fee, including organized concessions that actively undermine municipal sanitation development.⁴ More than 10% of the estimated 4,000-6000 tons of solid waste generated each day in Lagos are dumped directly into open spaces or municipal drainage systems,

¹ Rosenthal, Elisabeth. "Nigeria Tested by Rapid Rise in Population." *New York Times* (New York), April 15, 2012. Web. 09 Apr. 2014.

² Interview with Mr. Sewanu Adebodun.

³ Interview with Mr. Sewanu Adebodun.

⁴ Stimson. The Stimson Center. *Lagos: Growth Without Infrastructure*. Washington, D.C, 2009. Web. 09 Apr. 2014.

blocking drainage during heavy rains.¹ Lagos health and environment officials acknowledge that most of the rubbish and sewage collected by private operators, as well as the industrial effluent, ends up in the lagoons and creeks (See Figure 11).² Untreated sewage pollutes the lagoon and destroys marine and aquatic life.³ LASEPA is charged with the responsibility to protect and safeguard Lagos water bodies, but is only focused on pollution prevention, particularly from industrial effluents. It issues fines and permits to, but has made no efforts to clean up these polluted water bodies.

Figure 11: Dumping by the Lagos Lagoon



¹ Stimson. The Stimson Center. *Lagos: Growth Without Infrastructure*. Washington, D.C, 2009. Web. 09 Apr. 2014.

² Irin News. "Lagos: Crisis of Management." *Irin News*. Web. 09 Apr. 2014.

³ United Nations (UN). *City Profiles: Lagos*. Web. 09 Apr. 2014.

In the Makoko slum, residents use small enclosures attached to their shelters as toilets and bathrooms (See Figure 12). All their waste is dumped into the same lagoon where they fish. There are pit toilets in areas of the settlement lying on firmer ground, but each one serves several families.¹ This has a negative environmental impact, affects the food source and poses a significant risk of viral and bacterial diseases such as polio, meningitis, diarrhea, cholera, parasitic infection and fevers spread by waterborne vectors.² “Over 70% of visits to hospitals are related to water-borne diseases,” said Dr. Dotun Ojelade, a doctor at a private hospital in Lagos.³ The results show that about 45% of respondents complained about water contamination and/or have contracted waterborne diseases in the last 6 months.

Figure 12: Makoko Slum



¹ Durham, Mark. "Report From Lagos: Water Crisis." *URBim*. April 17, 2012.

² Irin News. "Lagos: Crisis of Management." *Irin News*. Web. 09 Apr. 2014.

³ Nigerian Journal. "Tackling Nigeria's Water Crisis." *Nigerian Journal* (2011). Web. 09 Apr. 2014.

D) Water Injustice and Inequity

Historically, there has been a skewed distribution of resources such as water resulting in inequalities in development across the state.¹ In many parts of Lagos Mainland, not only is there evidence of lack of access to public water, but also it is not uncommon to see women and children walking for miles carrying containers of diverse shapes and sizes in search of water. This is not due to the geographic factors as the mainland is closer to the water supply sources than the island, but due to chance of higher revenue generation in richer areas. The results from questionnaire illustrate this; the island residents had more access to water and mainland residents have to travel 4 times the distance to gain access to water. Even those living in riverine communities also struggle to have potable water. For example, it is not uncommon to find many of the residents of Makoko paddling their way to their various homes floating on the blackish water of the lagoon with kegs and buckets of clean water bought from water merchants. During my research, I witnessed women and children scamper over one another in order to fetch water from a burst pipe (See Figure 13).

¹ Ayinde, Olutoyin. "Implementation of Water and Sanitation Policies and Practices within the Spatial Plans of Lagos, Nigeria." Lecture. World Water Week. Stockholm. 4 Sept. 2013. Web. 9 Apr. 2014

Figure 13: Water Leaking From Burst Pipe



However, the wealthier areas have water piped to their houses or have water tankers deliver water to their houses at cheap rates; 0.10 Naira per liter (See Figure 14).

The poorest families pay more per month than some of the richest that can afford a connection. The amount paid, for a very limited volume of supply from private water vendors, can be four to ten times of what is paid for a month of pipe borne water, which provides a larger volume of water. My research showed that the cost of water for residents on the mainland who lack less access was 4 times more than the island residents’.

Figure 14: Water Tankers



Challenges

A) Poor Water Infrastructure and Utility Performance

Many Lagosians have to fend for themselves and most often depend on other sources of water than pipe borne water to meet their needs because of the inadequate water infrastructure in Lagos. The post-colonial successors never succeeded in building a fully functional metropolis through investment in the built environment or infrastructure. Vast quantities of capital that might have been invested in health care, housing or physical infrastructure were either consumed by political and military elites or transferred to foreign bank accounts with the connivance of Western financial institutions.¹ In

¹ Irin News. "Lagos: Crisis of Management." *Irin News*. Web. 09 Apr. 2014.

many parts of the city, pipe-borne water supplied by government agencies is virtually non-existent. Less than 30 percent of the population has access to piped water connections, closer to 10 percent if considering only household connections, not community standpipes.¹ Residents with an on-point or nearby connection to pipe borne water must contend with erratic access due to inconsistent production from the waterworks and power outages. During the interview, the manager of the Lekki Waterworks explained that production is cut in half due to unreliable power supply, maintenance issues, poor infrastructure, and insufficient equipment. Production facilities are rarely operated due to broken down equipment, or lack of power or fuel for pumping. Mechanical equipment and pipes are poorly maintained, leading to frequent breakdowns, and high loss of water through leakages.

The bulk of the water pipe network is comprised of old, rusty, and broken pipes, which pass through open gutters and stagnant pools of garbage-strewn water and despite being connected to pipe borne water, the water may not flow at all and when it does, it is colored with an odor; it is undrinkable.² In the past, huge pipes carried water from reservoirs of State Water Boards to neighborhoods. These pipes were usually on the surface or buried but linked to specific manholes. Trained technicians of the water corporations did the installation of these pipes. Some areas in the inner city,

¹ Okoye, Victoria. "On Clean Drinking Water in Lagos: Many Options, Few Solutions." *Sustainable Cities Collective*. August 8, 2012. Web. 09 Apr. 2014.

² Okoye, Victoria. "On Clean Drinking Water in Lagos: Many Options, Few Solutions."

like in Lagos, for instance, still have these connections but are now overstretched because of rapid population growth.¹ These days, to gain access to pipe borne water “it’s every man for himself”.² Different technicians require different types of pipes to be bought by homeowners and connect them to building through drains in the neighborhoods. But some of these pipes break either during installation or after. People use cellophane to tie them up so as to ensure partial flow.³ Thus, huge quantities of water is lost from leakages. What is worse is that germs get into the water. These pipes are made of material that crack with changes in temperature and people who are desperate for water, unscrew the joints, fill their containers and attempt to screw them back with little success. Even in the process of unscrewing the pipes, the water in the drains mix with that from the pipes.⁴ The Lagos state government finds water from pipes in drains objectionable and has established the LWRC to correct this harmful act amongst others.⁵ The Chief Executive Officer of the LWRC, Mrs. Tanwa Koya states that it is unacceptable for pipes to be laid in drains. She states “People ought to contact the LWC to connect the pipes for them. It is illegal to connect it themselves and for the LWRC it is an offence” (Oghifo).

Furthermore, the lack of metering, outdated information systems, and inconsistent billing practices cause severe revenue losses. The LWC is not

¹ Oghifo, Bennett. "Getting Clean Water Into Homes."

² Oghifo, Bennett. "Getting Clean Water Into Homes."

³ Oghifo, Bennett. "Getting Clean Water Into Homes."

⁴ Oghifo, Bennett. "Getting Clean Water Into Homes."

⁵ Oghifo, Bennett. "Getting Clean Water Into Homes."

proficient in customer billing, fee collection and as a result experience poor cash flows. Therefore, it fails to recover its operating expenses and remains dependent on the government for subsidies. The systemic challenges facing urban water infrastructure are worsened by the high demand for water resources from many sectors including agriculture, energy, and transportation.

B) Poor Planning

Infrastructure in Lagos falls short of meeting current needs and this is due to poor planning. Planning and management are decentralized through legislation creating various water agencies and more than 15 separate master plans exist within these agencies.¹ For example, LASEPA is responsible for water quality, LSWMO is responsible for waster management, LWC is in charge of water supply, LASEMA is in charge of drought management, the Office of Drainage Services is in charge of stormwater management and the ministry of health is in charge of waterborne diseases. All these facets of water management are interrelated and poor performance in one, adversely affects the other. However, the current water sector does not utilize integrated planning but rather all these agencies work independently, sometimes resulting in conflicting policies and strategies. For example, LASEPA mandates that no resident in Lekki should have septic tanks due to loose soils; however, LSWMO gives permits to Lekki residents to have septic

¹ Ayinde, Olutoyin. "Implementation of Water and Sanitation Policies and Practices within the Spatial Plans of Lagos, Nigeria."

tanks. LSWMO and LWC are to work together but are not because the LWC is just focused on water supply. 80% of the water LWC produces ends up as wastewater.¹ Both agencies have to the opportunity to work together and synchronize master plans to know how much water can be produced, is wasted and needs to be treated and explore wastewater recycling as a viable water supply option.

Development is a threat to Lagos' water bodies. But LWRC not LASEPA is in charge of controlling development, though LASEPA is mandated to safeguard Lagos' water bodies. Further, the LWRC is mandated to ensure proper delivery of water supply and wastewater management services in Lagos but nothing has been done so far and the water agencies responsible and the LWRC are yet to sit down to work to achieve proper water management. The Lagos State government perceives public private partnerships (PPP) as the best means of improving service delivery and investment in the water sector. However, Lagos lacks the policy, legal, and regulatory environment and expertise to attract and sustain private investment. It is a challenge to ensure sustainable water management, when there is a failure to coordinate and integrate planning approaches for stabilizing water supply, water quality and service delivery and other segments that affect them such as development, wastewater management, climate change, and transportation.

¹ Interview with Dr. Balogun from LWC

There is a lack of thorough analysis or projections while planning. The state government has largely emphasized public-private partnerships in service delivery and infrastructure development; ambitious projects are planned. However uncertainties exist around capacity and long-term financial resources to fund these projects.¹ Furthermore, there is an absence of zoning ordinances and subdivision regulations. Lagos was developed on a coastal strip, which requires substantial investment in drainage and stabilization to avoid flooding and erosion that the state lacks. "This is Lagos. People build anything they want, wherever they want" expressed Dr. Balogun during the interview.

C) Bad Governance and Lack of Political Will

Local governance impacts inhabitants, especially the urban poor. Almost all aspects of urban development: employment and job creation, public transport and traffic, solid-waste collection and disposal, water and sanitation, health services, shelter and housing, hinge on the issue of governance. The urban poor are dependent on city authorities to a far greater degree than their rural counterparts, because when deficiencies exist in urban areas, there are few alternatives available. The shortcoming of government intervention to make provisions to ensure implementation, enforcement and compliance with water agencies has resulted in poor water management in Lagos and this has left a vast gap between supply and

¹ Ayinde, Olutoyin. "Implementation of Water and Sanitation Policies and Practices within the Spatial Plans of Lagos, Nigeria."

demand, transforming potable water into an essential commodity. Over past decades, this gap has opened the way for informal and private sector led adaptations, as entrepreneurial youth and businessmen have devised ways to not only muddle through, but also to profit from the status quo. Nearly every resident finds him or herself relying on intermediate vendors, middlemen who source and sell water through varying and unsafe means.

Poor governance is also a major obstacle to water agencies in Lagos. The corruption, fragmentation, and duplication of institutional responsibilities and lack of coordination among agencies and ministries compound the problem.¹ All water agencies interviewed during my research complained of government interference and the restrictions placed on the agencies. "Government operation facilities that fail to comply to LASEPA policies cannot be regulated by LASEPA. There needs to be a provision such as checks and balances that would allow LASEPA regulate other government and water agencies," said Mr. Adebodun. Even with adequate funding, sustainable water management will be impossible without the political will to abandon corrupt practices and institute careful, appropriate planning.

D) Unreliable Electricity

One major constraint in providing Lagos improved and steady access to a reliable and safe water supply system is the erratic power supply. At both Iju and Adiyin waterworks, the epileptic electricity supply hampers production

¹ Irin News. "Lagos: Crisis of Management."

causing operation costs to rise. Unreliable electricity supply reduces production by about 60%; hence water pressure in the pipeline is low.¹ Due to acute problems of power supply, water agencies spend resources on diesel, standby generators or even building Independent Power Plants (IPP), thus increasing the cost of production and cutting down efficiency.²

E) Lack of Funds

The UN's target to halve the number of people without safe drinking water by 2015 is something the Lagos Water Corporation has been committed to. "Essentially increasing our infrastructure to probably twice the size it is now by 2015," stated LWC.³ However, the corporation will not reach this target as it has failed to increase production capacity and address infrastructure due to limited funding. The Lagos State Water Corporation needs resources, which are unlikely to be forthcoming from the state government; other sources of revenue such as the participation with the private sector are being considered. The biggest potential for revenue generation comes from tariffs, but a flawed pricing system, low metering rate, low billing and collection rate and poor service delivery, hinder gainful revenue generation. "LWC cannot run efficiently because it is not breaking even", stated Dr. Balogun. As in so many other sectors, it is the availability of funds that will eventually decide

¹ LWC. Lagos Water Corporation (LWC). *Water: Conserve and Use Wisely*. Lagos, Nigeria 2010. Web. 09 Apr. 2014.

² Interview with Dr. Balogun from LWC

³ BBC News. "Lagos: Water, Water Everywhere." *BBC News*, September 12, 2005. Web. 9 Apr. 2014.

whether or not the Lagos State Water Corporation achieve its goal of covering the demand gap.

Research Methodology

There is a water supply plan in Lagos, created by the Lagos State Water Corporation, which has a goal to improve access to clean drinking water, namely the Lagos State Water Supply Master Plan of 2010. The plan focuses on infrastructure development and does not address core issues such as monitoring and enforcement, water demand management, and stakeholder participation. This capstone report reviews the gaps and successes of this plan and build upon the plan to create a more comprehensive and sustainable water management plan that will be more effective in targeting the main challenges faced by the Lagos water sector and hence achieve better results. In addition to the master supply plan, I reviewed the legislation of the Lagos water sector.

A main feature of the plan that I create in this report is the privatization of water in Lagos. I reviewed several articles, case studies and reports that explore the successes, challenges and results of privatization of water and other utilities in Sub-Saharan Africa and recommend a structure of water privatization that avoids the failures of past attempts at water privatization and would be more suitable for achieving the Lagos water sector goals.

Research Question

My research was guided by the following questions:

How can water supply and access to clean drinking water be improved in Lagos?

Sub-Questions

- How is potable drinking water provided in Lagos?
- What is the role of the government and the informal private sector in water provision in Lagos?
- What are the current and future efforts and plans to ensure water provision in Lagos?
- How is water provision in Lagos governed or regulated to ensure service delivery?
- What are the strengths, challenges, failures and factors regarding water provision in Lagos?
- What are the social, economic, and environmental issues related to water provision in Lagos?
- What strategies, policies, and plans need to be put in place to ensure water provision in Lagos?

Materials & Methods

- *Study Area:* Metropolis of Lagos, Nigeria.
- *Focus Area:* Water resources management, water supply, water services delivery, water source protection

- *Components of Research:* Water sector policy, legislation and regulation; decentralization and devolution; sector-wide approaches; water sector financial management; monitoring and evaluation; integrated and trans boundary water resources management; transparency, accountability and corruption; investment, operations and management; water resource allocation; water source protection; enforcement (fees, fines, permits); civil society participation; alternative service provision and public-private partnerships; water justice (gender and poverty); risk management; and equitable service delivery
- *Level of Analysis:* State Water Sector
- *Stakeholders Involved:* Researchers, academics, civil society organizations, users organizations, operators and providers of water services, representatives of water sector institutions, public water systems, representatives of relevant accountability and oversight institutions, citizens of Lagos.
- *Theoretical Background:* Lagos is currently facing a water supply crisis. The state water utility has been unable to meet the growing demand gap, only about 10% are connected to the water supply system. The 90% have to fend for themselves and are often subject to exorbitant prices and unregulated and unsafe water. The water governance is poor; the large number water agencies leads to

inefficiencies and redundancy as they fail to work together. In addition, the lack of enforcement and implementation hinders progress toward achieving water sector goals. Other major challenges the water sector faces include: inadequate funding, rapid population growth, crumbling infrastructure, absence of central urban planning, climate change, poor utility performance, unreliable electricity and corruption. This has led to water pollution, water scarcity, and water inequity.

- *Methodology & Data Acquisition:*
 - Data collection has been carried out through legislation review and interviews with the Lagos state government officials. These interviews were carried out with Dr. Bola Balogun from the Lagos State Water Corporation; Mr. Adebodun Sewanu, Mr. Sanuth Hassan and Engr. Shabi Adebola from the Lagos State Environmental Protection Agency; and an official from the Lekki Waterworks who preferred to be unnamed. They were all purposively selected as they were considered to have relevant information required for this capstone. The notes from the interviews are included in the appendix.
 - Water resource quality assessments were carried out in both mainland and island areas through water sample testing.
 - Applied methodologies included: focus group discussions, key informant interviews, social and institutional mapping, reviews

of technical surveys and audits of the water-related infrastructure and the main sources of water supply in Lagos and a diagnostic assessment through identification of key gaps, needs, constraints and opportunities in Lagos state water plans, strategies and capacities. Also data sets from previous projects and reports in addition to analysis of state water sector statistics and data were utilized.

- Data acquisition was also made through stakeholder review by passing out surveys and questionnaires. The questionnaire was fairly short, just a page (See appendix for sample). However, it covered issues regarding water contamination, water scarcity, and access to water in Lagos. To make sure that correct answers were inputted, I filled out the responses from every respondent. This questionnaire was distributed to get a better understanding about issues facing the water sector in Lagos. By getting the opinions from Lagos citizens about how they get access to water, how much water is used and their views on Lagos water issues, I was better able to understand and therefore establish a more accurate analysis of the Lagos water sector and provide more suitable recommendations that would address the needs of these Lagos citizens.

Limitations of Study: Accessibility to safe water has many public health implications. Though water samples were taken, getting a biological test to analyze for the quality of water was difficult. However, other case studies on water quality in Nigeria were utilized to fill in the gap. I found it difficult to find out the income level of the water users, which was needed to measure for affordability of water. However, by getting the price paid for water and asking if affordability of water was an issue, I believe I was able to fill that gap. Additionally, a previous case study research on household income especially in the low-income areas was utilized.

Analysis & Results of Questionnaire

Questionnaire Results

Out of 100 questionnaires distributed, there were 66 respondents. To eliminate bias, these questionnaires were distributed in locations such as churches, universities, shopping malls, and restaurants, where there would be a high range and diversity of people based on gender, age, household size and location. However, respondents were reluctant to indicate household income. The absence of that parameter creates a bias. In addition, a majority of the respondents lived on the mainland. To eliminate this bias from the results, I analyzed the results by area; mainland and island. The results from the questionnaire demonstrate and validate the core issues around water supply and quality in Lagos.

Below are the results from the questionnaire.

Figure 15: Drinking Water Sources in Lagos

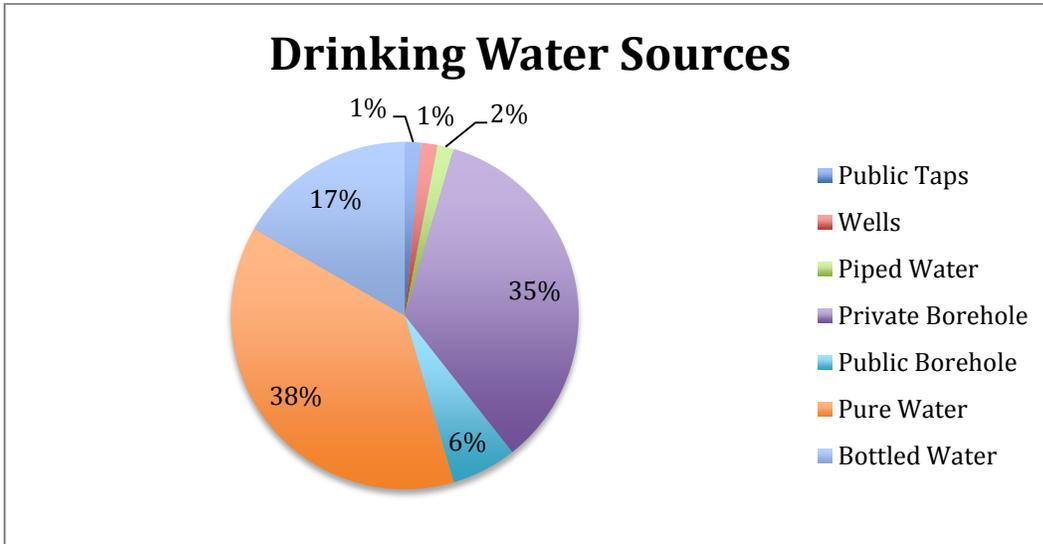


Figure 16: Water Sources for Other Purposes in Lagos

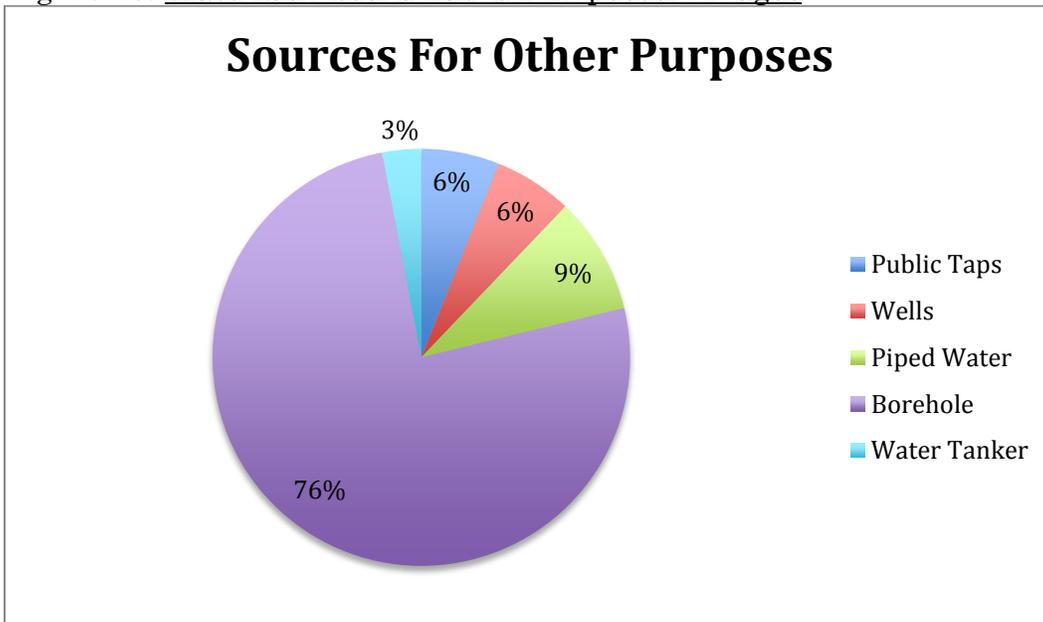


Table 2: Results From Questionnaire

	Island	%	Mainland	%	Total	%
<i>Total Respondents</i>	15	23%	51.0	77%	66	100%
<i>Females Being Responsible For Water</i>	6	40%	29	57%	35	53%
<i>Males Being Responsible For Water</i>	9	60%	22	43%	31	47%
<i>Pure Water & Bottled Water for DW</i>	11	73%	26	51%	37	56%
<i>Pure Water & Bottled Water for OW</i>	1	7%	0	0%	1	2%
<i>Borehole for DW</i>	3	20%	24	47%	27	41%
<i>Borehole for OW</i>	10	67%	42	82%	52	79%
<i>Public Taps & Well for DW</i>	0	0%	2	4%	2	3%
<i>Public Taps & Well for OW</i>	1	7%	7	14%	8	12%
<i>Piped Water for DW</i>	1	7%	0	0%	1	2%
<i>Piped Water for OW</i>	2	13%	4	8%	6	9%
<i>Percentage Who Treat Water</i>	7	47%	25	49%	32	48%
<i>Percentage Who Do Not Treat Water</i>	8	53%	26	51%	34	52%
<i>Percentage Who Drink Pure Water & Treat</i>	1	33%	9	39%	10	38%
<i>Percentage Who Drink Other Sources But Pure/Bottled Water & Treat</i>	1	7%	15	29%	16	24%
<i>Percentage Who Drink Other Sources But Pure/Bottled Water & Do Not Treat</i>	3	20%	11	22%	14	21%
<i>People Who Do Not Treat But Have Water Contamination & Waterborne Diseases</i>	4	27%	10	20%	14	21%
<i>Average Household Size</i>					5.596	
<i>Percentage with Access</i>	10	67%	31	61%	41	62%
<i>Average Distance Traveled for Access</i>	0.30		1.3		1.1	
<i>Regularity & Consistency</i>	3.66		3.49		3.53	

<i>Average Use</i>	254.33		140.69		166.5	
<i>Average Cost of Water</i>	0.17		0.63		0.52	
<i>Average Cost of Piped Water</i>	0.05		0.05		0.05	
<i>Average Cost of Water for Other Sources</i>	0.25		0.72		0.55	
<i>Waterborne Diseases</i>					8	12%
<i>Flooding</i>					10	15%
<i>Scarcity</i>					26	39%
<i>Contamination</i>					20	30%
<i>High Cost</i>					15	23%
<i>General Water Issues</i>					55	83%

DW = Drinking water

OW = Other water uses

The cost of water is in Naira (\$1 = 165 Naira)

The distance is in kilometers

Use is in liters

Discussion

Main Findings from the Questionnaire

- More females are more responsible for water on the mainland than on the island.
- Males are more responsible for water on the Island, than on the mainland where access is less and more distance is travelled.
- A majority of individuals rely on pure water and bottled water for drinking water. More rely on bottled water on the Island, while on pure water on the Mainland.
- A minor few use pure & bottled water for other purposes than drinking.
- A majority of individuals use borehole as their main source of water; there are more private boreholes on the island while there are more public boreholes on the mainland.
- Public taps & wells are a viable source of water on the mainland.
- A majority of individuals do not depend on piped water for water especially as a drinking water source; more people use piped water as a water source on the Island.
- Piped water is not a trusted source for drinking water and as such is used more for other purposes.

- More than half of Lagosians do not treat their water; this is especially worrisome on the mainland as they use sources that have poor quality (not pure or bottled water) for drinking water.
- The same number of people who drink untreated water reported to have either water contamination or water diseases.
- The average household size is 5.6 in Lagos.
- About 65% of the people both on the Island and the mainland have water in their house and do not have to go outside to find access. Within the Island, the more developed and wealthier areas all have water in their house. This is a result of having boreholes.
- The distance traveled on the mainland is 4 times the distance traveled on the Island. A majority of those on the island who lack access use water tankers which come to their house or have public boreholes near their household.
- Lagosians believe that their regularity of their source of water is between average and fairly consistent. When asked about pipe borne water, respondents rated it very inconsistent to inconsistent.
- The amount of water used on the Island is more per capita and the amount paid for this water is also lower than what is paid on the Mainland.

- People on the mainland pay 3-4 times more than what is paid on the Island because they lack their own private boreholes and are less connected to LWC.
- Only a few incidents of waterborne diseases were reported in the last 6 months, despite 33% reporting incidents of water contamination in the last 3 months. The number one problem regarding water is scarcity. In total, 83% of respondents had issues regarding the water supply and quality in Lagos.

SWOT Analysis For Lagos Water Sector

From the results obtained during my research from interviews and questionnaires, I have identified the strengths, weakness, opportunities, and threats in the Lagos water area. Strengths and weaknesses are internal factors, while opportunities and threats are posed by external factors. The internal factors give certain advantages or disadvantages to the water management in the basin. On the other hand, the external factors illustrate the opportunities and threats that exist independently of the water sector.

Indicators were used for this SWOT analysis. These indicators include; population density, elevation, annual rainfall, total water consumption, total water production, wastewater production, population connected to water network, ecological and chemical status of surface waters, water tariffs, cost recovery, quantity of groundwater, and water management authorities.

Strengths

- Abundant water resources including abundant rainfall
- Assets including waterworks, transmission and distribution mains
- Bustling private water suppliers

Weaknesses

- 60% unaccounted-for-water
- No integrated water management plan
- Polluted water resources
- Water inequity
- Inadequate access to water
- Inadequate tariff leading to low cost recovery
- Inefficient enforcement and implementation
- Weak infrastructure
- Unregulated groundwater abstraction
- Poor regulatory framework
- Insufficient wastewater treatment

Threats

- Climate change impacts such as reduced flows and increased water temperature, and rising sea levels that could cause salt water intrusion into aquifers
- Increased water demand due to rising temperatures or increasing population

- Increasing population growth impacts
- Epidemic from water borne diseases
- Crumbling infrastructure
- Subsidence and salt water intrusion from excessive groundwater abstraction
- Flood risk caused by episodes of heavy rain
- Corruption
- Uncertain financial resources for infrastructure investments

Opportunities

- Additional supply from wastewater recycling
- Synergies from consolidation and integration
- Higher efficiency from privatization
- Improved billing, metering, and collection rate
- Appropriate legislative framework for proper water management
- Restructuring of governance in water agencies
- Water source protection and effective water clean up
- Regulation of groundwater extraction
- Water conservation & efficiency
- Integrated water resources management

The SWOT analysis can provide insight into developing water management strategies for Lagos state. These strategies can be classified into four types¹:

- Offensive strategies which use strengths to exploit opportunities;
- Reactive strategies which aim to overcome weaknesses by taking advantage of opportunities;
- Defensive strategies which use strengths to avoid threats;
- Adaptive strategies, which reduce the weaknesses and avoid threats.

I will expand on these strategies later and incorporate them into the plan.

Factors That Exacerbate the Water Crisis

A) Population Growth

With an annual population growth rate of about 5%, its population has grown from 1.4 million in 1970 to more than 20 million today, and is projected to grow to 29 million by 2020.² Lagos covers just 0.4 percent of Nigeria's entire land area, however, it has the greatest number of inhabitants, representing 10 percent of the country's population.³ This population increase has put a constraint on providing and sharing of available resources, especially water, leading to a situation where too many people place too much demand on too few resources. The provision of adequate supplies of water to the growing number of urban residents in Lagos, especially the urban poor, is one of the

¹ Water Incore. "'Sustainable Water Management through Common Responsibility Enhancement in Mediterranean River Basins'." *European Regional Development Fund* Sept. 2011: n. page. Web. 9 Apr. 2014.

² LWC. *Lagos Water Supply Master Plan*

³ Irin News. "Lagos: Crisis of Management."

biggest challenges face the government and local authorities. In addition, the rapid population growth rate hampers the quality of water bodies in Lagos, due to larger generation of wastewater and sewage and more instances of waste dumping and open defecation.

B) Migration and Urbanization

More than 65 percent of those who migrate to Lagos end up living below the national poverty line, only marginally better than the national average of 70 percent. Migrants usually live in one of the city's 200 slums, which range in size from clusters of shacks to entire districts. It is these people, currently living in wretched conditions, who suffer more if governments are unable or unwilling to put human and financial resources into planning for the future and improving governance.¹ People who dwell slums, lack access to basic necessities and adequate sanitation, and as such pollute the water with waste, both solid and human.

C) Climate Change

Although Africa contributes only 3.8% of the global GHG emissions; it will suffer greatly from the impact of climate change. Lagos is Africa's largest coastal city and will suffer major impacts from climate change. The OECD published a report that stated that Lagos was one of the world's cities most exposed to coastal flooding and is at risk of being submerged in the next 50 years.² Wetlands and low-lying areas occupy about 78% of the land area of

¹ Irin News. "Lagos: Crisis of Management."

² United Nations (UN). *City Profiles: Lagos*. Web. 09 Apr. 2014.

Lagos, making it highly vulnerable to the impacts of climate change. These threats include water scarcity, extreme drought, accelerated coastal erosion, storm surges, flooding, depletion of natural resources, and devastation of livelihoods. Currently, approximately 60-80% of industries and the state's incremental economic activities including trade, commerce, and agriculture are located in these vulnerable areas.

D) Corruption

In Lagos, city management is compromised by the influence of informal relationships. "Land rights, employment, industry and other sources of wealth rely on political interaction, involving patron-client relations, bribery, corruption, and nepotism. There is considerable interaction and interference between leaders at national, state and local levels and sectors of the general public..."¹ Nigeria is ranked as one of the most corrupt countries in the world by Transparency International and is only able to control 16% of corrupt practices. ²These informal relationships give rise to social inequity, ethnic tensions and political instability. Without effective governance, the entire concept of rights disappears. Unless concerted action is taken to redress inequalities and corruption within the Lagos water sector, Lagos may well become a predominant site of social exclusion and instability, and will never be able to achieve sustainable water management.

¹ Irin News. "Lagos: Crisis of Management."

² United Nations (UN). *City Profiles: Lagos*.

E) Restrictions and Redundancy of State Water Authorities

The Lagos State government created LWC to manage and operate systems for water service delivery in all urban areas. LWC was established as an autonomous agency, but it suffers from a high degree of political interference, due in part to its reliance on state subsidies. This interference reduces incentives for operational and commercial improvements and adds unnecessary bureaucratic overhead.¹ In addition, there are various state water agencies that have the same functions, but do not collaborate. As such there are duplications in policies. This multiplicity of agencies is a key challenge to governance in the Lagos water sector.

F) Violence

While improving the city's urban water infrastructure must be a key component of improving access to potable water in Lagos, progress will take time and must take into account the political economy of water stakeholders, many of who have stakes in maintaining the existing environment. Municipal authorities' previous attempts to extend and improve the water supply infrastructure have been met with violence and intimidation from entrenched political units like formal water tanker lobbies and informal gangs known as "area boys." These groups profit from the status quo and readily crack down on any threats of municipal encroachment on their informally inscribed

¹ Interview with Dr. Balogun

territories where they exercise influence in water provision; this is particularly the case in the city's slums.¹

G) Inefficient Water Tariff System

Most Lagos water supply connections are not metered; the metering ratio is 1%.² Over 80% of water users connected to pipe borne water are billed on a flat rate, while collection rate is less than 50% as majority of users are not on the database. There is currently no standardized water tariff system in place in Lagos, with a cubic meter of water being sold for as little as NGN0.50 (\$0.001) by the LWC.³ This is extremely low by any standards, and particularly when compared to the NGN200 (\$1.25) that private water vendors charge for just 20 liters of water.⁴ The poorest families pay more per month than some of the richest families who can afford a connection. For unmetered residential customers, the monthly flat rate is NGN5000 (\$30) despite erratic supply or their actual use.⁵ The tariff revenues cover only 2% of the cost of supplying water.⁶ Outdated information systems and inconsistent billing practices cause additional revenue losses and the revenue collection rate is very low. In some areas, it is less than 10% of the billed

¹ Okoye, Victoria. "On Clean Drinking Water in Lagos: Many Options, Few Solutions."

² Interview with Dr. Balogun

³ LWC. *Lagos Water Supply Master plan*

⁴ GWI (2010). Global Water Intelligence (GWI). "Nigerian Water Sector Embraces PSP." *Global Water Intelligence* 11, no. 6 (2010). Global Water Intelligence, 11 Apr. 2010. Web. 09 Apr. 2014.

⁵ Interview with Dr. Balogun

⁶ GWI (2013). Global Water Intelligence (GWI). "Lagos Promotes Two-Tier Water PPP Initiative." *Global Water Intelligence* 14, no. 5 (2013): 1-5. Web. 09 Apr. 2014.

amount.¹ Being unable to cover their operating costs and unable to secure regular revisions of the tariff, the LWC receives financial assistance from the state and federal governments. These subsidies are inadequate and unpredictable. Implementing a new tariff system is difficult, as the service delivery is low and water is considered a public good that the government is expected to provide by law².

Current Governmental Efforts to Ensure a Long-Term Reliable Water Supply

The Federal government handles issues relating to water resources development such as holistic drainage basin development, hydrogeologic mapping, large-scale irrigation projects, wetland management, hydrologic data collection and management, and water for hydroelectric power through the Federal Ministry of Water Resources.³ The state government, through the Lagos State Water Corporation (LWC), is in charge of municipal water supply and quality for both domestic and industrial uses. The Lagos State Water Corporation is in charge of water supply to the metropolitan area including the mainland and the islands, not the rural areas. Some areas are cut off from metropolis and as such regarded as rural. Being riverine, Lagos has many tiny islands off the coast and there is no way to lay water pipes from

¹ Interview with Dr. Balogun

² Interview with Dr. Balogun

³ Fasona et al. *Sustainable Water Management Solutions for Large Cities*

mainland to these rural areas.¹ Examples include Epe, Badagry, and Ikorodu. The Ministry of Rural Development provides potable water supply to the rural areas.² They provide potable water for rural areas by way of drilling boreholes, providing hand pumps, and building small water treatment plants, however most of these rural areas do not have these water treatment plants.³ The LWC is also in charge of determining appropriate pricing for water supplied and mobilizing tariffs and is responsible for cost recovery through customer payments, though the recovery rates are low (Balogun).

The Lagos State Water Corporation is the largest water utility in Africa. Its total assets are 40.34 billion Naira and it operates in 11 service areas. The LWC currently has an installed water supply capacity of 210 MGD, but aging supply lines, poorly ran waterworks and unreliable public electricity hamper the services of the corporation, hence it is operating at only 48% capacity, or only 36% of water demand (See Table 3).⁴ As such, about 10 per cent of households have access to piped water.⁵

About 90% of water sourced by the LWC is from surface water, the Ogun and Aje Rivers.⁶ The major waterworks use surface water to supply potable water to the rising population of Lagos. These water bodies and the irrespective major waterworks are all located in the neighboring Ogun state,

¹ Interview with Dr. Balogun

² Interview with Dr. Balogun

³ Interview with Dr. Balogun

⁴ LWC. *Lagos Water Supply Master Plan*

⁵ Campbell, John. "This Is Africa's New Biggest City: Lagos, Nigeria, Population 21 Million." *The Atlantic*, July 10, 2012. Web. 9 Apr. 2014

⁶ Interview with Dr. Balogun

hence the city has to purify and transport water to provide water supply for industrial, agricultural and domestic uses.¹ Ogun River traverses so many states, which all utilize the water body as their source of water. Lagos is at the terminating end of the Ogun River and therefore faces challenges regarding pollution of this water source. This leads to increased costs of production and also low water levels during dry season. The Ogun/Osun river basin utilizes Integrated Water Resource Management. All states utilizing the water in this river basin have to work together to manage the water resources within their environment. The LWC liaises with the Ogun/Osun water basin authorities to release the dammed water. The states address various factors that can affect water resources such as industrial effluents, development along riverbanks and damming. The aim is for good quality water to be available for every state's use.

¹ Fasona, Mayowa, Ademola Omojola, and Nenna Amogu. *Sustainable Water Management Solutions for Large Cities*

Table 3: Monthly Production at LWC Waterworks in 2010

MAJOR WATER WORKS	DESIGNED CAPACITY M/GD	MONTHLY PRODUCTION M/ GALLON												TOTAL
		JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	
ADIYAN	70	650.11	923.78	939.64	1,136.56	978.58	932.84	700.22	717.04	888.59	797.80	1,081.00	1,024.23	10,770.39
IJU	45	432.87	393.37	483.89	370.69	247.70	177.83	183.26	209.55	342.77	275.88	450.18	517.75	4,085.74
ISASHI	4	46.70	39.10	56.60	41.10	37.70	13.04	16.30	12.03	11.05	17.97	32.37	23.23	347.19
SUB TOTAL	-	1,129.68	1,356.25	1,480.13	1,548.35	1,263.98	1,123.71	899.78	938.62	1,242.41	1,091.65	1,563.55	1,565.21	15,203.32
MINI WATER WORKS														
AGEGE	2	-	-	-	-	-	-	-	-	-	-	-	-	-
AMUWO ODOFIN	3	-	-	-	-	-	-	-	-	-	0.80	2.36	3.06	6.22
APAPA	2	24.01	19.14	9.36	16.92	22.00	17.05	17.26	17.47	12.37	15.31	18.10	20.33	209.32
BADAGRY	2	21.09	20.16	25.44	23.47	26.19	16.15	12.13	17.30	20.42	19.00	20.00	23.18	244.53
EPE	3	5.50	3.73	4.33	4.67	2.58	1.95	1.68	3.44	3.25	0.62	3.31	3.05	38.11
IKORODU	3	14.49	7.30	6.51	13.46	11.64	10.50	14.01	14.30	14.99	12.80	12.90	14.93	147.83
IKOYI	2	22.13	23.16	29.54	32.98	36.30	28.40	32.46	36.52	34.78	32.78	35.64	35.24	379.93
ISOLO	3	10.17	10.09	9.39	7.60	8.15	11.86	8.20	10.20	14.30	10.58	17.34	21.01	138.89
SHASHA	2	3.24	1.40	3.96	8.01	8.56	8.82	11.35	11.09	11.46	8.27	6.32	7.08	89.56
SHOMOLU	2	3.29	7.44	9.13	9.01	7.06	6.56	8.42	10.32	12.44	12.25	12.23	12.64	110.79
SURULERE	2	6.27	6.06	7.50	5.67	4.41	4.26	2.26	7.14	12.09	10.46	10.05	14.10	90.27
V/ISLAND	2	1.91	4.23	6.26	4.93	4.00	7.42	5.24	5.93	3.77	7.61	9.49	7.33	68.12
ISHERI OSHUN	2	-	-	-	-	-	-	-	-	5.22	-	-	19.71	24.93
MEIRAN	2	-	-	-	-	-	-	-	-	-	-	1.36	-	1.36
AJANGBADI	2	-	-	-	-	-	-	-	-	-	-	-	30.80	30.80
EPE-AGRIC	2	-	-	-	-	-	-	-	-	-	-	-	10.34	10.34
OTTA-IKOSI	1	-	-	-	-	-	-	-	-	-	-	-	-	-
SUB TOTAL	-	112.10	102.71	111.42	126.72	130.89	112.97	113.01	133.71	145.09	130.48	149.10	222.80	1,591.00
MICRO WATER WORKS														
AGBOWA(OTA-ONA)	1	-	-	-	-	-	-	-	-	-	-	-	-	-
ALAUZA	0	7.24	7.41	8.07	6.65	8.08	7.37	7.81	7.58	7.40	7.21	6.81	6.63	88.26
AJEGUNLE	1	3.02	3.48	6.49	4.44	3.65	2.46	1.15	2.51	6.09	3.97	2.75	3.11	43.12
EREDO	1	4.31	-	3.14	4.21	3.97	4.19	4.47	4.40	5.64	4.52	4.59	4.44	47.88
IDIMU	1	2.14	2.20	3.10	2.38	2.33	1.14	1.58	1.60	1.59	-	-	-	18.06
IKORODU LAGOS	1	-	-	-	-	-	-	-	-	-	-	-	-	-
LEKKI MICRO	1	11.35	9.39	9.50	9.80	9.86	6.34	5.90	8.66	16.29	20.86	20.51	18.73	147.19
V/ISLAND ANNEX	1	11.40	6.93	7.96	8.73	4.96	3.87	6.37	9.86	7.91	5.18	3.26	5.87	82.30
IWAYA	1	6.58	5.52	5.50	4.96	2.96	1.52	1.56	4.70	5.44	4.76	6.24	8.28	58.02
IKEJA-GRA	1	8.29	5.96	6.14	7.08	7.33	6.41	7.14	7.28	7.03	6.75	7.19	8.79	85.39
ONIKAN	1	7.55	9.13	12.02	9.66	11.19	5.89	2.91	4.47	6.90	2.23	1.28	0.74	73.97
DOLPHIN	1	10.38	7.13	7.38	5.32	5.87	4.48	6.90	9.86	9.11	5.87	4.20	6.85	83.35
OWORONSONKI	1	3.83	3.83	3.39	4.15	3.67	2.42	2.95	2.99	2.99	3.60	3.94	3.91	41.67
IGANDO	1	8.49	4.50	8.00	5.25	4.05	2.14	1.92	5.13	8.99	8.17	9.30	10.53	76.47
OJO	1	2.98	2.77	2.30	1.60	0.60	0.50	0.67	0.77	2.29	4.39	4.98	5.39	29.24
OTTO-AWORI	1	7.56	6.82	8.58	7.46	6.64	3.06	3.58	5.08	6.08	4.97	6.19	6.88	72.90
IJORA-BADIA	1	9.50	7.42	10.43	9.10	7.04	5.22	7.15	11.74	8.56	8.65	-	-	84.81
BARIGA	1	13.05	11.15	13.35	8.85	9.95	10.60	5.19	8.84	7.15	8.41	10.57	11.59	118.70
SUB TOTAL	-	117.67	93.64	115.35	99.64	92.15	67.61	67.25	95.47	109.46	99.54	91.81	101.74	1,151.33
TOTAL	176	1,359.45	1,552.60	1,706.90	1,774.71	1,487.02	1,304.29	1,080.04	1,167.80	1,496.96	1,321.78	1,804.46	1,890.18	17,946.19

The mini and micro waterworks, on the other hand, use groundwater as they produce water on a much smaller scale. Groundwater can only be obtained from two regional hydrogeological aquifers: the Abeokuta and Coastal Plain Sands Formations, with the latter being the main aquifer for Lagos.¹ It has a yield value varying from 20-100m³/h. A major concern, however, is the recharge of these aquifers with projected usage of groundwater to meet the water demands for Lagos. This source of water is highly competed for in Lagos as many residents utilize groundwater through private and public boreholes and wells. The results from my questionnaire show that about 82% of respondents use boreholes and wells as their source of water. Though groundwater is highly sought after, there is a lack of water source protection. Customers don't necessarily include those who have boreholes. Some customers are connected to the LWC water supply but also have boreholes but this group of customers isn't accounted for and the excessive use of boreholes in Lagos is not factored into projections of available water.

The Lekki Waterworks, which is considered to be mini waterworks with a production capacity of 1.2MGD to serve the Lekki axis, uses borehole and groundwater abstraction to produce water (See Figure 16). Lekki was developed on reclaimed land and was formerly a beach. This doesn't seem like

¹ Oyegoke, S. O., A. O. Adeyemi, and A. O. Sojobi. "The Challenges of Water Supply for A Megacity: A Case Study of Lagos Metropolis." *International Journal of Scientific & Engineering Research* 3.2 (2012): 1-10. Print.

a suitable place to use groundwater as a source of water supply, however, that is the way it's done. Before abstraction, there are analysis and tests done to determine the dynamic and the static water level, and the water table. The manager of the Lekki Waterworks states "These boreholes are sustainable, as the groundwater levels are not decreasing. If the water table is believed to be decreasing, another borehole is constructed about 50 meters away from the next one." There is a belief that the risk of groundwater intrusion is low, despite many communities being adjacent to the ocean and the water table being surrounded by septic tanks and open sewers. The boreholes are cased by steel or cement "so intrusion is quite difficult", so he believes.

Figure 17: Borehole at Lekki Waterworks



These waterworks face a huge risk because their source of water is overused and changeable; constructing another borehole is only a temporary solution. What happens in the long run where there is saltwater intrusion or subsidence from depletion of groundwater supplies? By law, the LWC is to regulate groundwater abstraction through boreholes because of risks of saltwater intrusion and subsidence, however this function has been overlooked.¹

There is a high rate of population increase in Lagos, well above 5%, and the LWC believes that the freshwater sources will not sustain the megacity. As such, the corporation is considering the use of brackish water, lagoon water, and saltwater to meet growing demand.² The LWC plans to set up a 50MGD desalination plant along the Badagry axis, to be funded, built and operated by a Singaporean company called Hyflux.³ When asked why a city surrounded by so much freshwater sources would need a desalination plant, Dr. Balogun responded, “hydrological studies show need for the desalination plant to serve Badagry axis”. These hydrological studies were performed 5-10 years ago and are being used to make future projections for 5, 10 and 20 years. It is unclear how accurate these hydrological studies are as she also stated that the LWC doesn’t have the capacity to conduct in-depth research or hydrological and impact studies but are contracted out to consultants or from agencies who generate such data water basin authorities

¹ Interview with Dr. Balogun

² Interview with Dr. Balogun

³ Interview with Dr. Balogun

and the navy.¹ The LWC has a lack of data and uses the WHO water use standards (110 liters per capita per day) for projections². The results from my questionnaire illustrate that the actual use is more than that, at about 165 liters per capita per day for all uses. Dr. Balogun acknowledges that water conservation is recognized by the LWC as something that must be done but it still not high on the priority list as compared to building capacity for water supply. With rapid growth, faulty projections and uncontrolled water use in Lagos, how does the Lagos State Water Corporation intend to cover the water supply gap?

The delivery system to provide water to end-users is insufficient, with treatment plants suffering from electricity shortages and pipe infrastructure that cannot meet the needs of the population. Though the production capacity is 210MGD, actual production is 60MGD and of the 60MGD, 60% is unaccounted-for-water.³ Hence the current network coverage is just 44%.⁴ Increasing coverage to 80 percent by 2020 would require over US\$10 billion annually. These investment costs would only be approximately four percent of Nigeria's GDP⁵, but there are already complaints about misappropriation of funds. A Lagos State lawmaker, Mr. Saka Fafunmi, a member of the Lagos State House of Assembly (LAHA), expressed dissatisfaction at the

¹ Interview with Dr. Balogun

² 1 liter = 0.264 gallons

³ Interview with Dr. Balogun

⁴ LWC. *Lagos Water Supply Master Plan*

⁵ The World Bank (2010). *New Project to Bring Clean Water to 50,000 Households*. Washington, D.C., 2010. Web. 09 Apr. 2014.

performance of the Lagos State Water Corporation and said that the corporation had not been able to justify statutory allocations to it.¹ "Anyone that is using water will be willing to pay for it, but the corporation has not been giving us water. Is there any new community that Water Corporation has given water? People depend on boreholes; even government estates have industrial boreholes. Why do we keep pumping money into an agency that does not give us the desired results?" he asked.² He noted that the Adiyin Waterworks was located at Ifako-Ijaiye, where many of the residents had resorted to digging boreholes as a means of getting water.³

In my interview with Dr. Balogun, she stated, "that LWC cannot run efficiently because it is not breaking even." Funding for LWC comes from state subsidy, tariffs, and donor transfers but funding is insufficient to cover costs including energy, chemicals, wages, aging infrastructure and expansion costs.⁴ As a result, such water schemes eventually collapse partly due to poor maintenance of power generating equipment and unbearable running costs. There's belief that the corporation has the capacity to generate much funding internally through water rates but has relied solely on government funding because of poor performance. Although this might be the case, it is necessary to acknowledge that the metering, billing and collection rates are very low;

¹ NAN. "Lawmaker Scores Lagos Water Corporation Low." *Punch Nigeria* [Lagos] 21 Nov. 2013. Print.

² NAN. "Lawmaker Scores Lagos Water Corporation Low."

³ NAN. "Lawmaker Scores Lagos Water Corporation Low."

⁴ Interview with Dr. Balogun

the metering rate in Lagos is approximately 1%, most of which are in Lekki.¹ A flat rate is charged and when payments aren't received, water service is shut off. This turns out to be ineffective as most of these customers would go and seek alternative sources of water. This demonstrates the LWC's inability to enforce or implement its strategies. The Lagos State Water Corporation is supposed to be an independent, standalone company relying only on internally generated revenue, but has not been able to achieve full autonomy because of a lack of profits and limited funding. As such the LWC relies on the government to empower the corporation and provide legal capacities to enforce and implement policies and strategies. However, the LWC doesn't have the provisions to enforce their initiatives such as metering, they can only encourage wise water use through public awareness and education.² Dr. Balogun states "it is very difficult to change the law to enable provision of capability for enforcement and implementation for LWC. It is a long and bureaucratic process. The LWC doesn't have the grounds as they have failed to provide reliable water supply so as such cannot require citizens to adhere to their policies." Providing water in such an environment where water supply is still a political issue and where an alternative source of water supply is readily available makes providing water to the general population even more difficult. The LWC believes that when service delivery improves, there would be a natural migration toward pipe borne water, as their rates

¹ Interview with Dr. Balogun

² Interview with Dr. Balogun

are 500 times cheaper than alternative at just 150 Naira/m³ or 0.05 Naira/liter.

Lagos has experienced an outbreak of waterborne diseases in the past few months.¹ The quality of water from the waterworks is up to standard but quality declines due to intricate reticulation, rapid population increase, poor planning that put pipes by sewage and drains, and roads (Balogun). The manager of the Lekki Waterworks expressed “pipes pass through the drains and gutters. These gutters aren’t cleaned out and are constantly full, even worsened during periods of flooding. This leads to seepage and intrusion into the pipe borne water.”

“A lot of people are falling sick because they don’t drink clean water. In the same compound, where you have sewage, is where you have a borehole. There is no way you can manage the sewage that it will not leak and pollute the water; everyone drinking such is drinking contaminated water,” said Mr. Saka Fafunmi.² The water agency responsible for providing clean drinking water is LWC, while the agency responsible for wastewater is LSWMO. Because these two agencies have failed to work together, serious consequences have arisen. LWC plans to ensure service delivery and improved quality, including plans to extend the network and construct booster stations to inject chlorine to disinfect receiving waters to prevent

¹ Interview with Mr. Sewanu Adebodun

² NAN. "Lawmaker Scores Lagos Water Corporation Low."

waterborne diseases.¹ But what the Lagos State Water Corporation needs to realize is that there is no point in pumping clean water into a system that is easily polluted by sewage. It is time and money wasted if these agencies do not work together to create a plan that will ensure better and more sustainable water management.

Figure 18: Polluted Water Body in Lagos



There isn't a corporate concern for environmental sustainability. The LWC has no overarching environmental goals. "Sometimes Environmental Impact Assessments are utilized but not always and sometimes projects fail as a result," states Dr. Balogun. Furthermore, LWC's impact on the environment is not addressed. There have been cases of environmental

¹ Interview with Dr. Balogun

damage; the Adiyari plant effluents polluted a nearby community and silted up the Adiyari River, but no effort was made on LWC's part to prevent or correct this situation. The water corporation does not address environmental justice and social equity, "the primary concern is to get a return on their investment and cover costs" said Dr. Balogun.

Lagos State Water Supply Master Plan (2010-2020)

The Lagos State Water Supply Plan was created by the LWC to improve the water supply system in Lagos and provide pipe borne water for every citizen in Lagos state. The strategies to achieve this goal include boosting supply and increasing access to potable water, largely driven by infrastructure development. The Lagos State Water Supply master plan has three phases: short term (2010-2013), medium term (2014-2017), and long term (2018-2020). The plan utilizes 2010 baseline data and projections of population growth, water production and the availability of water, water demand and the demand gap. In 2010, the population was 18 million and the demand gap was 330 MGD with production at 210 MGD and water demand at 540 MGD. The water demand was estimated to be 136.2 liters per capita per day.

Based on the master plan, the projected water demand for the megacity in 2020, estimated to be 733 MGD would be met by the projected production capacity of 745MGD (See Table 4)¹. LWC plans to cover demand gap in the short, medium, and long terms by expanding infrastructure including building new and upgrading water production and treatment plants. The LWC also projects that the water demand will decline due to increased demand side management and efficiency, but neglects to include plans to ensure that (See Figure 18). As part of the short term plans, the

¹ LWC. *Lagos Water Supply Master Plan*

LWC has commenced an engineering design to work on the expanding Adiyin Water Works phase II to add another 70 million gallons, bringing it to a total of 140 million gallons of water per day.¹ The government has also completed the construction of the Otta-Ikosi Water Works, a 4 MGD plant, which will be commissioned later in the year. When fully in operation, these plans in the short term are expected to increase the total installed water production capacity for the state to 317 MGD and are expected to provide water sufficiently for 8 million residents of the state. However, this would not be enough to provide water to the ever-growing population. Therefore, the LWC plans to boost capacity by 260 MGD in the medium term and by 168 MGD in the long term. In addition to expanding and building water plants, the LWC plans to expand the distribution network.

Table 4: Demand Gap Estimates: Short, Medium, Long Term

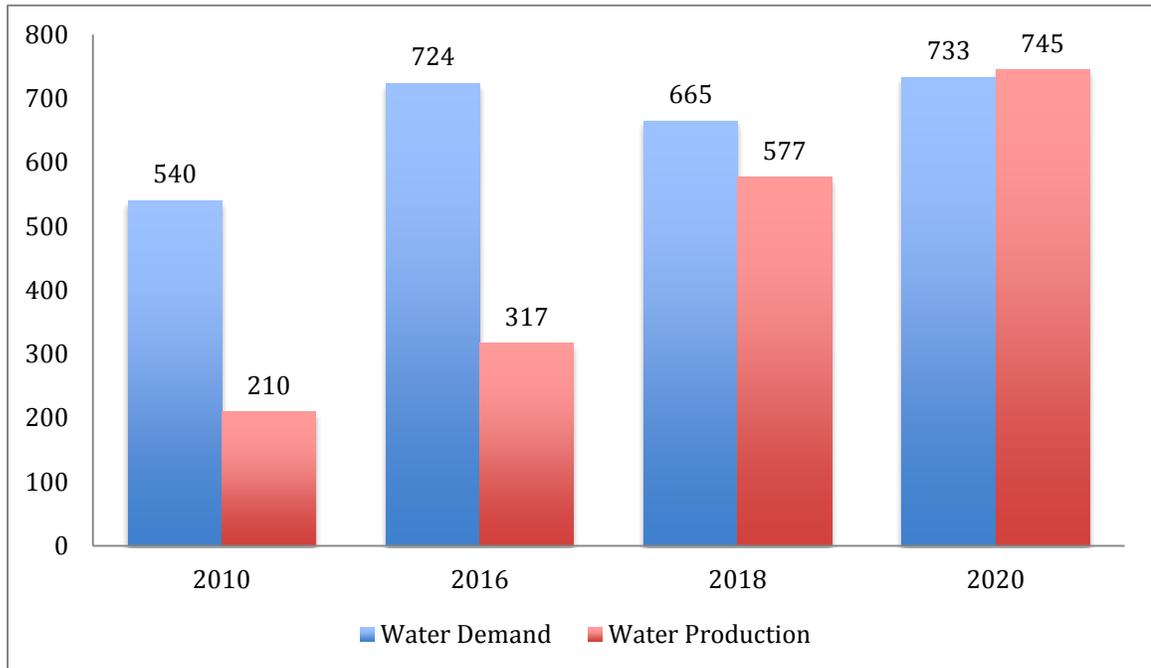
Year	Population	Water Demand (MGD)	Water Production (MGD)	Demand Gap (MGD)
2010	18,000,000	540	210	330
2016	24,121,722	724	317	407
2018	26,594,198	665	577	88
2020	29,320,103	733	745	(12)

Source: Lagos Water Supply Master Plan²

¹ LWC. *Lagos Water Supply Master Plan*

² LWC. *Lagos Water Supply Master Plan*

Figure 19: Projected Demand & Supply



Source: Lagos Water Supply Master Plan¹

The total cost of this plan is projected to be about \$2.5 billion, which the government hopes to fund through public-private partnerships (PPP).² Part of the LWC's PPP vision is to outsource the operation of existing drinking water treatment plants to the private sector.³ Lagos state will employ the International Finance Corporation (IFC) as a transaction adviser to ensure the operational sustainability and commercial viability of existing assets. The great emphasis on public-private partnerships in service delivery and infrastructure development allows for ambitious project to be planned but uncertainties remain around long-term financial plans to fund the

¹ LWC. *Lagos Water Supply Master Plan*

² LWC. *Lagos Water Supply Master Plan*

³ GWI (2010). Global Water Intelligence (GWI). "Nigerian Water Sector Embraces PSP."

improvement of wider, existing areas. Tentatively, the idea is to tender simultaneously three separate operation and management (O&M) contracts for the existing surface water treatment plants at Adiyari, Iju and Ishasi, and to bundle the operation of 48 smaller treatment plants spread across 11 service areas into a number of smaller contracts.¹ Through this, the state aims to achieve better operations. In addition to the operation and management contracts, LWC also intends to form a series of joint ventures with private sector partners to oversee downstream operations in each of the state's 11 service areas, such as metering, billing and customer service.² It remains unclear whether the downstream operations will be incorporated into the scope of the plant operation and management contracts, as the LWC has failed to incorporate those strategies into the master plan.

Assessment of Lagos Water Sector Efforts & Plans to Ensure Sustainable Drinking Water Supply

A. Non-Comprehensive, Incongruent & Insufficient Master Plan

- Lagos State lacks a comprehensive and integrated water management plan to ensure adequate sanitation or improved water supply or quality; there are several plans to improve water supply or advance wastewater management, however, these plans are not consolidated or integrated;

¹ GWI (2013). Global Water Intelligence (GWI). "Lagos Promotes Two-Tier Water PPP Initiative."

² GWI (2013). Global Water Intelligence (GWI). "Lagos Promotes Two-Tier Water PPP Initiative."

- The Lagos Water Supply Master Plan is one-dimensional, only addressing water supply management such as expanding infrastructure but fails to include strategies such as water demand management. It ignores viable options for boosting water supply through wastewater recycling but includes plans to build a costly desalination plant. This plan also excludes efforts that could address other water quality problems it faces, such as escalating water pollution and bad water insecurity and injustice;
- Though there are targets and plans to expand infrastructure, there are no goals and objectives for water quality and supply, in the LWC master plan or other state government efforts, that reflect federal and state requirements as well as the community desires;
- There are no goals or plans to maintain or improve surface or groundwater quality or to protect present and future sources of drinking water;
- The LWC master plan fails to integrate wider infrastructure plans, such as road construction or flood protection, which could impact the ability to improve water supply;
- There is a lack of analysis to determine the community's future water quality and supply needs and identify threats, including projections of population growth, impacts of excessive groundwater withdrawals and impacts of climate change;

- The plan does not include sufficient data or information such as an inventory or mapping of the location, quantity and quality of waterways, water bodies, and groundwater in the community or the location and severity of existing or potential point and nonpoint sources of pollution and communities who lack access to adequate sanitation;
- The state government lacks action strategies that present techniques and programs for achieving water quality and also lacks a timeline to make the implementation of these strategies feasible.
- There are no source water protection programs or plans by the government to clean up impaired water bodies or control nonpoint or point sources of pollution from either farms or industries. These water bodies are critical sources of drinking water and, if not regulated, can hinder the provision and access to improved water sources in the state. Lagos needs to make plans to secure the city's water supply by protecting its fresh water resources for parts of the plan to be feasible.
- Although the state government recognizes the importance of legislation as an instrument for ensuring an effective and integrated water supply system, major legislation that could ensure the ability of enforcement and implementation of the water agencies plans and policies are absent within the state. For example, there are regulatory standards set by LASEPA and NAFDAC to ensure the provision of clean and safe

drinking water, but these are not enforced on majority of private water service providers, who provide 70% of water for consumption. As such, many are not in compliance with these standards.

- The LWC master plan and other government efforts to increase water supply and improve access to clean drinking water fail to include frequent monitoring and assessment of its goals. Developing indicators and targets and carrying out performance measurement will assist in the assessment and tracking of the state efforts.
- The plan's success is dependent on private sector participation; however, it doesn't include a well-detailed plan to guarantee that the occurrence of private sector participation or a strategies to provide an enabling environment that would ensure private-public partnerships.

B. Institutional & Regulatory Challenges

1. The Lagos State government has set up various structures including regulatory bodies, policies and several mechanisms to tackle the chronic water issues it faces. These governmental structures are meant to aid in achieving sustainable water quality. However they are not efficiently and sufficiently monitored, managed or enforced.
2. Some of the regulatory and enforcement agencies in wastewater management laws no longer exist.
 - a. Example: The Environmental Sanitation Law is to be enforced by the Ministry of the Environment and Physical Planning (now

Environment, & Physical Planning & Urban Development, respectively).

3. There are duplications in the functions of Lagos water agencies.
 - a. Example: The MOE is empowered by the Environmental Pollution Control Law to monitor & survey water, including groundwater to determine pollution levels or collect baseline data while the monitoring bodies under the Lagos State Water Sector Law such as LASEPA are also empowered to determine pollution levels, & collect baseline data.

4. Legal Pluralism

Legal pluralism is a key challenge to governance in Lagos. It occurs because there are multiple systems of rules that apply to the same situation. Example

- a. The Lagos State Environmental Protection Law prohibits the use of pesticide, insecticide, explosives, or any other chemicals to kill aquatic animals, or for any other purposes in rivers, lakes, & streams, while the Lagos State Water Sector Law permits the discharge of inflammable solvent, tar or other liquids miscible with water and hazardous or toxic substances to a set limit.
- b. The newer laws have not repealed some of the old laws, even where they relate to similar issues.

5. Some of the existing laws prescribe meager fines. Example: the Environmental Sanitation Enforcement Agency Law prescribes fines from ₦1000.

C. Weak Strategies That Fail To Target Critical Problems, Deficient Monitoring and Evaluation

The state government has focused its efforts on ensuring improved water supply through infrastructure investment rather than ensuring reliable service delivery and improved access, controlling pollution, protecting water sources or providing wastewater treatment and sanitation services. The efforts undertaken in the plan are one-dimensional and fail to address the critical factors such as corruption, lack of education and awareness, poor land use planning and development, climate change and poor implementation and enforcement, which combine to compound the water quality crisis the state is facing. There are still abundant cases of water pollution, poor drinking water facilities and inadequate sanitation and this further hampers Lagos' water supply development. The system appears to be fractured, as there is limited cooperation between different water agencies regarding water and sanitation. The inadequate tariff structures for water supply in Lagos result in limited funding for expansion of coverage. In addition, there is a lack of political support and a lack of effective policies and institutional capacities to create an enabling environment.

D. Disabling Environment

Another finding of my research is that non-state providers of water, that is, the informal private water participants, are tolerated, but they do not get legal recognition by the government, and consequently they do not receive material or technical assistance from the state. They are seen as illegal providers of water or at best, informal providers of water.¹ Consequently, these informal private water participants have no working relationship with the state; as a result, government cannot facilitate the efforts of the informal private water participants to enhance the quality of water they provide. Furthermore, the government is not able to regulate the market for water provision in terms of demand and supply factors. The LWC desires public private partnerships, but has not created an enabling environment to facilitate participation.

E. Absence of Community Participation

The water quality and supply issues that Lagos state faces are created by both the government and the citizens. However, government efforts to provide reliable water quality and improve access to clean drinking water exclude the input of the very people who require these services. The users do not have control over the quality, price, or quantity of water they get. There are no plans that account for community perceptions of water quality and supply or that provide community education and improve capacity

¹ Interview with Dr. Balogun

development. The government efforts neglect the importance of effecting sustainable water conservation, hygiene and sanitation behavior changes, as there is lack of strong communication and social mobilization. Although clean drinking water and adequate sanitation facilities and services can be provided for, citizens can still waste and pollute water sources through unsafe and unhygienic practices, such as open defecation.

The Viability of Water Privatization in Lagos

The Lagos water sector continues to face difficult challenges. Despite several decades of efforts to improve access to clean drinking water, the demand gap is about 300MGD, some of which the informal private sector participants cover. Some of these challenges include low levels of productivity and efficiency, poor infrastructure, limited funding, and lack of skilled manpower. Because there is very poor water governance with little hope of improvement, to achieve accelerated economic growth and sustainable development, and reduce inefficiency as desired, privatization of the water sector is necessary. Several studies on privatization in Africa reveal that it brings about numerous benefits, and empowers the private sector.¹ The benefits that accrue to the nation include efficiency gains, stable and reduced prices, reduced government subsidies that can be redirected to other

¹ Pamacheche, Fudzai, and Baboucarr Koma. "Privatization in Sub-Saharan Africa - an Essential Route to Poverty Alleviation." *African Integration Review* 1.2 (2007): 151-71. Print.

development initiatives, at times, payment of dividends to government and increase in employment.¹

Privatization already exists in Lagos; most notable is the privatization of another utility, the energy sector. The Nigerian government has handed over the physical assets of Power Holding Company of Nigeria (PHCN) to private companies. Vice President, Nnamandi Sambo believes the privatization of the country's power sector would lead to greater efficiency. "It needs to be restated that the electricity power reform program became imperative in order to improve efficiency, reduce losses and cost. No doubt, this reform will lead to increased access to electricity, engender private sector investment, improve infrastructure, and create employment for the growing population," he said². The deteriorating condition of public utilities has resulted in the public water sector not being able to meet the water needs of a majority of the population, especially residents of low income areas and slums. Other states in Nigeria, such as Nassarawa, have formally engaged private water companies to be responsible for water provision and have seen an improvement in service delivery through contracts with local private water companies.³ Privatization is in the interest of the Lagos water sector, to improve efficiencies and expand access to clean drinking water in the

¹ Pamacheche, Fudzai, and Baboucarr Koma. "Privatization in Sub-Saharan Africa - an Essential Route to Poverty Alleviation."

² AllAfrica. "Nigeria: Privatization Will Lead to Power Sector Efficiency." *AllAfrica*. 1 Nov. 2013. Web. 9 Apr. 2014.

³ Obayagbona, Harrison. *Governance Without Government: Water Provision in Lagos, Nigeria*. Diss. Graduate School of Development Studies, 2008. Netherlands: Institute of Social Studies, 2008. *Institute of Social Studies*. Web. 9 Apr. 2014.

state. However, in order to have this desired impact, it is of paramount importance that privatization programs are properly designed and well integrated with state water sector development plans.

In 1999, the World Bank's private sector arm, the International Finance Corporation (IFC), developed a proposal that "required the Lagos state government to seek private sector operators for the operation of its water utility".¹ Privatization was expected to reduce the cost of water, enable investment, and improve public health and economic growth. Thames Water, Severn Trent, Veolia and Suez prequalified as bidders. But later that year the multinationals decided on a global withdrawal from developing countries, and so the entire World Bank/IFC plan for Lagos became pointless.² This failed because there was an absence of a proper structure and design to facilitate an effective privatization of water. The LWC states that private public partnership is a main thrust of the Lagos water sector policies and goals and hopes to improve access through improved public private partnerships, however, a structured plan for water privatization or designed programs to facilitate privatization have not been developed. Merely wishing for public private partnerships doesn't make them come into existence.

Types of Water Privatization

There are varying types of privatization, with differing levels of corporate

¹ Hall, David. *Nigeria: Water Impact on Lagos Water of the World Bank Privatization Plans, Union Response*. Public Services International Research Unit, 2010. Web. 09 Apr. 2014.

² Hall, David. *Nigeria: Water Impact on Lagos Water of the World Bank Privatization Plans, Union Response*.

control. There are three types of contracts used for the privatization of a service sector: concession, lease, and management.¹

- *Lease*: A lease contract requires that the private operator run the day-to-day operations and make needed investments in existing infrastructure.² The private firm takes the responsibility of operating and maintaining the assets of a hitherto publicly owned firm. The government covers all new investment costs. The government retains ownership and is responsible for financing capital investments, usually through a special agency established for the purpose. Because the new operator has a strong incentive to reduce cost and improve efficiency, the government will benefit from the efficiency gains that occur.
- *Concession*: Under a concession contract, the private company takes over responsibility for operating and managing the assets of a public enterprise, as in the case of a lease arrangement. However, unlike in the case of a lease, the private firm takes on the further responsibility of financing the long-term capital investment of the firm. It also provides incentives for the private operator to minimize cost and increase efficiency. The government benefits directly from the improved level of efficiency as well as the reduced burden to undertake long-term capital investments, given that such responsibility is shifted to the private sector operator.

¹ Burke, Kelsey. *The Viability of Water Privatization in Sub-Saharan Africa*. Diss. Connecticut College, 2013. Economics Honors Papers. Paper 13, 2013. Print.

² Pamacheche et al. "Privatization in Sub-Saharan Africa - an Essential Route to Poverty Alleviation.

- *Management:* In a management contract, the responsibility for the provision of services that were previously provided by a state-owned firm is passed on to a private provider. Ownership, however, remains with the state and all required capital investments continue to be provided by the state. Usually, a performance contract is signed with outsourced management. Government tends to benefit because management contracts typically bring market discipline and technical know-how to a state-owned firm and hence, all the efficiency gains that are common in market-oriented firms are likely to be realized.

Given the nature and structure of the Lagos water sector, I would recommend that a management contract be utilized. Despite limited funding in the past, the LWC has been able to build, expand, and upgrade infrastructure to improve access to water and has future plans to build and expand existing infrastructure. However, the LWC is currently unable to handle all the responsibilities of a water utility and as such operations, maintenance, and management have fallen behind. There is a lack of skilled employees; the billing, metering and collection rate is low during because of a mismanagement of records; there is inadequate maintenance of infrastructure; and there is inefficient monitoring giving room for poor performance and corruption. This reduces efficiency and all efforts by the LWC to ensure improve service delivery are impeded. By utilizing a management contract, there would be higher resource efficiency and greater

productivity as the LWC would be able to focus its resources on infrastructure investment, while the private sector will improve service delivery by ensuring effective operations and management. Lastly, the state government would be in charge of the regulatory framework to provide an enabling environment for private sector participation and to monitor and regulate the activities of the private sector so as to prevent cases exploitation and mismanagement such as poor service delivery or high prices.

Possible Benefits of Privatizing the Lagos Water Sector

- Improved performance & efficiency
- Higher resource efficiency
- Improved operation and management
- Fostering water conservation
- Improved coverage and access to water
- Competition leading to improved service delivery
- Attraction and greater inflows of foreign investment
- Technology and skills transfer
- Improved infrastructure
- Less corruption due to attached fiscal responsibility for return on investment

Possible Concerns and Issues in Privatizing the Lagos Water Sector

Efficiency or Profit

An issue to consider when advancing towards privatization of water is whether private sector participation would provide more efficiency or only result in the introduction of profit hungry companies. From the case studies of water privatization in Sub-Saharan Africa, we see evidence for both sides of the argument. In Guinea, the sector was more efficient and better run after privatization. While better managed, water became so highly priced that people could not afford their water. This is a dire position that needs to be averted in the case of privatization of water in Lagos, by keeping the regulatory power in the hands of the government. As such, private companies will only be able to charge prices approved by the government. Senegal shows that water privatization can result in an efficiently run sector without an over-emphasis on profits; prices were not increased drastically but the sector was better run. It is clear from the Senegal case that it is possible to have privatization be more efficient without costs rising excessively in order to satisfy the private operator's profit needs. This success is highly dependent on the relationship and contract between the private operator and the government. This point on the necessity of a good working relationship goes back to the discussion on thoroughly planning the project prior to implementation to ensure all parties are on the same page.

Economic Good or Human Right

The fact that water has a cost associated with delivery automatically requires that it be looked at as an economic good.¹ Yet, the fact that water is vital for human life means that it must also be seen as a need. Water should be a human right because it is needed to sustain life. And, both national and international law uphold human rights.² If water is to be seen as a human right, it must be at the most basic level because most countries do not have the capacity or capital to provide every citizen with this resource, as is the case with Lagos. Would it be better for these citizens to be denied access to water due to the inability of the public water utilities to provide or for private companies to cover the gap and to provide them access to water? As long as the Lagos water sector works towards achieving improved coverage, water privatization should not be seen as infringing on citizens' human rights.

Water Pricing

Water pricing is one of the more controversial aspects of privatization because of how great an impact it has on the users of water, most importantly the residents. Residents in Lagos already pay exorbitant prices for water. As demonstrated by the results of my questionnaire, a majority of residents who get access to water from the informal private sector pay up to 4 times as much as the residents who are connected to pipe borne water. In addition, the LWC believes that the willingness to pay is high as long as service delivery is

¹ Burke, Kelsey. *The Viability of Water Privatization in Sub-Saharan Africa*

² Burke, Kelsey. *The Viability of Water Privatization in Sub-Saharan Africa*

guaranteed and as a result, there are plans to increase water tariff rates.¹ As mentioned previously, the best option is to ensure that a water sector is operating at a level of full cost recovery but accompanied by social programs that ensure that the poorest can still afford water. A level of full cost recovery ensures that the sector is financially stable. As long as a social dimension is also included in the final price of water, full cost recovery should not be a major issue.

Impact on Employment

Another issue regarding water privatization was seen in the impact of privatization on employees in the case studies. Those opposed to privatization argue that the process results in increased unemployment while proponents argue that overtime the unemployed find new jobs due to increased expansion of the sector.² The case studies show that most likely there will be an increase in unemployment. The severity of the increase depends on the conditions of the sector prior to reform. Senegal had a limited increase in unemployment because the water sector was already operating at an efficient level. This is not the case with the Lagos public water sector, which is operating an inefficient level and the city's water system operators will see most likely see an increase in unemployment. However, these cuts most often lead to increased efficiency.³ Guinea cut 149 workers and both connections per worker and output per worker improved. However, there is opposing

¹ Interview with Dr. Balogun

² Burke, Kelsey. *The Viability of Water Privatization in Sub-Saharan Africa*

³ Burke, Kelsey. *The Viability of Water Privatization in Sub-Saharan Africa*

evidence that suggests that privatization is in the interest of employees because employment levels tend to increase after privatization; remuneration packages improved after privatization, and; many employees bought shares at discounted prices in the privatized firms and benefited when share prices eventually rose.¹ While a potential increase in unemployment hurts those involved, employees receive generous severance packages and the sector is more financially stable and more efficient in terms of operation.

Implementing a program to help train terminated employees for other careers could help lessen the social burden of such needed cuts.

Case Studies: Privatization of Water in Sub-Saharan Africa

To support my recommendation for privatization of the Lagos water sector, I reviewed research done by Kelsey Burke. She explores the viability of water privatization in Sub-Saharan Africa by presenting and analyzing three distinct case studies; Guinea, Ghana and Senegal.² I reviewed models and structure of water privatization utilized in these three countries and drew lessons from the successes, gaps and challenges to recommend ways privatization of the Lagos water sector can be successful and lead to improved access to water and high efficiency.

Critical Factors for Successful Water Privatization in Lagos

The conditions mentioned below do not guarantee the transformation of the failing Lagos water sector to a level of proficiency through water

¹ Pamacheche et al. "Privatization in Sub-Saharan Africa - an Essential Route to Poverty Alleviation."

² Burke, Kelsey. *The Viability of Water Privatization in Sub-Saharan Africa*

privatization. Instead, it lays out a few recommendations that were cultivated from the three case studies on water privatization in Guinea, Senegal and Ghana. It is believed that meeting the conditions below would help improve the chances of success for water privatization in Lagos. The Lagos water sector has a unique set of circumstances and a water privatization model should be designed based on the Lagos water sector's needs and strengths. In addition to these conditions, the case studies gave a clearer understanding of some of the issues regarding water privatization.

Planning

One of the key findings of the case studies was the need to plan out the process prior to the implementation of privatization. Senegal represents the model for this strategy. Senegal created a committee that evaluated the needs of the water sector. The agreed upon layout clearly defined each party's responsibilities which led to smoother operations later. Additionally, by taking the time to create the financial model, the government and the private operator could test different scenarios and understand how the sector would operate. In hindsight, this model was accurate and helped eliminate conflict. This sort of planning is imperative for water privatization to be successful in Lagos.

While Senegal models the need for proper planning prior to implementation, there are still valuable lessons to be learned from the less successful privatizations in Guinea and Ghana. In Guinea, there was time

spent looking at different model options. But the greatest issue was an unclear distribution of responsibilities. Without clearly defined roles, the asset holder and the private operator had numerous disagreements over their roles. These disagreements hindered the ability of each to do their job and slowed progress. Had the two parties taken the time to clearly define the role of each entity, and ensured no overlapping responsibilities, the project would have been more successful and achieved better results. In Ghana, the project went through an extended planning phase but there weren't agreed upon goals. Numerous delays in the negotiations, and the continued cancellation and restart of the project, resulted in a poor start. Ghana illustrates that in order for water privatization to be successful, the planning stages must also be successful.

It is important that the state government, LWC and private operator all take the needed time to plan the process prior to implementation. Too rash of a decision to implement private sector water management hurt the chance of success. By taking the time to plan the timeline, responsibilities, and financing, water privatization in Lagos is more likely to be successful and sustainable.

Contract Type

The countries represented in the three case studies utilized three different contracts: lease, concession, and management. One contract was not found to be better than another, but rather, a country's needs determined the choice.

It is important to note that the current state of privatization will impact the contract options for future projects. Ghana illustrated that due to past privatization failures, private companies are hesitant to contribute investment funds due to the financial risk associated with privatization. This current situation means that concession and lease contracts may be less favorable to management contracts. As stated above, a management contract will be more suitable for the Lagos water sector.

Regulation

Many privatizations fail to achieve their objectives, not because they were improperly executed, but because the institutional and regulatory framework is lacking. Without the introduction of a regulatory framework to enhance competition, consumers could be in a worse off situation than prior to the privatization. A good regulatory framework must be in place in order to resolve disputes that may arise. This was an issue in Guinea where there was no independent regulatory body put in place. In Senegal, the most successful case, there was no regulator body but a regulatory system was already built into the contract. While this worked well in Senegal, contracts may not provide enough regulation for every project, and having an independent regulatory system in Lagos would ensure at the very least a backup for dispute resolution. While a contract may help to create defined roles and help solve any potential issues, it is best that there be a body independent of the government and the private participants that can hear disputes. Finally, it is

important that the regulatory body be completely autonomous in its role. The regulatory body must have power over all participants for monitoring and control. In Ghana, there was an attempt to create a regulatory body, the Public Utility Regulatory Commission (PURC).¹ Unfortunately, the World Bank and IMF had influence on their operations and thus it was not a strong regulatory body. If privatization is to reemerge as a focal point of water development policy, it should be stressed that all projects have some form of independent regulatory agency in place. Regulation is vital and will greatly impact the success of water privatization in Lagos.

Full Cost Recovery

One of the major controversies with privatization is whether pricing water to achieve full cost recovery is necessary for a successful sector. The three case studies clearly indicate that full cost recovery is important, but that it can be achieved in different ways. All three sectors were financially unstable prior to privatization. They were selling water at too low a price to cover daily costs and expansion needs, pay off accumulated debt, and fund future investments. Such is the case with the Lagos water sector. The trouble arose when it became clear that operating at full cost recovery would result in the poorest citizens not being able to afford their water. However, Lagos is different because already the poorest pay exorbitant prices for water from the informal private sector, such as commercial boreholes and mairuwas, and these

¹ Burke, Kelsey. *The Viability of Water Privatization in Sub-Saharan Africa*

sources are not guaranteed to be safe. The main issue here is to make sure that water tariff due to water privatization can ensure full cost recovery whilst not being unreasonable, i.e., not exceeding what is being paid currently. While operating at full cost recovery is vital, there must also be an accompanying social dimension to projects that ensures the poorest citizens can still afford this vital resource.

Social Dimension

The water privatization model adopted in Lagos should take into account the needs of the poor, and create a social dimension to how the sector is run. Senegal implemented a scaled tariff where different levels of consumption were charged different amounts. This created a cross-subsidy where those consuming more were charged more per liter and helped to pay for the lesser charge applied to those using a minimal amount of water. Additionally, while somewhat controversial due to the requirements needed to qualify, the social connection program has allowed for an increase in the number of poor people connected to the water system. This is significant because the cost to connect to the sector can often be too high negating the issue of the subsequent cost of water. The privatization in Ghana also implemented a social program through the private sector's creation of the separate "Water For Life".¹ This venture helped fund the connection cost for the poor but did not help with the cost of water. Full cost recovery is vital because it ensures that the cost of

¹ Burke, Kelsey. *The Viability of Water Privatization in Sub-Saharan Africa*

delivering the services, as well as any future improvement cost, is covered. But a social program in Lagos would be important to ensure that full cost recovery can be successful while ensuring that the poorest citizens of the community can still meet their basic needs.

Public Support

An important consideration for privatization of water in Lagos is whether to include the public into the decision making process that comes with undergoing a shift to a private water system. While none of the three cases sought public inclusion, it is important that the water privatization process in Lagos includes inputs from the public so their needs can be addressed. The state government, LWC, and potential private operators, would be smart to include citizens in the decision making process as a way to gain their support. Understanding, and acknowledging the public sector's needs and concerns would help gain support for the project.

The New Water Supply Plan

Water supply plans should ensure the continued ability of community water systems to provide potable water to meet current and projected future needs.¹

As illustrated previously, the Lagos water supply plan is one-dimensional and lacks significant components that are necessary to achieve a sustainable water supply system in Lagos. As such, I intend to build upon the Lagos Water Supply Master Plan to create a more comprehensive and sustainable plan based on its gaps and the needs of the Lagos water sector. This new water supply plan will include additional initiatives, strategies and programs to ensure the protection of water resources and related natural systems and the sustainable provision of adequate water supply in Lagos through 2020.

Inventory & Analysis

Due to the limitation of this study to obtain significant data and perform needed analysis, I will be utilizing inventory data and subsequent analysis performed by the LWC to formulate strategies and programs to create a more comprehensive and sustainable plan, which facilitates a more pragmatic realization of sustainable water supply in Lagos. However, it is important to state that the Lagos State Water Corporation and other relevant water agencies, lack substantial data as they have limited capacities due to limited funding, manpower, and required technical skills to gather data and perform analyses.

¹ Daniels, Thomas L., and Katherine Daniels. *The Environmental Planning Handbook for Sustainable Communities and Regions*. Chicago, IL: Planners, American Planning Association, 2003. Print

Goals

To formulate an environmentally holistic, community-based, and economically viable water supply plan that will:

1. **Governance:** Reform current water governance structure to improve efficiency and facilitate successful enforcement and implementation;
2. **Infrastructure & Planning:** Improve the Lagos water infrastructure to ensure reliability, efficiency, and high quality of the Lagos water supply system;
3. **Quality:** Ensure the quality of Lagos drinking water;
4. **Management:** Achieve profitability and realize higher efficiency through improved operations and management;
5. **Sustainability:**
 - Achieve 100% coverage and eliminate the water demand gap in Lagos by 2020; and
 - Provide sustainable groundwater and surface water use, development, and protection to serve present and future citizens of Lagos.

Objectives

Governance

- Restructure the current governance structure through consolidation of water agencies to eliminate redundancy and improve efficiency;

- Improve communication and cooperation among Lagos water agencies to facilitate effective and sustainable water management;
- Facilitating public participation by educating and engaging users and general public in matters related to water management;
- Establish the necessary structures for a successful implementation of the Plan and;
- Establish processes to promote water justice.

Infrastructure & Planning

- Defining priorities for investments in infrastructure;
- Improving the efficiency of water supply infrastructure;
- Identify ways to reduce 60% unaccounted-for-water losses;
- Integrate planning to ensure sustainable water development and
- Identify mechanisms and help ensure that the water systems have the long-term capacity to meet standards and requirements.

Quality

- Define and include measures for water source protection including a source protection plan for improving and protecting the quality of the water bodies used in Lagos;
- Define measures to reduce the risk of groundwater pollution including saltwater intrusion; and
- Establish measures to eliminate sources of diffuse pollution and illegal dumping.

Management

- Institute effective and responsible management;
- Ensure successful adoption of privatization of water operations and management in Lagos; and
- Enhance the cost recovery associated with the use made by each consumer.

Sustainability

- Recommend ways to deliver water from existing and future water systems to Lagos residents in the most reliable, cost-effective, and environmentally responsible means;
- Define, encourage and implement water conservation measures, including wastewater recycling;
- Regulate and control excessive groundwater abstraction;
- Define measures for the adaptation or the control of damage caused by climate change; and
- Adopt appropriate measures to reduce flood risk by heavy floods.

Strategies

Governance

***Goal:** Reform current water governance structure to improve efficiency and facilitate successful enforcement and implementation.*

1. Water Governance Restructuring

The current structure of the water system in Lagos state is fragmented, non-collaborative and restrictive (See Figure 19 for proposed governance structure). Many policies and plans have been developed but the state still faces significant challenges in implementing them. Lagos lacks adequate and appropriate political, social, economic and administrative systems required to develop and manage resources and ensure delivery of water services at all levels of the society. This is very significant as the presence of water governance determines who gets water, when and how, and who has the right to water.¹ A successful governance structure must be able to deliver: clear vision and goals; secure resources; define clear roles and responsibilities; establish benchmarks for performance and monitoring; accountability to key stakeholders; transparency and access to information; and integrated management of surface and groundwater quality and quantity.

Action 1: Water Governance Assessment: A water governance assessment must be performed on stakeholders and institutions; on Lagos' governance principles such as transparency, accountability, collaboration, and

¹ UNDP. *Water Governance Facility*. Rep. United Nations Development Programme (UNDP), 15 July 2013. Web. 09 Apr. 2014.

participation; and on the performance and organization of water management functions of the Lagos water governance structure, to identify gaps and needs and help improve the Lagos water sector performance. The sustainable use of water, efficient use of water, equitable use and access to water, and equal democratic opportunities should be reviewed to assist the water governance assessment.

The eight steps in conducting a water governance assessment include:¹

- Clarify the objective;
- Conduct a stakeholder analysis;
- Decide on a stakeholder engagement strategy;
- Decide on assessment framework and scope;
- Select indicators;
- Collect data;
- Analyze results; and
- Communicate results

The developed water governance assessment framework should combine different approaches to better understand current water governance realities and measure the performance of current governance systems in relation to the desired future.² There should also be extensive assessment of the roles of the various water agencies, as well as the mode of operation of the private

¹ UNDP. *Water Governance Facility*.

² UNDP. *Water Governance Facility*.

service providers to ensure relevance, clarity of rules & functions, participation & mutual support within the provisions of regulations.

Action 2: Water Governance Scorecard: Developed by the Overseas Development Institute (ODI), the water governance scorecard provides insight into where gaps and challenges in a water governance system can occur and can be used to assess effective water management.¹ The scorecard stipulates that the following legislative and regulatory instruments, and institutions, service providers, and coordination mechanisms must be in place and function effectively.²

*Categories of the Water Governance Scorecard (Adapted)*³

Appropriate legislative frameworks, including:

1. Legislation for water allocation
2. Legislation for water quality
3. Existence of conflict-resolution mechanisms
4. Legislation for privatization

Appropriate regulatory instruments, including

5. Groundwater regulation
6. Land-use planning control
7. Water body protection

Functioning institutions, including:

8. Apex bodies

¹ UNDP. *Water Governance Facility*.

² UNDP. *Water Governance Facility*.

³ UNDP. *Water Governance Facility*.

9. Basin organizations
10. Community resource management organizations
11. Regulatory bodies
12. Enforcement agencies

Functioning water service providers that secure:

13. Awareness campaigns
14. Urban water supply
15. Water treatment
16. Irrigation, drainage and flood control

Functioning coordination mechanisms with:

17. Sectors: Hospitality, agricultural, marine, and energy
18. Local governments

It is necessary that the Lagos government utilize this scorecard to identify legal and regulatory structures and mechanisms that it lacks and requires. This will help eliminate redundant procedures and agencies and set up mechanisms and structures that will help ensure effective water management. This process will also help facilitate the consolidation of the numerous water agencies that bear similar functions into one, thus removing inefficiencies and opportunities for bottlenecks. This will enable a more uniformed process of water governance in Lagos.

Action 3: Mandated Monthly Meetings: Cooperation between state water agencies and local water systems should be encouraged to facilitate effective

water supply planning. Greater collaboration may mitigate any conflicts of functions or operations between the various water agencies in the exercise of their respective regulatory and policy development functions. To foster sustainable planning, regular monthly reviews and meetings among agencies should be mandated and would be a proactive and effective mechanism for promoting expeditious procurement activities, cost savings and resolving problems. By working together, water agencies, specifically LWC, LASEPA, LWRC and LSWMO, would be more able to plan more efficiently for interrelated water issues such as wastewater management, water pollution, and water supply, thus eliminating the self-sabotaging processes that exist in the Lagos water sector. Furthermore, by ensuring coordination amongst water sector agencies, institutional capacity building can be encouraged.

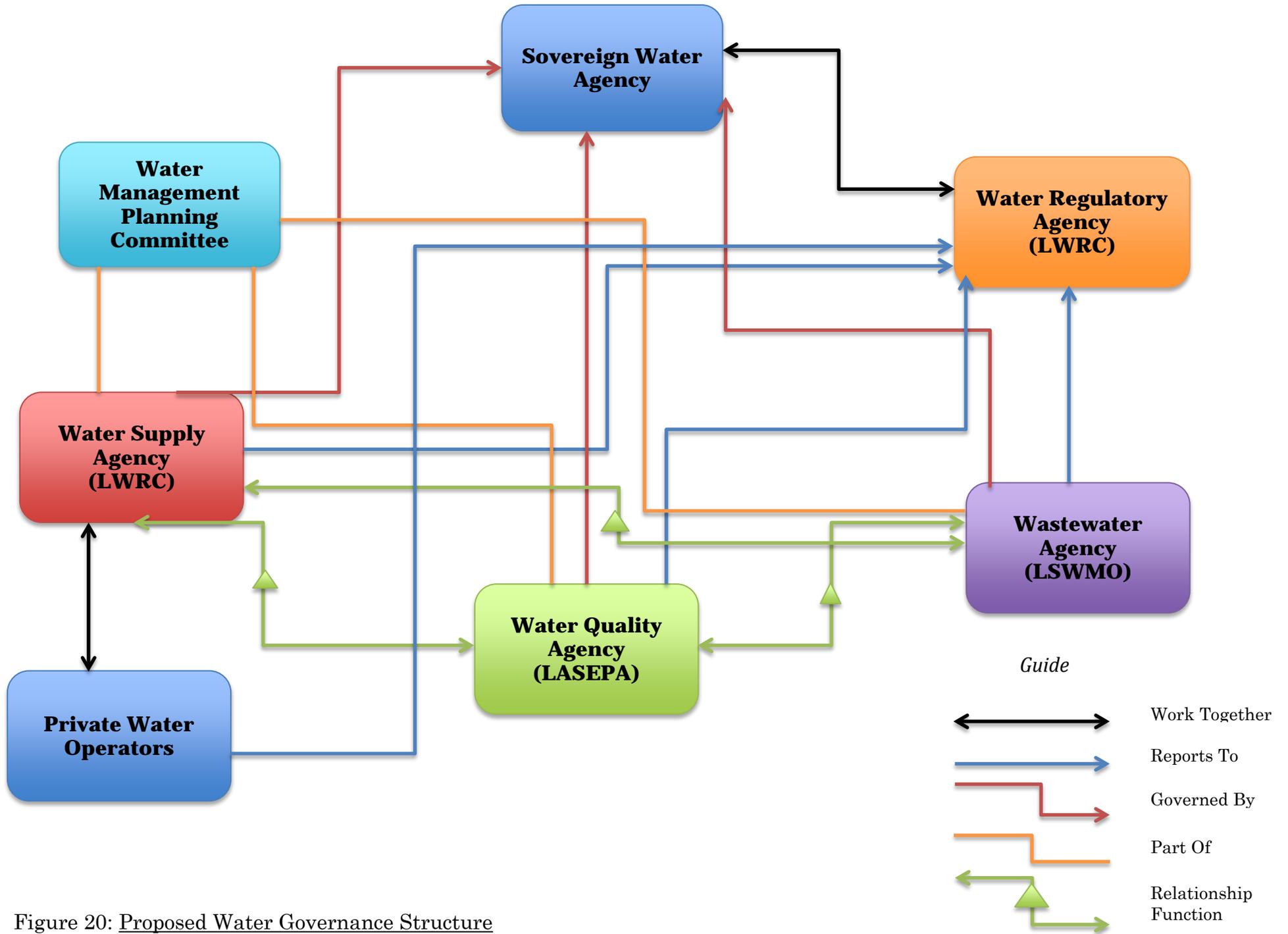


Figure 20: Proposed Water Governance Structure

Examples of Functions From Proposed Water Governance Structure

Sovereign Water Agency

Policy-making, their implementation and enforcement

- Developing a long-term framework for water resources and service;
- Setting strategies and priorities;
- Ensuring human resources management, including training;
- Budgeting and fiscal transfer; and
- Governing all Lagos water agencies.

Water Regulatory Agency

Regulating water resource and services

- Monitoring water agencies and private water service providers;
- Economic regulation by setting water tariffs;
- Monitoring and enforcing water regulations, permits and standards, ensuring compliance and implementation;
- Applying incentives and sanctions;
- Implementing water rights systems; and
- Settling disputes

Water Planning Committee

Planning and organizing and building capacity in water

- Facilitating coordinated decision-making within and among different water agencies and sectors;

- Developing planning and management tools to support decision making;
- Designing strategies for long-term planning of water resources and service development, including infrastructure investments;
- Collecting, managing, storing, sharing, and utilizing water-relevant data; and
- Facilitating stakeholder participation.

Water Quality Agency

Ensuring Water Quality & Protection

- Protecting ecosystems and water bodies;
- Ensuring cleanup of polluted water bodies; and
- Prevention of pollution through permits, standards, and sanctions.

Wastewater Agency

Managing & Treating Wastewater

- Treating wastewater for recycling;
- Ensuring coordinated and uniformed wastewater system; and
- Building a centralized wastewater system.

Water Supply Agency

Developing & Managing Water Resources

- Construction of public water infrastructure and authorizing private sector infrastructure for other sectors;
- Monitoring and evaluation of private water suppliers; and

- Tendering and procurement.

Private Water Operators

Water Supply Service Delivery

- Operating and maintaining infrastructure;
- Organizing water services delivery, such as water supply and irrigation;
- Forecasting and managing the effects of floods and droughts; and
- Organizing stakeholder participation.

2. Stronger Enforcements and Requirements for Effective Implementation

The existing Lagos State Water Supply Plans has some good strategies and goals, but they however appear to be unattainable and overambitious, as they lack suitable structures such as requirements, permits, and penalties to enhance enforcement and implementation. Lagos state government must:

Action 1: Provide Adequate Resources and Structures for the Effective

Implementation of Regulations and Programs: This includes regulation that provides the water agencies and water systems with the capacity to enforce compliance, issue permits and fines, perform site and municipal inspections, and enforcement and technical assistance.

Action 2: Take Progressing Steps in Implementation: To ensure

implementation, strategies need to be taken in steps, which would encourage future stages. For example, all boreholes must be registered, then mandated to install hydrometers, before they can be monitored and controlled.

3. Public Education and Participation

Community participation and stakeholder engagement is critical to ensure sustainable water supply in Lagos State. Community participation in the design, construction and operation and maintenance of sub-projects will lead to socio-economic benefits to the local people.¹

Action 1: Public Consultation: Project formulation should involve extensive consultation with local government staff, local NGOs, representatives of residents, both island and mainland, and other beneficiaries while addressing their concerns about the impacts of water supply and sanitation projects.

This can be done through focus group discussion, interviews, and surveys

Action 2: Public Awareness Campaign: Public awareness and attitudes towards water use, water pollution and wastewater are a big factor in ensuring good water quality. Therefore, there is need for proper education of the people to encourage them to see the need to embrace water conservation, proper waste disposal and water protection.

A public awareness campaign should be started to educate Lagos' residents on policies and initiatives related to water supply, wastewater and water pollution. Lagos residents need to become more aware of the rights and wrongs when it comes to water related issues such as siting boreholes or laying pipes. Adequate information should be provided to the public about existing aids and management opportunities to aid in water development.

¹ Oyegoke et al. "The Challenges of Water Supply for A Megacity: A Case Study of Lagos Metropolis."

The change in social perception will eradicate the major issues such as dumping, open defecation, and improper pollution of water sources and promote sustainable development in Lagos.

Infrastructure & Planning

***Goal:** Improve the Lagos water infrastructure to ensure reliability, efficiency, and high quality of the Lagos water supply system.*

4. Sustainable and Integrated Planning

Lagos state must to engage in sustainable and integrated planning to provide adequate, long-term supplies of high-quality water to its residents. Water supply planning can help Lagos manage its water demand and ensure a reliable long-term water supply.

Action 1: Incorporate Land-Use Planning: Poorly planned, rapid, and excessive development in Lagos has threatened its water supplies causing overdrafts of water, pollution runoff into water sources, and infiltration of sewage and contaminants into groundwater. Land-use planning should be incorporated when making efforts to improve access to sustainable water services.¹ The incorporation of land-use planning will help prevent system failures that threaten water sources such as laying water pipes in drains or siting boreholes beside septic tanks or in areas with loose soils. The majority of the populations in Lagos sink boreholes and wells to get access to water

¹ Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*

causing excessive groundwater withdrawal and contamination such as saltwater intrusion. These practices are unsustainable, thus reliance on public water systems should be encouraged through zoning and growth boundaries in Lagos.¹ By engaging in land-use planning, the Lagos government will be able to promote coordinated development and management of water resources and help direct and manage the impact of growth and development on Lagos water resources, to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment

- *Sub-Action 1: Land Use Regulations & Mechanisms:* The Lagos government needs to establish regulations that will ensure that development is sited to minimize threats to its water sources, so that it can safeguard these water sources for the future. This can be achieved through public land purchases, conservation easements and implementing a transfer of development rights program.² In addition, the Lagos state government should identify minimum design, building and siting requirements for best management practices to protect water sources from runoff and pollution.

Action 2: Develop A Comprehensive Water Management Plan: A

comprehensive plan for the state needs to be developed to ensure sustainable water supply and quality. Unlike the current master plan, the new water

¹ Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*

² Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*

plan must incorporate inventory information on the state's watersheds, groundwater, waterways, and water bodies; analysis that integrates projections for population growth and climate change and its potential impact, and provides evaluation of the state's water systems to meet projected future water demands; contain goals and objectives that seek to protect water sources by directing growth and development; include zoning and subdivision regulations to separate conflicting land uses and help protect water supplies, and involve a capital improvements program to expand infrastructure and coverage.¹ Lastly, planning should incorporate ways to deliver water from existing and potential water systems to residents in the most reliable, cost-effective and sustainable means and develop effective ways to provide water outside of local water system service areas, especially in mainland areas.²

Action 3: Unchanging & Consistent Planning Agencies: Furthermore, water supply planning and land use planning must be coordinated and performed by the same agencies to prevent errors, sprawl, and unsustainable use of open space, hence ensuring sustainable and uniformed planning.³

5. Smart Growth Infrastructure Development

Though all of the strategies in the Lagos state water supply master plan are to build infrastructure to improve water supply, this plan can be more effective if they link proposed development to existing infrastructure and

¹ Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*

² Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*

³ Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*

integrate wider infrastructure plans, such as road construction or flood protection into their plans (See Table 5). Infrastructure development plans should include more cost-effective ways of improve water supply.

Action 1: Build & Upgrade Infrastructure: Proposed plans such as desalination plants would require larger investments and are not well integrated due to the lack of adequate foundation and structure to support the projects. The plans for building desalination plants to boost water supply is unwise especially when there is an absence of infrastructure plans to add storage capacity or cut water losses and reduce the 60% unaccounted-for-water (See Figure 21).

Figure 21: Summary of Cost Implications

Short Term (2010–2016)		Medium Term (2017–2018)		Long Term (2019–2020)	
Adiyan II (70mgd) Waterworks - USD 300m Network - USD198.8m Total - USD498.8m		Odomola II (90mgd) Waterworks - USD264.3m Network - USD123.99m Total - USD338.29m		Yewa II (Desalination) (50mgd) Waterworks - USD201.6m Network - USD51.26m Total - USD252.86m	
Odomola I (25mgd) Waterworks - USD8.4m Network - USD153.02 Total - USD161.42		Adiyan III (70mgd) Waterworks - USD85.02m		Odomola III (95mgd) Waterworks - USD285m Network - USD65.46m Total - USD350.46m	
Isashi Expansion (8mgd) Waterworks - USD14.39m Network - USD49.1 Total - USD63.49m		Yewa I (Desalination) (50mgd) Waterworks - USD145.0m Network - USD180.09m Total - USD325.09m		Upgrading Isashi (23mgd) Waterworks - USD23.43m Network - USD85.6m Total - USD109.03m	
Ota Ikosi (4mgd) Network - USD13.95m		Ibeshe (Desalination) (50mgd) Waterworks - USD145.0m Network - USD92.54m Total - USD237.54m			
Total USD 737.66m		Total USD 1035.94m		Total USD 712.35m	
Grand Total= USD 2,485.95million	source : http://costwater.com/watertreatment.htm				

Source: Lagos Water Supply Master Plan, 2010¹

¹ LWC. Lagos Water Supply Master Plan

Table 5: Infrastructure Development Projects in Master Plan

Treatment Plants & Associated Network		
<i>Short-Term (2010-2016)</i>	<i>Medium-Term (2017-2018)</i>	<i>Long-Term (2019-2020)</i>
Adiyani II (70MGD) 95km Trunk & 2,369km Distribution network	Odomola II (90 MGD) 500km Distribution network	Yewa II (Desalination) (50MGD) 20km Trunk & 50km Distribution network
Odomola I (25MGD) 67km Trunk & 247km Distribution network	Adiyani III (70MGD)	Odomola III (95MGD) 20km Trunk & 80km Distribution network
Ishasi Expansion (8MGD) 30km Trunk & 120km Distribution network	Yewa I (Desalination) (50MGD) 60km Trunk & 200km Distribution network	Upgrading Ishasi (23MGD) 50km Trunk & 120km Distribution network
Ota Ikosi (4MGD) 45km Trunk & 40km Distribution network	Ibeshe (Desalination) (50MGD) 60km Trunk & 200km Distribution network	
<i>Total Capacity: 107MGD</i>	<i>Total Capacity: 260MGD</i>	<i>Total Capacity: 168MGD</i>
Total: 745MGD		

Source: Lagos Water Supply Master Plan, 2010¹

Action 2: Smart Growth Land Use & Water Supply Investments: Water resources investments should correspond to smart growth land use and water supply planning objectives to guide regional development.² Promoting the adaptation of land use will optimize water resource efficiency. An example of this is the improvement of riparian vegetation in Lagos to reduce pollution of water sources and the potential temperature rise in the water due to climate change.

¹ LWC. *Lagos Water Supply Master Plan*

² Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*

6. Reduction of Unaccounted-for-Water Losses

Unaccounted-for Water (UFW) is the difference between the quantity of water supplied to a city's network and the metered quantity of water used by the customers.¹ UFW has two components: (a) physical losses due to leakage from pipes, and (b) administrative losses due to illegal connections and under registration of water meters.² The reduction of UFW is a crucial step in improving water supply and saving water resources. Lagos is currently experiencing 60% UFW due to both components. It is thus my recommendation, that the Lagos government utilizes its financial resources more effectively by investing in strategies to reduce these water losses. By adopting a strategy to reduce UFW, the Lagos government will be able to recover production capacity lost to leaks and unauthorized use.

While water utilities should strive to reduce unaccounted-for-water to a minimum, some loss is unavoidable. Generally, 5% of less loss is considered excellent, while 10% is considered is considered marginal.³ If these water losses are reduced to a marginal level, the government will only have to build and expand infrastructure up to 489MGD* to meet a projected 733MGD demand. That is, 278 MGD in additional infrastructure development (See Table 6). Thus, the Lagos government averts wasted financial investment in unrequired desalination plants, resulting in savings of 815.49 million dollars.

¹ The World Bank (2002). "Resources for Water: Unaccounted-For-Water." The World Bank, 10 Jan. 2002. Web. 09 Apr. 2014.

² The World Bank (2002). "Resources for Water: Unaccounted-For-Water."

³ TRWA. Texas Rural Water Association. Texas, USA. *Reducing Unaccounted for Water*. By Larry Bell. Texas Commission on Environmental Quality, 15 Aug. 2006. Web. 9 Apr. 2014.

The percentage of physical losses is influenced by the deterioration of the piped network, the total amount of water used, system pressure, and the degree of supply continuity. While the percentage of administrative losses is influenced by the degree of effort exerted in identifying illegal connections and in installing and repairing meters.

Action 1: Water Audit of Water Records & System: The LWC must conduct a water audit to update records on all water users. This would enable them identify all water connection, both legal and illegal. In addition, the LWC should enforce and prosecute infractions to reduce unauthorized use.

Action 2: Leakage Detection and Control Program: This can be achieved by performing a leak detection survey and through the utilization of valves, sonic leak detection equipment, and leak correlators. A sonic leak detector amplifies the sound caused by water escaping from a pipeline while a leak correlator is a computer-based device that can collect sound vibrations through pipe or valves rather than through the ground by using microphones in two or more locations.¹ Sonic leak detection equipment is inexpensive and easy to operate while leak correlators are more expensive.² Other equipment include data loggers, and ultrasonic and helium leak detectors.³

¹ Armentrout, Gary. "Technologies Help Detect Unaccounted for Water Loss." *The Kansas Lifeline* (2008). Web. 9 Apr. 2014.

² TRWA. Texas Rural Water Association. Texas, USA. *Reducing Unaccounted for Water*.

³ Armentrout, Gary. "Technologies Help Detect Unaccounted for Water Loss." *The Kansas Lifeline* (2008). Web. 9 Apr. 2014.

Action 3: Replacement of Old Pipe Systems. The quality of construction and materials used in pipe systems has a large impact on UFW losses. From the Bahrain case study, by using better quality corrosion-resistant materials and medium density polyethylene (MDPE) pipes for service connections, the country was able to reduce the number of leaks in the distribution network.¹

Action 4: Installation of Water Meters: Installation of water meters will immediately increase revenue and promote water conservation. Proper meter selections and installations; proper meter testing and maintenance; and proper meter readings are required.

7. Coordinated Infrastructure Development in Growth & Peri-Urban Areas

Future infrastructure development should cover water service areas with projected growth. This development should be coordinated and consistent with the recommended growth areas of local comprehensive plans and capital improvements programs. To eliminate the skewed distribution of water services in Lagos state, and ensure that both poor and wealthy residents have access to equal water supply and quality service, the LWC needs to extend its development plans and projects and public water systems to reach future peri-urban communities in the mainland and island areas, improved equal distribution of services. These projects should be pro-poor to help in

¹ GWI (2003). Global Water Intelligence (GWI). "Reducing Unaccounted-for-Water." *Global Water Intelligence* 4, no. 4 (2003). Global Water Intelligence, 03 Apr. 2003. Web. 09 Apr. 2014.

poverty reduction, greater productivity violence elimination and improved healthcare.¹

From Table 7, the elimination of the Ibeshe and Yewa desalinization plants will remove coverage in the many peri-urban areas including Badagry, Amuwo-Odofin and Ikorodu Axis. Isashi and Adiyin expansion aim to serve areas around or in the Badagry, Amuwo-Odofin and Ikorodu Axis. It is therefore recommended that these areas be covered by these respectively plants by expanding trunk and distribution network lines.

¹ Obani, Pedi. Lecture. REGULATING WASTEWATER MANAGEMENT IN LAGOS STATE.

Table 6: Proposed Infrastructure Development in New Plan

Treatment Plants & Associated Network		
<i>Short-Term (2010-2016)</i>	<i>Medium-Term (2017-2018)</i>	<i>Long-Term (2019-2020)</i>
Adiyan II (70MGD) 95km Trunk & 2,369km Distribution network ⁺	Odomola II (90 MGD) 500km Distribution network	Odomola III (95MGD) 20km Trunk & 80km Distribution network
Odomola I (25MGD) 67km Trunk & 247km Distribution network	Adiyan III (70MGD) Trunk & Distribution Network ⁺	Upgrading Ishasi (23MGD) 50km Trunk & 120km Distribution network ⁺
Ishasi Expansion (8MGD) 30km Trunk & 120km Distribution network ⁺	Reduction of UFW Strategy	Reduction of UFW Strategy
Ota Ikosi (4MGD) 45km Trunk & 40km Distribution network		
Reduction of UFW Strategies		
<i>Total Capacity: 160.5MGD*</i>	<i>Total Capacity: 240MGD*</i>	<i>Total Capacity: 177MGD*</i>
Total: 787.5MGD		

⁺There would needed increase and expansion of the trunk and distribution network to cover the peri-urban areas in Badagry & Amuwo-Odofin.

*This new plan would reduce UFW losses to 10% while simultaneously build and expand infrastructure during each periods. Thus, each term total capacity is improved by 50%, resulting in a 787.5MGD total capacity in 2020.

Table 7: Details of Project Plans in Master Plan (2010 – 2020)

Project	Intake Point	Source	Expected Year of Completion	Design Capacity		Coverage Area / Axis	Additional Population to be Served
				(mld)	(mgd)		
Adiyan Phase II Plant & 95 km Trunk; 2,369 km Distribution Network	Akute	River Ogun	2016	317.8	70	Agege, Alimosho, Shomolu, Kosofe, Ojo, Ikorodu, Lagos Island, Victoria Island, Isolo	2,333,333
Odomola Phase I Plant & 67 km Trunk ; 247km Distribution Network	Igbonla/ Lekki Lagoon	River Osun	2016	113.5	25	Epe, Eti-Osa, Ibeju-Lekki, Victoria Island, Ikoyi, Lagos Island	833,333
Upgrading Isashi to 12mgd Plant & 30 km Trunk ; 120km Distribution Networks	Isashi	River Owo	2015	36.32	8	Amuwo Odofin, Festac, Ojo, Satelite Town, Ijanikin	266,666
Ota-Ikosi Plant & 45 km Trunk ; 40km Distribution Network	Igbede	River Aye	2013	18.16	4	Ota-Ikosi, Agbowa, Imota	133,333
TOTAL A				485.8	107		

Odomola Phase II Plant & 500 km Distribution Network	Igbonla/Lekki Lagoon	River Osun	2018	408.6	90	Epe, Eti-Osa, Ibeju-Lekki, Victoria Island, Ikoyi, Lagos Island	3,600,000
Adiyan Phase III	Akute	River Ogun	2017	317.8	70	Isheri-Oke, magodo, Mile 12, Ikorodu, Ikorodu-Agric.	2,800,000
Yewa I (Desalination) Plant & 60 km Trunk; 200 km Distribution Network	Ajilete	River Yewa /Lagoon	2018	227	50	Badagry, Ojo, Agbara, Oto- Awori, Ijanikin, Imeke Iworo, Sibiri, Kirikiri, Old Ojo, Ilado	2,000,000
Ibeshe (Desalination) Plant & 60 km Trunk; 200 km Distribution Network	Ibeshe	Majidun / Lagoon	2018	227	50	Bayeku, Ogijo, Odogunyan, Oriokuta, Ikorodu Port, Igbogbo, Ilemere, Osoru, Oke-Ota, Ijede, Isiwu	2,000,000
TOTAL B				1180.4	260		

Odomola Phase III Plant & 20 km Trunk; 80 km Distribution Network	Igbonla	River Osun	2019	431.3	95	Epe, Eti-Osa, Ibeju-Lekki, Victoria Island, Ikoyi, Lagos Island	3,800,000
Upgrading Isashi (12-35mgd) Plant & 50 km Trunk; 120 km Distribution Network	Isashi	River Owo	2019	104.42	23	Amuwo Odofin, Festac, Ojo, Satelite Town, Ijanikin	920,000
Yewa II (Desalination) Plant & 20 km Trunk; 50 km Distribution Network	Ajilete	River Yewa /Lagoon	2020	227	50	Badagry, Ojo, Agbara, Oto- Awori, Ijanikin, Imeke Iworo, Sibiri, Kirikiri, Old Ojo, Ilado	2,000,000
TOTAL C				762.72	168		

Source: Lagos Water Supply Master Plan, 2010

Quality

8. Development of Water Protection Plans and Initiatives

Majority of the water supplied in Lagos comes from freshwater sources are extremely vulnerable to pollution from agricultural runoff, illegal dumping, and human waste. Although most water requires some treatment before use, protecting this source water is an important part of providing safe drinking water to the public. Currently, the Lagos government has no plans to protect its water resources. Protecting drinking water sources would require the combined efforts of the major water agencies in Lagos including LWC, LASEPA and LSWMO; the water basin authorities in Ogun state; other states who utilize the Iju and Adiyin rivers; private water suppliers; and the public.

Action 1: Source Water Assessment & Plan: To secure the city's water supply and protect its freshwater resources, Lagos needs to develop and enforce a source protection plan for its rivers, lagoons, and creeks including its watersheds, wetlands, wellheads, and aquifers. To achieve this, the Lagos state government needs to perform source water assessments and take the following steps to achieve safe, clean drinking water:

- Delineate ground and surface water protection areas and water resources;
- Take an inventory and identify potential sources of contamination within these protection areas;

- Determine the susceptibility of the water supply system to these various sources of contamination;¹
- Notify and involve the public about threats identified in the contaminant source inventory;
- Implement management strategies;
- Develop and apply watershed and wellhead protection measures; and purchase lands near reservoirs, lakes, and lagoons to keep them undeveloped and protect public water systems;²
- Develop contingency planning strategies to deal with water supply contamination or service interruption emergencies; and
- Furthermore, water boreholes, wells, and septic systems should be monitored and regulated to encourage source-water protection.³

This source water protection plan should include risk prevention, risk management, and risk monitoring and compliance barriers.

Action 2: Effective Water Pollution Control & Cleanup Programs: The Lagos state government should also develop and implement plans and programs to cleanup and protect the quality of the state's water quality aimed at controlling and reducing water pollution and ensuring the quality of public drinking water systems.

¹ EPA. The Environmental Protection Agency. EPA Office of Ground Water and Drinking Water. *Consider the Source: A Pocket Guide to Protecting Your Drinking Water*. Web. 9 Apr. 2014.

² Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*

³ Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*

- *Sub-Action 1: Develop and Enforce Water Quality Standards:* The Lagos government needs to establish water quality standards for other water uses other than drinking water and require water quality monitoring, water treatment, and the public reporting of contaminants in water systems. The LWC should enforce all water standards by maintaining an inventory of water systems in the state; conducting sanitary surveys of water systems; collecting compliance reports; certifying lab testing of public water quality; requiring public water systems to report and assess fines for violation; and ensuring that water systems comply with state water regulations.¹ The Lagos government also needs to ensure enforcement and compliance drinking water quality standards especially with pure water and bottle water companies through NAFDAC.
- *Sub-Action 2: Cleanup Polluted Sources:* The Lagos state government should make efforts to clean up its impaired water bodies.
- *Sub-Action 3: Regulations*
 - o The Lagos state government needs regulate the draining and filling the wetlands, and frequently monitor and enforce compliance;
 - o There should be regulations intended to minimize the pollution of water by requiring the proper disposal of wastewater sewage

¹ Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*

- sludge, and establishing planning procedures and construction grants for new and upgraded sewage treatment plants;
 - These regulations should also prohibit the discharge of any pollutants into navigable waters from not only industrial sources but also other point and non-point sources especially in farmland areas to minimize agricultural runoff; and
 - There should be anti-corruption efforts and properly trained personnel.
- *Sub-Action 4: Stormwater Management:* To minimize stormwater runoff from development, the state needs to adopt and implement stormwater management measures and ordinances in order to reduce the diffuse pollution of water bodies such as requiring stormwater permits; utilizing technologies to control discharges; developing long-term overflow control plans; and incorporating green infrastructure projects.¹

Sustainability

The Lagos government needs to balance current and future needs of clean water of Lagos residents in the context of limits to development while simultaneously achieve four things: providing all humans with access to safe, clean supplies of water to meet their basic needs; sustaining healthy

¹ Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*

freshwater ecosystems; enabling and sustaining the remaining water to supply and serve various purposes; and supplying water in a way that does not compromise the abilities of future generations to achieve sustainable water supply.

9. Coastal and Flood Zone Management

Lagos is the largest coastal city in Africa and is made of low-lying areas adjacent to water bodies and most of its development is located in coastal areas making it vulnerable to natural disasters and climate change impacts. As such, it is imperative that the state government adopts regulations and schemes to manage development and minimize hazards and risks in coastal areas. Strategies and programs can include flooding insurance, preventing development in coastal areas, creating concrete flood channel redesign projects, water redevelopment, managing coastal recreation, using zoning overlay districts to protect floodplains and wetlands, and mitigation development.¹

10. Sustainable Water Supply Projects

There is need for a radical change in paradigm in water supply projects' design, implementation, monitoring and maintenance in Lagos state. Water supply projects should be designed to be cost effective and the tariffs introduced should be pro-poor, gender sensitive and exhibit price differentiation for the different socio-economic groups in the state where

¹ Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*

necessary. Also, water supply projects should embrace technical innovation and environmental protection including aquifer recharge using an infiltration basin since there is a great focus on groundwater abstraction within Lagos. This would allow for significant reduction in untreated wastewater allowed to flow back to the ecosystem and promote rational use of water resources and improved the quality of freshwater and coastal ecosystem.¹

11. Promotion of Water Conservation Initiatives

Water conservation plans and programs should be incorporated into the new plan to ensure reliable and long-term water supply. Several initiatives that could be utilized include:

- Metering all end uses to accurately measure and charge for water used;
- Controlling leaks and losses through the maintenance and repair of water pipes and pumping systems;
- Conducting public information and education programs to encourage water conservation;
- Setting an increasing block water rate to reduce waste and cover expenses;
- Encourage water efficient fixtures in current and future development;
- Installing control volumes systems and;
- Utilizing water audits and retrofits to improve efficiency.

¹ Oyegoke et al. "The Challenges of Water Supply for A Megacity: A Case Study of Lagos Metropolis."

12. Improving Groundwater Resource Management

There is excessive abstraction of groundwater in Lagos through public and private boreholes, therefore the state needs to manage groundwater withdrawals from boreholes to protect productive yields. This can be achieved by charging the LWRC to control groundwater abstraction by using a regulatory approach and economic tools. LWRC has to be equipped with the technical expertise, financial resources, and legal backing to supervise the licensing processes and to ensure their enforcement. Furthermore, a significant administrative is how to exert control over large numbers of small resource abstractions and polluting discharges. Thus, LWRC needs to create public awareness and stakeholder dialogue on the status of groundwater resources and the need for introducing management measures. This would create a social climate favorable for the promotion of sustainable policies of groundwater allocation and protection.

An equity issue arises, as majority of Lagosians get their access to water from groundwater abstraction, through boreholes; cutting off this source will be cutting off their access with no alternatives. Therefore, the goal should be to constrain groundwater abstraction with environmentally tolerable limits in the first stage. In the later stages, when the government can ensure efficient delivery of water, control and reduce groundwater abstraction. The LWRC should create initiatives and mechanisms that can

monitor and control water withdrawals that will be evaluated on cumulative impacts and ensure renewable yields.

Phase 1

- Groundwater information system development and data acquisition;
- Aquifer classification and aquifer management system development;
- Identify critical areas where abstraction can lead to land subsidence and intrusion;
- Identification of groundwater protection priorities;
- Establish an understanding of the relationship between polluting activities and quality of groundwater;
- Regulation and prohibition of land-based activities, which threaten or may affect the quantity and quality of water;
- Safeguard groundwater quality through appropriate zoning, restriction on contaminant loading and restriction on development density;
- Groundwater pollution control and community water source protection;
- Facility level groundwater monitoring;
- Resource level groundwater quality monitoring;
- Create awareness of the importance and vulnerability to pollution of the State's groundwater resources: and
- Encourage public participation.

Phase 2

- Establish groundwater legislation providing clear definition of water use rights through granting of license and levying of charges for groundwater exploitation and prohibiting illegal and unpermitted use of groundwater abstraction and discharge of liquid effluents or disposal of solid waste;
- Licensing and permit process for private boreholes;
- Placement of hydrometers to private boreholes for domestic, industry and irrigation;
- Establish groundwater resource charges including groundwater use fees and conservation fees: and
- Control and authorization of boreholes to prevent illegal pumping through sanctions and water well sealing.

13. Encourage Wastewater Reuse and Recycling

Wastewater recycling should be embedded into integrated water management in LWC due to benefits such as protection and conservation of freshwater resources, amongst others. The applications of water and wastewater reuse should include agricultural irrigation; urban, recreational and environmental uses including aquifer recharge; process water for industry; and direct and indirect portable water production.¹ Water reuse and recycling would help Lagos decrease net water demand hence closing the

¹ Oyegoke et al. "The Challenges of Water Supply for A Megacity: A Case Study of Lagos Metropolis."

gap; use potable water for drinking and reclaimed water for non-potable use; reduce manufacturing industries cost that use high-quality reclaimed water; reduce nutrient discharge to the environment and loss of freshwater; manage the recharge of surface and groundwater to optimize quality and quantity; control the problem of over-abstraction of surface and groundwater; and increase local ecological benefits through the creation of wetlands and urban irrigation.

Action 1: Integrated Wastewater Planning & Management: The LWC and the LSWMO need to work together to plan for effective wastewater management. Additionally, the LWRC must provide support by providing regulatory and enforcement capabilities to both agencies.

Lastly, these water agencies, private service providers, community organizations and other stakeholders at all levels of water supply & wastewater management should be trained on the skills and principles of integrated wastewater management.

Action 2: Adoption of Effective Wastewater Management: Effective wastewater management principles must address challenged in the following areas: water resources assessment; management of wastewater; utilization of regulatory & economic instruments; stakeholder participation & transparency; information management & knowledge exchange among the various stakeholders; and integrated water resource management.

Action 3: Improved Wastewater Treatment Plants: Existing wastewater treatment plants should be upgraded in order to improve the quality of the effluents and fully achieve the legislation limit for the disposal in water. In addition, there should be construction and operation of wastewater treatment plants in areas that lacks access to these facilities.

Action 4: Planning for Wastewater Reclamation: Planning for wastewater reclamation has to be incorporated into wastewater management to advance wastewater reuse and recycling. The LSWMO and the LWC can work together to create wastewater reclamation projects and encourage low impact development design concepts in future development.

Management

14. Privatization of Water

Action 1: Creation of Privatization Committee: to evaluate past water privatization schemes and assess the best option for Lagos' needs. Under my recommendation, a management contract should be established. LWC would be the owner of the water supply assets as well as plan and implement all large investments, while the private operators will be in charge of management and operation to ensure service delivery. This contract should delineate what each part's responsibilities are.

Action 2: Plan: To ensure a successful transition into water privatization, it is necessary for the Lagos government to develop a coordinated plan. The water

privatization plan should include a unanimous vision, comprehensive goals and strategies, clearly defined roles and responsibilities, and a well-structured layout. As mentioned previously, it is important that a financial model be also created, to ensure successful implementation.

Action 2: Water Privatization Regulation: Lagos lacks an enabling regulatory and political environment to foster privatization. Though the Lagos State Water Sector Law stipulates water privatization, it fails to delineate the structures of water privatization such as the rights and responsibilities of the government, LWC or private sector operators. Thus, the state must establish a more comprehensive water privatization regulation. Under the new policy and institutional arrangements, private participants must remain under government control and oversight, through the independent regulatory body. This will ensure accountability and transparency.

Action 3: Stakeholder Inclusion: to safeguard consumers from high prices an increasing block tariff system should be formed. This would include a “social tariff” for those consuming less than 20 m³ over 60 days, a “dissuasive tariff” for using more than 100 m³ over 60 days, and then a normal tariff for consumption between these two levels, as in the case of Senegal.¹ This approach will create a cross-subsidy where, “consumption in the higher blocks will generate enough surplus to finance the subsidy delivered to

¹ Burke, Kelsey. *The Viability of Water Privatization in Sub-Saharan Africa*.

customers consuming water in the lowest brackets”.¹

Stakeholder participation should also be encouraged during the decision process.

Action 4: Structural Reform Programs: Building strong institutions is a central challenge of development and is key to controlling corruption and improving transparency. Ways of strengthening institutions through reform programs can focus on strengthening private water systems to improve service delivery, establishing sound financial management, promoting disciplined and transparent policymaking, and establishing a balanced division of responsibilities among the state and private sector participants. Economic reforms that would reduce opportunities for corruption include: stabilization of water tariffs and unifying market determined rates and strengthening licensing requirements and permits. By utilizing these methods to eliminate corruption and improve transparency, a sustainable water supply system can be achieved through improvements in efficiency, service delivery, higher returns, effectiveness, and quality assurance.

15. Integrated Water Resources Management

By engaging in Integrated Water Resources Management (IWRM), the Lagos water sector can ensure a participatory planning & implementation process that promotes the coordinated development and management of water resources. This would ensure the sustainability of vital ecosystems, while

¹ Burke, Kelsey. *The Viability of Water Privatization in Sub-Saharan Africa*.

maximizing the resulting social welfare & economic benefits in an equitable manner.

Action 1: Integrated Management: to ensure a holistic approach to water management for water supply, wastewater, and water quality across all water agencies and a bottom-top approach to water management will promote responsibility at the lowest effective level of administration in line with the principle of subsidiarity. Furthermore, effective measures such as the use of technology for the collection and monitoring of water resources data should be implemented in order to better manage the water for urban use.

Action 2: Participation: Strengthen community-based organizations, consumer groups, & vulnerable groups such as women & youths to enable them participate in the management decision-making process.

Action 3: Ensure Economic Sustainability: Adopt the polluter-pays principle and economic instruments to address inefficiencies in service delivery. But no one should be deprived of access to essential services as a result of pricing policy.

16. Water Pricing and Audit System

Action 1: Update Tariff System: The inadequacy of the tariff structures for water supply in Lagos has resulted in limited funding for efficient performance of public water systems and expansion of coverage. An effective

water tariff system that encourages conservation and reuse of water supplies through increasing block rate pricing should be established.

Action 2: Ensuring Billing & Revenue Collection: All users should be connected to the water supply database and collection should be guaranteed through enforcement of fees or disconnection if payments are not made. To eliminate opportunities for corruption, these customers should be metered.

Action 3: Water Audits: Frequent water audits need to be performed to match water use to water needs, determine efficient use of water and manage water demand. Water audits will enable the private water companies save money and identify leaks in the piping systems.¹

17. Targets & Performance Measurements

Both the LWC and the private water utility companies need to include frequent monitoring and assessment of its goals.

Action 1: Utilization of Performance Indicators & Balanced Scorecard:

Developing indicators and targets and carrying out performance measurement will assist in the assessment and tracking of project and program efforts. Thus, the use of performance indicators, benchmarking and balanced scorecard should be adopted in Lagos water supply system. The performance indicators for benchmarking relevant to the water supply should include: production, distribution, environment, customer service and orientation, financing, water quality, planning, operation and maintenance,

¹ Daniels et al. *The Environmental Planning Handbook for Sustainable Communities and Regions*.

level of service and operational performance, engineering and purchasing processes, and technical and market processes.¹

The benefits of benchmarking to the LWC are enormous and provide decision makers with an overall perception of the utility performance as a strong support in making strategic choices and helps in identifying areas with potential for performance improvement. As a result, the water supply system becomes more apt in overcoming performance limitations while boosting discussion of roles, functions and procedures.

The performance measurement system for water supply for Lagos should address several main issues including: state of water resources; access to water and adequate sanitation; governance and regulatory framework; sustainable development; private sector participation; community education and participation; environmental sustainability; and management, monitoring and enforcement.²

¹ Oyegoke et al. "The Challenges of Water Supply for A Megacity: A Case Study of Lagos Metropolis."

² Oyegoke et al. "The Challenges of Water Supply for A Megacity: A Case Study of Lagos Metropolis."

Timeline

To ensure effective and successful implementation of the above-mentioned strategies for a more comprehensive plan, it is necessary for the state government to adopt them in an appropriately scheduled and programmed manner.

Governance		
<i>Strategies</i>	<i>Action</i>	<i>Timeline</i>
Water Governance Restructuring	Establishment of Water Planning Committee	June 2014
	Water Governance Assessment	Jul 2014 – Sept 2014
	Water Governance Scorecard	Jul 2014 – Sept 2014
	Establishment of Sovereign Water Agency	October 2014
	Establishment of Required Legislations: For groundwater; privatization	Oct 2014 – Jan 2015
	Establishment of Communication Mechanisms including Monthly Meetings	October 2014
	Establishment of an Efficient Water Tariff System	Nov 2014 – Jan 2015
Stronger Enforcements & Requirements	Establishment of Legislation & Mechanisms to Increase Implementation & Enforcement Capacity	Nov 2014 – Mar 2015
Public Education & Participation	Public Consultation	Jan 2015 (Continuing)
	Public Awareness Campaign	Jan 2015 (Continuing)
Infrastructure & Planning		
Development of Comprehensive Water Management Plan	Taking of Inventory; Performance of Analysis; Establishment of Goals & Objectives; Creation of Strategies, Zoning & Subdivision Regulations & Capital Improvements Program	Jun 2014 – Mar 2015

Land Use Planning	Establishment of Land Use Regulations & Mechanisms such as TDR and conservation easement program	March 2015
	Implementation of Land Use Mechanisms including TOD and conservation easement, public land purchases	Apr 2015 (Continuing)
Infrastructure Development	Construction of Adiyari II Plant & Distribution Network	Feb 2013 – Jan 2016
	Construction of Odomola I Plant & Distribution Network	Aug 2013 – Jan 2016
	Construction of Ishasi Expansion & Distribution Network	Mar 2013 – Feb 2015
	Construction of Adiyari III Plant & Distribution Network	Oct 2014 – Feb 2017
	Construction of Odomola II Plant & Distribution Network	Jan 2016 – Jun 2018
	Construction of Odomola III Plant & Distribution Network	Oct 2016 – Mar 2019
	Construction of Ishasi Upgrading Plant & Distribution Network	Oct 2016 – Mar 2019
Reduction of Unaccounted-for-Water Losses	Water Audit of Water System	Mar 2015 – Mar 2017
	Update of Customer Records	Mar 2015 – Aug 2015
	Leakage Detection & Control Program	Mar 2015 (Continuing)
	Replacement of Old Pipe Systems	Aug 2015 – Aug 2018
	Installation of Water Meters	Aug 2015 – Mar 2017
Infrastructure Development in Peri-Urban Areas	Extension of Ishasi and Adiyari trunk & distribution networks to serve Badagry, Amuwo-Odofin & Ikorodu Axis	Jun 2014 – Feb 2018
Quality		
Development of Water Protections Plans & Initiatives	Performance of Source Water Assessment	Jul 2014 – Mar 2015
	Creation of Source Water Assessment Plan	Mar 2015 – Aug 2015

	Development and Application of Watershed & Wellhead Protection Measures	Mar 2015 – Mar 2018
	Development of Contingency Planning Strategies	Mar 2015 – Aug 2015
	Development & Enforcement of Water Quality Standards	Mar 2015 (Continuing)
	Cleanup of Pollution Sources	Aug 2015 (Continuing)
	Regulation for Draining & Filling of Wetlands	March 2015
	Regulation for Proposal Disposal of Wastewater, Sludge & Sewage	May 2015
	Regulation Prohibiting/Regulating the Discharge of All Pollutants	June 2015
Adoption of Stormwater Management Measures	Creation of Stormwater Management Plan & Long-term Overflow Control Plans	Aug 2015 – Dec 2015
	Construction of Stormwater Drainage Channels	Feb 2016 – Jul 2017
	Creation of Stormwater Ordinances	Jan 2016 (Continuing)
	Building & Incorporating Green Infrastructure Projects	Jan 2016 (Continuing)
Sustainability		
Coastal Zone & Flood Management	Creation of Coastal Zone & Flood Management Plan	August 2017
	Creation of Concrete Flood Channel Redesign Projects	Aug 2017 (Continuing)
	Development of Flooding Insurance	January 2019
Water Conservation	Metering of Users	Aug 2015 – Mar 2017
	Maintenance & Repair of Water Pipes & Pumping Systems	Aug 2015 – Aug 2018
	Installation of Control Volumes Systems	November 2018
	Water Retrofit Program	June 2018
	Public Education Program	Jan 2016 (Continuing)
Groundwater Resource Management	Development of Groundwater Information System	Feb 2015 – Feb 2016
	Aquifer Classification & Management	Feb 2015 – Jun 2016

	Critical Areas Identification	Feb 2015 – Feb 2016
	Groundwater Quality Management & Pollution Control Program	Feb 2015 – Jun 2016
	Regulation to Prohibit Groundwater Pollution	January 2016
	Legislation to Control Groundwater Abstraction	August 2018
	Installation of Hydrometers for Private Boreholes	November 2018
	Establishment of Groundwater Resource Charges	November 2018
	Establishment of Licensing & Permitting Process	January 2019
Wastewater Management	Integrated Wastewater Planning & Management	Jun 2014 – Mar 2015
	Creation of Wastewater Plan & Strategies	Jun 2014 – Mar 2015
	Establishment of Planning Procedures & Construction Grants for New & Upgraded Sewage Treatment Plants	Jan 2014 (Continuing)
	Wastewater Reclamation Project	Jan 2016 (Continuing)
Management		
Privatization of Water	Creation of Privatization Committee	January 2015
	Creation of Water Privatization Contract & Plan	April 2015
	Amendment of Water Privatization Regulation	July 2015
	Structural Reform Programs	Jul 2015 (Continuing)
Water Pricing & Auditing	Update of Water Tariff System	Nov 2014 – Jan 2015
	Performance of Water Audit	Mar 2015 – Mar 2017
	Improvement of Water Supply Database	Mar 2015 (Continuing)
Targets & Performance Measurement	Utilization of Performance Indicators & Balanced Scorecard	Jul 2015 (Continuing)
	Measurement & Evaluation of Results	January 2019
	Revise Plan with Improvement	July 2019

Conclusion

Despite a growing economy, Lagos state has failed to provide adequate access to water supply to its residents. Despite governmental effort to ensure reliable water supply, the city still faces a demand gap of 330 MGD. Several issues such as inadequate infrastructure, lack of funding, corruption, and poor implementation has posed a significant challenge to government efforts to tackle its water crisis. Rapid population growth, urbanization and climate change also act as additional barriers to resolution and further exacerbate the water supply crisis.

Though the Lagos State Water Corporation has made steps in trying to ensure a sustainable water supply system through the creation of the Lagos Water Supply Master Plan, the proposed strategies and projects will fail to realize the goal of covering the water demand gap because the plan is flawed and thus unrealistic. The Lagos Water Supply Master Plan utilizes analysis and projections to formulate its projects, however it is one-dimensional as it focuses only on infrastructure development and fails to address all the gaps and failures of the Lagos water supply system. Though Lagos is in dire need of improved water infrastructure, a sustainable water supply system cannot be ensure if a plan fails to: provide an effective water governance structure; establish proficient water resource and demand management systems; develop strategies to improve water quality, reduce water losses and ensure service delivery; and take steps to ensure social, economic and environmental

development. As such, Lagos is still facing water losses and shortages, water pollution and water injustice and is far from providing equitable access to clean and safe drinking water to all its residence.

The path to a sustainable water management in Lagos is a rough one but there is hope for Lagos if it adopts a more comprehensive and strategic plan develop to target the core problems of the Lagos water supply system. I have developed a plan that cuts across five main capacities; governance, infrastructure and planning, quality, sustainability, and management. Some of the core strategies included in this plan include: integrated water resource management; smart growth infrastructure development; water governance restructuring; source water protection plans; water audit and leakage control programs; wastewater and groundwater resource management; improved tariff structure and metering rate; stakeholder involvement; and water privatization. It is my belief that by adopting and properly implementing the strategies and initiatives in my proposed plan, all Lagosians will have access to clean and safe drinking water by 2020.

Appendices

Appendix 1: **Functions of Lagos Water Corporation**¹

The functions of Lagos Water Corporation, as stated in Section 6 of Lagos State Water Sector Law No. 14 of 2004 are –

- a) Develop all water services assets, new water services assets, and sewage services assets.
- b) Prepare on behalf of the State, plans for the maintenance and development of water services, water service assets, and new water services assets in the State (referred to as the “Development Plans”), pursuant to consultation with the relevant authorities and consumer groups.
- c) Identify and implement projects for the provision of water services which may be undertaken with private sector participation, pursuant to consultation with the relevant authorities, in order to fulfill the water service obligations of the State.
- d) Ensure the supply of potable water in the State, either pursuant to project agreements with private participants, or by raising necessary funds through the capital market.
- e) Control and manage all waterworks and groundwater in the State.
- f) Extend and develop existing waterworks within the State.
- g) Establish, manage, control, and develop new waterworks and sewerage systems for public, agricultural, domestic, industrial, and general purposes in the State.
- h) Ensure the supply of adequate and potable water throughout the State at reasonable charges.
- i) Manage and regulate wastewater and sewerage services in the State.
- j) Verify and monitor compliance by the private participant with any project agreements.
- k) Establish and implement proper accounting procedures for all of the assets and liabilities of the Corporation.
- l) Encourage from time to time the conduct of research for the purposes of carrying out the functions of the Corporation.
- m) Submit the results of such research to the Board for the utilization of some for the formulation of the policy relating to water supply, and water pollution control in the State.
- n) Authorize or delegate any officer, employee, or servant of the Corporation to act as agent of the Corporation for any functions, services, or facilities which may be exercised, performed, or provided by the Corporation under the 2004 water sector law.

¹ LWRC. Lagos Water Regulatory Commission (LWRC). *Lagos State Water Sector Law, Law No. 14.* 2004.

- o) Establish four standing Board Committees or any other ad-hoc Committee as provided under this 2004 water sector law.
- p) Undertake accounting of Public Assets.
- q) Manage public financing, including loans (multilateral and local).

Appendix 2: **Notes From Interviews**

Lagos Water Corporation – Dr. Mrs. Bola Balogun

- LWC provides potable water to Lagos metropolis not rural areas. Some past rural areas are now beginning to become urban areas. Responsible for water supply (pipe borne water) from abstraction to tap including agricultural users.
- The Ministry of rural development serves the rural areas. They provide water for rural areas by way of drilling boreholes, providing hand pumps, and building small water treatment plants. Most of the rural areas do not have these water treatment plants. They also take care of sanitation in these areas.
- 90% of water sourced from surface water (Ogun and Aje rivers)
- 45 waterworks. Major waterworks, Iju, Adiyin and Ishasi, extract from surface water. Ishasi waterworks extracts from Owo from the Badagry axis.
- After abstraction, water is treated by LWC and transmitted and distributed through the network
- Responsible for cost recovery through customer payments
- LWC is the biggest water utility in the West Africa.
- Some areas are cut off from metropolis and as such regardless as rural. Being riverine, Lagos has many tiny islands off the coast and there is no way to lay water pipes from mainland to these rural areas. Examples include Epe, Badagry, and Ikorodu.
- Customers don't necessarily include those who have boreholes. Some customers are connected to the LWC water supply but also have boreholes but this group of customers isn't accounted for.
- LWC are operators of the state and the agency that produces the water. The LWRC regulates the water sector including activities of the LWC including water supply, regulate packaged water producers including bottled and pure water, and regulate boreholes and issue borehole licenses.
- LWRC is a new agency and have been working together in a tariff review, as the tariff charged by the LWC is low. LWRC is talking to the governor to accept the plan to increase tariffs.
- Planning: Master Plan to provide pipe borne water for every citizen in Lagos state. Use population figures, availability of water and water use per capita. Use the WHO water use standards (110liters per capita per day) for these projections.

- There is a high rate of population increase, well above 4%, so the freshwater sources will not sustain the megacity. Considering the use of brackish water, lagoon water, and saltwater to meet growing demand.
- Extensive hydrological studies are done. Hydrological data dating back 5-10 years used to make future projections for 5, 10 and 20 years. These studies are not performed by the LWC but are contracted out to consultants or from agencies who generate such data water basin authorities and the navy. The Ogun and Osun water basin authorities have extensive data on river basins that surround Lagos.
- Ogun River traverses so many states and they all use the water. Lagos is at the terminating end of the Ogun River. Lagos therefore faces challenges regarding pollution of this water sources, therefore increased costs of production and also low water levels during dry season. Talk to the Ogun/Osun water basin authorities to release the dammed water.
- Utilization of Integrated Water Resource Management in the Ogun/Osun river basin. All states utilizing the water in this river basin have to work together to manage the water resources within their environment. Also address factors that can affect water resources such as industrial effluents, development along riverbanks and damming. So that good quality water would be available for every state.
- The excessive use of boreholes in Lagos is not factored into projections of available water.
- LWC doesn't have the capacity to conduct in depth research and impact studies such as the impact of climate change, industries (sugar manufacturers, bottling companies, and water producers) or excessive use of groundwater abstraction. There is no data.
- By law, the LWC is to regulate groundwater abstraction through boreholes because of risks of saltwater intrusion and subsidence, however this function has been overlooked.
- The governor has transferred this responsibility to the LWRC, but it is not in the law yet. The Lagos Water Sector Law of 2004 that set up the LWRC does not include it as one of statutory responsibilities. They will be issuing licenses just for industrial users of groundwater not the domestic users. Cannot regulate domestic users because the LWC cannot efficiently provide water to all Lagosians and water is a right in Lagos.
- LWC priorities are to increase production, to increase access to water and to undertake the PPP program to improve service quality.
- PPP is one of the policy thrusts of the state government. Using PPP as a tool to improve services as the state government cannot fund all of LWC activities. Believe that PPP will improve sustainability of the

water supply sector. PPP is engaged at all levels. Include both foreign and domestic companies.

- Planning to set up a desalination plants along the Badagry axis to be funded, built and operated by a Singaporean company called Hyflux. They intend to build a 50MGD plant to serve Badagry axis. Hydrological studies show need for the desalination plant to serve Badagry axis.
- Another plan to set up a 35MGD plant along the Epe Axis. There is a transaction advisor from a U.S company Chester to midwife the project. Adiyon Phase II in Ogun state. In Ogun state because it is the highest point in the area and LWC is abstracting from Ogun River, Thus the water comes down by gravity, requiring less energy. Being constructed by Salini an Italian company and being funded by the Lagos state government. This is to be a 70MGD plant.
- There is a huge gap of 330MGD.
- The state has a central PPP office attached to the governor's office that is responsible for creating an enabling environment by enacting laws and policies. The LWRC is not charged with the responsibility of ensuring enforcement or implementation or providing an enabling environment. The LWRC is responsible in ensuring fair returns on investment and consumers get fair price for quality water service. The LWRC also settles disputes between consumers and service providers.
- LWC is supposed to be an independent, standalone company relying only on internally generated revenue, but has not been able to achieve full autonomy by the LWSL (2004) because of lack of profits and limited funding.
- The LWC doesn't have the provisions to enforce their initiatives such as metering. They can only encourage through public awareness and education.
- The LWC has zero-tolerance for mairuwas. There are 2 means of enforcing the total elimination of mairuwas. 1) The LWC has been giving an enforcement privilege from the state ministry of environment go around and seize all the carts and trucks of mairuwas. 2) There's also a water court (miscellaneous offences court) that try cases of water theft and vandalization.
- Very difficult to change the law to enable provision of capability for enforcement and implementation for LWC. It is a long and bureaucratic process. Also, the LWC doesn't have the grounds as they have failed to provide reliable water supply so as such cannot require citizens to adhere to their policies. It is however in the law that if you have LWC pipes near your household, which would provide you, access to water, you must connect for health reasons. However, law doesn't enforce this.

- When service delivery improves, there could be a natural migration toward pipe borne water.
- The major challenges facing LWC: lack of funding, lack of man power (just 1,200), rapid growth in population and migration.
- LASEPA is in charge of water source protection and water pollution not LWC. LSWMO is in charge of wastewater. They are supposed to be working with LWC but are not because the LWC is just focused on water supply. 80% of the water LWC produces ends up as wastewater. Both agencies have to work together to synchronize master plans to know how much water is produce, wasted and needs to be treated and explore wastewater recycling as a viable water supply option.
- No central water body that governs all water agencies. Different water agencies take care of different aspects of water but they do not work together. Ex: The Waterfront Agencies mandate the coastal front.
- There isn't a corporate concern for environmental sustainability. LWC has no overarching environmental goals but can differ by department. Sometimes EIAs are utilized but not always and sometimes projects fail as a result. LWC's impact on the environment is not addressed.
- There have been cases of environmental damage from Adiyen plant effluents polluting the nearby community; silting up Adiyen river.
- LWC does not address environmental justice and social equity as their primary concern is to get a return on their investment and cover costs.
- LWC Costs: energy, chemicals, wages and salary, aging infrastructure, and expansion costs.
- Unaccounted for Water is 80% due to leakage, theft, unrecovered bills, uncollected revenue and wastage. The production capacity of the LWC is currently is 210MGD but the actual production is 60MGD. 80% of the 60MGD is UAW.
- The government is providing money to buy vehicles for the operational units to fix leakages to reduce UAW.
- Funding for LWC: Tariffs, state subsidy, PPP & donor transfers such as the World Bank.
- There are internal and state auditors to make ensure efficient funding allocation.
- The M&E unit sets targets, uses benchmarks and evaluates performance. Departments are to send quarterly reports on performance. For ex: the quality assurance unit has to send reports on water quality to measure if they conform to national standards. How effective the process is, how the information is utilized and how much weight the reports carries are all questionable.
- Quality from the waterworks is up to standard but quality declines due to intricate reticulation, poor planning that put pipes by sewage and drains, roads and rapid population increase. Therefore, there is a high chance that polluted water seeps into the pipe borne water.

- Plans to ensure service delivery and improved quality include plans to extend the network and construct booster stations to inject chlorine to disinfect receiving waters to prevent waterborne diseases. Lagos has been experience an outbreak of waterborne diseases in the past few months.
- Water conservation is recognized as something that must be done but it still not high on the priority list as compared to building capacity.
- Metering rate is 1% mostly in Lekki. It is an isolated network not connected to Iju and Adiyin. Flat rate is then charged when not metered. The water service is shut off if the payment is not received. Price of water: 150 Naira/m³ and 0.05 Naira/liter. International standards are 110 liters/capita but is much less in Nigeria.
- LWC cannot run efficiently because it is not breaking even.
- Areas of Improvement
 - Power: need for consistent or a more efficient means to generate or receive energy.
 - Chemicals: cheaper and more efficient use of chemicals.
 - Need more manpower, better staff appraisal system, and higher skilled workers.
 - Need for total independence from the government due to frequent political interference.
 - Network extension.
 - Bigger waterworks that need to abstract from surface water not ground water.

Lekki Waterworks

- Mini waterworks use groundwater while major waterworks use surface water as water is produced on a larger scale.
- Not meeting demand so have extension plans. Production is 1.2MGD (about 50% due to challenges), which is 40% of Lekki area. The extension will increase coverage to about 60%. Consistent power will improve coverage as well.
- There are plans to connect to the major waterworks through booster stations.
- Challenges: unreliable power supply, maintenance issues, lack of good and sufficient equipment, lack of manpower and lack of funding.
- Funding comes from internally generated revenues, transfers from donor agencies, and government funding.
- There are many areas that have been cut off from the system because of the refusal to pay. However, they would like to get them back so offer to offset the bills by certain amount. This would increase revenue and increase production.
- The metering rate is 60% while others are served flat fees. This metering started in December 2012 and is a flat rate.

- Use of borehole and groundwater abstraction to produce water. Before production, there are analysis and tests done to determine the dynamic and the static water level, and the water table. These boreholes are believed to be sustainable, as the groundwater levels are not decreasing. If the boreholes are believed to be decreasing, another borehole is done about 50 meters apart.
- In the evenings, there is excess demand, which exceeds supply. The mornings are peak periods too. However, there are no water use restrictions.
- Water conservation is promoted but it is not effective because of the refusal of residents to manage or conserve water.
- Belief that the risk of groundwater intrusion is low, despite being adjacent to the ocean and surrounded by septic tanks and open sewers. The boreholes are cased by steel or cement “so intrusion is quite difficult”. The only thing done to protect the water source is borehole servicing about once a year, to make sure the borehole is still viable.
- There is treatment before distribution with chemicals (hydrated lime, chlorine, aluminum sulfate (major waterworks only but the ph. is already high)). Most of distribution lines are mild steel so there is some corrosion and they haven’t been changed in the while. Lines are hardly washed out.
- Work to make sure water standards are being met with NSDQW.
 - Chlorine- 0.3 (max), Iron- 0.3 (max), pH- 6.5-7.5 (max), Calcium, and magnesium
 - Physical parameters: color, turbidity, temperature, taste, appearance, salinity, conductivity, total dissolve solids, alkanity, and water hardness.
 - “Groundwater doesn’t usually have pollution from coliform so microbiological analysis” except from when there is heavy rain
 - Major waterworks perform a more intense treatment process than the mini waterworks
 - Currently facing quality problems because the treatment isn’t working effectively because they have closed systems, therefore there is no aeration process. Therefore the iron is hard to get out.
- Three categories
 - Micro waterworks: 1MGD plant
 - Mini waterworks: 2-4 MGD plant.
 - Major waterworks: 3 major waterworks from 50MGD and above (Iju, Adiyari and Ishasi)
- Production process: water from borehole > sedimentation basin > filtration > storage unit > overhead > pump out to consumers.
- No drought management plan or emergency plan for the mini waterworks. At the major waterworks water is recycled and conserved

incase of emergencies. Mini waterworks are not looking into wastewater recycling, but recognize that they should.

- Major costs: manpower, chemicals, power generation, and cost of maintenance. There is an allocation of about 4 million Naira monthly and power generation takes about 2 million Naira. This is in additional to the revenue generated.
- Uniform water rate structure. Price of water: 0.05 naira/liter. No excess use charge or peak load pricing. The cost of water is much higher. There is likely risk for the plant, as a 20% percentage increase in total water costs would jeopardize overall plant competitiveness. Businesses pay higher than the residents. Those that are charged flat fees also pay different fees depending on type of housing. So, a bungalow would pay less than a duplex.
- Charging a flat fee provides more revenue than metered rates.
- There are plans to increase the water rate by about 40%. The business impact of this increase would be low.
- High risk in production as there would be a significant impact if water availability were reduced by 10%. Stressed to maintain level of water production.
- There are some measures taken to improve water efficiency and reduce water leakages such as maintenance of leakages from pipes, valves, tanks, and backwashing. It's a long process to fix these leakages because it is hard to identify when and where these leakages happen; there are no sensors.
- All employees are made aware of water efficiency and little assessments are performed.
- There are no restrictions on the siting and use of borehole and no use of zoning ordinances. There is no integrated planning with regards to water use.
- Ecologically sensitive areas exist, there are no assessments performed to determine if they have been affected.
- Pipes pass through the drains/gutters. The New Town Development is in charge of cleaning out the gutters however they aren't cleaned out and are constantly full, even worsened during periods of flooding. This leads to seepage and intrusion.
- Public participation is reactionary.
- The public landscape would impact operations greatly illustrating dependence on government.

Lagos State Environmental Protection Agency (LASEPA) – Mr. Sewanu Adebodun

- Main responsibility of LASEPA is to protect and safeguard Lagos water bodies, both groundwater and freshwater. There are 33 receiving water bodies in Lagos. Both surface water and ground water is very

polluted in Lagos due to maritime waste, dumping, industrial waste, leakages from sewer lines, leachate movement, agricultural runoff and open defecation. All water bodies are polluted in Lagos, both surface and groundwater from oil and industrial pollutants.

- The goals of LASEPA are to ensure environmental sustainability and reduce pollution load of the state.
- The quality of water has been adversely affected by the rapid increase in population. Water from houses drains into canals which empty into water bodies.
- Law in Lagos that every resident should have a “suitable” toilet (WC) at residences. These empty into the septic tanks. Pit latrines were abolished in 1988, however there are still some using them. Now there is the notion of ecological sanitation (ECOSAN) via pier latrines.
- The state government has about 5-6 sewage treatment plants where the dislodgers take the waste. This doesn’t serve the whole population and residents are averse to paying the cost to empty their septic tanks. But there are fines and other punitive measures. The product from the plants must meet up to the permissible standards in the state. There is no centralized sewage system in Lagos.
- LASEPA doesn’t have the responsibility of providing WASH services. It is the responsibility of every resident, and the state government provides these services in public places such as parks and markets through the Ministry of Women’s affairs.
- There are about 57 local governments in the state. Law mandates all local governments must have health centers, which have to be connected sewage treatment plants.
- LASEPA established in 1996. Before the establishment, all water bodies were highly polluted due to non-regulation of the activities of industries.
- Currently, the industries are highly monitored to prevent additional pollution, carry out advocacy and public awareness to prevent pollution, monitor sewer lines and have fines, permits, incentives and policies to ensure compliance.
- UNEP & UNIDO help LASEPA to cleanup the water bodies. But there is a higher focus on pollution prevention than cleanup. LASEPA is currently focused on pollution prevention from industries.
- Lagos State Environmental Law of 2003 to protect and safeguard water bodies. Chapter 2 Section 20 of the constitution states that states should improve and safeguard their environment. Additional law includes Pollution Control Law of 1989, The LASEPA Act of 2003 & Sanitation Act of 2000. These empower the LASEPA to carry out their activities.
- 70% have access to adequate sanitation in Lagos; the other 30% live in slums and riverine areas like Makoko, Badiya, Badagry, Agege and

- Ajegunle. The state government is doing work to develop the slums and also to relocate residents in that area to a better environment.
- There is an opportunity of synergy if LASEPA works with other water agencies, however none of the agencies work together. LAWMA is responsible for solid waste and LSWMO is responsible for sewage.
 - There is use of projection and analysis in planning, however projections of population growth and climate change are not used in planning.
 - Challenges:
 - Government interference
 - Government operation facilities that fail to comply and being a government agency LASEPA cannot regulate.
 - Poor funding and low financing
 - Poor regulations standards with enforcement
 - Little man power
 - LMDGP is looking at slum upgrading. They have an interface with LASEPA by providing water supply through deep wells and boreholes and also some sanitation services. This presents an opportunity for LASEPA to work with them but that is yet to happen. Some of these slum areas like Badiya have mini waterworks but the flow lines are not laid out completely.
 - There is lack of water solidarity in Lagos. “What is out of mind is out of sight”. Public participation is in form of complaints
 - Most waters in Lagos are not clean or swimmable. This affects tourism. Ministry of Tourism, Ministry of Environment and LASEPA are currently working together to develop a policy that would make the water navigable and swimmable to encourage tourism. The water grade is at the lowest now.
 - Water quality management and sanitation should be approached in an integrated manner.
 - In Lekki, there are septic tanks but there are septic tanks. This is as a result of a disconnect. LSWMO and private companies who do not report to LASPEA do the septic tanks designs and laying. There is need for communication amongst the water agencies. There also needs to be corporation, integrated planning and consistency to eliminate confusion.
 - The current design for the wastewater management and sewage is causing pollution, but it is not feasible currently to have a central sewage system. So the seepage is hoped to be filtered by the soil before it gets to the water body.
 - There is no categorization of water bodies according to use. Lagos gets majority of its water from Adiyari but there little water source protection and lack of proper form of treatment.

- Development is a threat to Lagos' water bodies but LWRC not LASEPA is in charge of controlling development.
- No strong systems to regulate wetlands but pollution of these areas are monitored.
- Office of Drainage Services (within the MOE) is in charge of stormwater. They do the channelization to ensure that runoff water gets into the receiving bodies; the runoff to be treated is by LSWMO. LASEPA is responsible for coastal and flood zone management; the beach, the development, and the cleanup. The Ministry of Waterfront handles the infrastructure built in these areas. There is no agency in charge of protecting the coastal zone areas. LASEMA is in charge of emergency and drought management. Office of Transformation sets targets and benchmarks for LASEPA. Ministry of health is in charge of controlling waterborne diseases.
- There is water quality assessment of water discharge by quality and destination. There are also state water quality standards, which are stricter than the national standard, because of the peculiarity of the state. These are Effluent Limitation Standards.
- There needs to be a provision such as checks and balances that would allow LASEPA regulate other government and water agencies.

Bibliography

Aalto University: School of Engineering. *Case Study of Lagos*. 2009. Web. 9

Apr. 2014.

Adegboye, Kingsley. "Lagos Plans Huge Investments in Wastewater

Infrastructure." *Vanguard News*. Vanguard Nigeria, 3 Jan. 2011. Web.

9 Apr. 2014.

Akoni, Olasunkanmi, and Monsur Olowoapejo. "Lagos: Water, Water

Everywhere, None to Drink." *Vanguard* (Nigeria), March 25, 2013.

Web. 9 Apr. 2014.

AllAfrica. "Nigeria: Privatization Will Lead to Power Sector

Efficiency." *AllAfrica*. 1 Nov. 2013. Web. 9 Apr. 2014.

Armentrout, Gary. "Technologies Help Detect Unaccounted for Water

Loss." *The Kansas Lifeline* (2008). Web. 9 Apr. 2014.

Ayinde, Olutoyin. "Implementation of Water and Sanitation Policies and

Practices within the Spatial Plans of Lagos, Nigeria." Lecture. World

Water Week. Stockholm. 4 Sept. 2013. Web. 9 Apr. 2014.

BBC News. "Lagos: Water, Water Everywhere." *BBC News*, September 12,

2005. Web. 9 Apr. 2014.

Burke, Kelsey. *The Viability of Water Privatization in Sub-Saharan Africa*.

Diss. Connecticut College, 2013. Economics Honors Papers. Paper 13,

2013. Print.

- Campbell, John. "This Is Africa's New Biggest City: Lagos, Nigeria, Population 21 Million." *The Atlantic*, July 10, 2012. Web. 9 Apr. 2014.
- Daniels, Thomas L., and Katherine Daniels. *The Environmental Planning Handbook for Sustainable Communities and Regions*. Chicago, IL: Planners, American Planning Association, 2003. Print
- Durham, Mark. "Report From Lagos: Water Crisis." *URBim*. April 17, 2012.
- EPA. The Environmental Protection Agency. EPA Office of Ground Water and Drinking Water. *Consider the Source: A Pocket Guide to Protecting Your Drinking Water*. Web. 9 Apr. 2014.
- Fasona, Mayowa, Ademola Omojola, and Nenna Amogu. *Sustainable Water Management Solutions for Large Cities: The Proceedings of the International Symposium on Sustainable Water Management for Large Cities (S2) : Held During the Seventh Scientific Assembly of the International Association of Hydrological Sciences (IAHS) at Foz Do Iguacu, Brazil, 3-9 April, 2005*, 49 - 57. Wallingford, Oxfordshire, UK: IAHS, 2005.
- GWI (2003). Global Water Intelligence (GWI). "Reducing Unaccounted-for-Water." *Global Water Intelligence* 4, no. 4 (2003). Global Water Intelligence, 03 Apr. 2003. Web. 09 Apr. 2014.
- GWI (2010). Global Water Intelligence (GWI). "Nigerian Water Sector Embraces PSP." *Global Water Intelligence* 11, no. 6 (2010). Global Water Intelligence, 11 Apr. 2010. Web. 09 Apr. 2014.

- GWII (2013). Global Water Intelligence (GWI). "Lagos Promotes Two-Tier Water PPP Initiative." *Global Water Intelligence* 14, no. 5 (2013): 1-5. Web. 09 Apr. 2014.
- Hall, David. *Nigeria: Water Impact on Lagos Water of the World Bank Privatization Plans, Union Response*. Public Services International Research Unit, 2010. Web. 09 Apr. 2014.
- Irin News. "Lagos: Crisis of Management." *Irin News*. Web. 09 Apr. 2014.
- Longe, E. O. "Groundwater Resources Potential in the Coastal Plain Sands Aquifers, Lagos, Nigeria." *Research Journal of Environmental and Earth Sciences* 3.1 (2011): 1-7. *Maxwell Scientific Organization*. Web. 9 Apr. 2014.
- LRDC. Lagos Research & Development Council (LRDC). *Research Brief. November 2013*. Issue brief. *Innovate Lagos*. Web. 09 Apr. 2014.
- LWC. Lagos Water Corporation (LWC). *Water: Conserve and Use Wisely*. Lagos, Nigeria 2010. Web. 09 Apr. 2014.
- LWC. Lagos Water Corporation (LWC). Lagos, Nigeria. *Lagos Water Supply Master Plan*. By Lagos Water Corporation. 2010.
- LWRC. Lagos Water Regulatory Commission (LWRC). *Lagos State Water Sector Law, Law No. 14*. 2004. Web. 09 Apr. 2014.
- Lagos (2010). "Lagos Gross Domestic Product Survey 2010." Lagos Bureau of Statistics. Web. 09 Apr. 2014.

- Lagos State (2011) Digest of Statistics, 2011. Lagos Bureau of Statistics.
Web. 09 Apr. 2014.
- NAN. "Lawmaker Scores Lagos Water Corporation Low." *Punch Nigeria* [Lagos] 21 Nov. 2013. Print.
- Nigerian Journal. "Tackling Nigeria's Water Crisis." *Nigerian Journal* (2011).
Web. 09 Apr. 2014.
- Obani, Pedi. Lecture. REGULATING WASTEWATER MANAGEMENT IN LAGOS STATE. Lagos, Nigeria. 3 Oct. 2013. *LWRC*. Web. 09 Apr. 2014.
- Obayagbona, Harrison. *Governance Without Government: Water Provision in Lagos, Nigeria*. Diss. Graduate School of Development Studies, 2008. Netherlands: Institute of Social Studies, 2008. *Institute of Social Studies*. Web. 9 Apr. 2014.
- Oghifo, Bennett. "Getting Clean Water Into Homes." *ThisDay* [Lagos] 1 Feb. 2014: 49. Print.
- Okoye, Victoria. "On Clean Drinking Water in Lagos: Many Options, Few Solutions." *Sustainable Cities Collective*. August 8, 2012. Web. 09 Apr. 2014.
- Okparaocha, Chukwuma. "Surrounded by Water, None to Drink. Plights of Lagos Residents on Potable Water." *Nigerian Tribune*, April 16, 2013. Web. 09 Apr. 2014.

- Oyegoke, S. O., A. O. Adeyemi, and A. O. Sojobi. "The Challenges of Water Supply for A Megacity: A Case Study of Lagos Metropolis." *International Journal of Scientific & Engineering Research* 3.2 (2012): 1-10. Print.
- Pamacheche, Fudzai, and Baboucarr Koma. "Privatization in Sub-Saharan Africa - an Essential Route to Poverty Alleviation." *African Integration Review* 1.2 (2007): 151-71. Print.
- PM News. "World Water Day: Lagos Targets 733 Million Gallons Of Water In 2020." March 21, 2011. Web. 09 Apr. 2014.
- Rosenthal, Elisabeth. "Nigeria Tested by Rapid Rise in Population." *New York Times* (New York), April 15, 2012. Web. 09 Apr. 2014.
- Siemens. *Africa Green City Index: Lagos*. 2013. Web. 09 Apr. 2014.
- Stimson. The Stimson Center. *Lagos: Growth Without Infrastructure*. Washington, D.C, 2009. Web. 09 Apr. 2014.
- ThisDay. "Nigeria: Government to Hand Over Power Assets Tomorrow." AllAfrica, 31 Oct. 2013. Web. 09 Apr. 2014.
- TRWA. Texas Rural Water Association. Texas, USA. *Reducing Unaccounted for Water*. By Larry Bell. Texas Commission on Environmental Quality, 15 Aug. 2006. Web. 9 Apr. 2014.
- Unicef. STANDARDS ORGANISATION OF NIGERIA. *Nigerian Standard for Drinking Water Quality (NSDWQ)*. Unicef, 5 Apr. 2007. Web. 09 Apr. 2014.

- United Nations (UN). *City Profiles: Lagos*. Web. 09 Apr. 2014.
- UNDP. *Water Governance Facility*. Rep. United Nations Development Programme (UNDP), 15 July 2013. Web. 09 Apr. 2014.
- Vanguard. "Water Crisis: As borehole becomes ticking timebomb?" *Vanguard* (Nigeria), May 29, 2012. Web. 09 Apr. 2014.
- Water Incore. "'Sustainable Water Management through Common Responsibility Enhancement in Mediterranean River Basins'." *European Regional Development Fund* Sept. 2011. Web. 9 Apr. 2014.
- The World Bank (2002). "Resources for Water: Unaccounted-For-Water." The World Bank, 10 Jan. 2002. Web. 09 Apr. 2014.
- The World Bank (2008). *Groundwater in Urban Development: Assessing Management Needs and Formulating Policy Strategies*. By Adrian Lawrence, Brian Morris, and Stephen Foster. 390th ed. Vol. 23. Washington, D.C: World Bank Technical Papers 390, 2008. Print.
- The World Bank (2010). *New Project to Bring Clean Water to 50,000 Households*. Washington, D.C, 2010. Web. 09 Apr. 2014.