

**PUBLIC WATER SUPPLIES, WATER POLICY AND MANAGEMENT OF
MULTIFACETED WATER RESOURCES IN MATHARE SLUMS,
NAIROBI CITY COUNTY, KENYA**

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DECLARATION

This research project is my own original work and has not been presented for any award in any University.

Patrick Ouma Obunga - L50/21619/2019

Date

This research project has been submitted with my approval as the University supervisor.

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DEDICATION

This work so far is dedicated to my spouse, Caroline Anyango Ouma; Our sons Hempstone, Humphrey, Mark (the late) and Teddy Wallace; and finally to my boss and mentor Prof. Tom Peter Ogada who is the Executive Director of ACTS and Chairman of NACOSTI for their unwavering support both emotionally, socially and financially.

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ABBREVIATIONS AND ACRONYMS

ACTS	: African Centre for Technology Studies
GoK	: Government of Kenya
IBRD	: International Bank of Reconstruction and Development
JMP	: Joint Monitoring Programme
KNBS	: Kenya National Bureau of Statistics
MDGs	: Millennium Development Goals
NACOSTI	: National Commission of Science Technology and Innovation
NCWSC	: Nairobi City Water and Sewerage Company
NGOs	: Non-Governmental Organizations
SDGs	: Sustainable Development Goals
SP	: Strategic Plan
SPSS	: Statistical Packages for Social Sciences
SSIPs	: Small Scale Private Partnerships
UN	: United Nations
UN-DESA	: United Nations –Department of Economic and Social Affairs
UNFPA	: United Nations Population Fund
UNICEF	: United Nations Children’s Fund
UV	: Ultraviolet
WASH	: Water Sanitation and Hygiene
WASREB	: Water Services Regulatory Board
WB	: World Bank
WHO	: World Health Organization
WRA	: Water Resources Authority
NRW	: Non-Revenue Water
WSPs	: Water Service Providers
WSTF	: Water Sector Trust Fund

ABSTRACT

The statement of the problem of the study was to investigate the water supply sector which appears to focus more on supply oriented provision that is done through expansion of physical access instead of focusing beyond just the physical access, but be extended to maintaining dignity, protecting people's health, and preventing extra costs that could be used in catering for other basic needs. An ideal model is the centralized piped water supply system which delivers potable water to premises and piped water is by far the most efficient technological outlet that delivers water to densely populated slum settlements and this technology is the long term goal for water supply sector development. The purpose of the study was to assess and gain deeper understanding of the extent to which public water supplies, water policy influence management of multifaceted water resources in Mathare slums, Nairobi County. The objectives of the study were; to establish the extent to which sources of water supplies influence management of Multifaceted water resources in Mathare Slums, Nairobi County; to determine the extent to which treatment of water and storage influence management of multifaceted water resources in Mathare Slums, Nairobi County; to examine how distributions of water to users influence management of multifaceted water resources in Mathare Slums, Nairobi City County; to assess how water policy influence management of multifaceted water resources in Mathare Slums, Nairobi City County; and finally, to determine the extent to which public water supplies influence management of multifaceted water resources in Mathare Slums, Nairobi City County. The study employed descriptive design with a sample of 413 respondents consisting of the target population of 398 households and 15 focus group discussion drawn from 74,967 households and those organizations managing water resources was conducted to gather additional qualitative data on the research project on those managing water resources that formed the focused group discussion and included Nairobi City Water Sewerage Company, Water Resources Authority, Water Services Regulatory Board, Mathare – Kosovo Water Supply (NGO), Water Sector Trust Fund, Pamoja Trust (NGO), Area Chief/ Assistant Chief and Water kiosks owners/ operators. The study used stratified random sampling for the six strata mapped out due to the nature of the population under study. The study used primary data collected using questionnaires and secondary data gathered from existing literatures, books, articles, journals, and online sources. The study used correlational and descriptive analysis of data aided by use IBM® SPSS version 20 and Microsoft Excel to analyze data, present and interpret the findings of the study. The study found that there was improved water access/supply, though more sensitization on treatment and storage still required, water distribution infrastructure requires more management attention, resident also need more awareness creation on pro-poor water policy and finally holistic urban water management strategy noted to be critical in the management of multifaceted water resources. The study concludes that extending access to piped water requires data for coordinated low settlement urban planning, increased investment in water infrastructure and maintenance and good governance. This can be realized through extending formal piped network with the goal of meeting universal access to piped water to the resident plots; addressing context-specific of intermittent water supply, using technology to detect leaks, and improving regular infrastructure maintenance to reduce leaks; pursuing diverse strategies to make water affordable with special consideration to the slum dwellers (pro-poor policy); and lastly, supporting informal settlement upgrading to improve water access. The study recommends that water resources management should be prioritized to increase the amount and quality of available water but good water resources management is essential to ensuring sustainability and resilience. Good water governance to ensure adequate supply of water where interventions such as strengthening policy, institutional and regulatory frameworks. Further research on opportunities and prospects of different policies & institutional arrangement for improving urban water access; how social & power relations between different actors influence who has access to water in slum areas; and finally, on the concerns of worsening water quality and water pollution that reduce the suitability of low water levels.

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

The emergence of human settlements around the availability of fresh water sources is evidenced in many parts of Nairobi City. In the history of humanity, development and nourishment of cities and urban towns of economic and socio-cultural activities caused about the logistical challenges of sourcing/ fetching water from distant sources. By 2030, the projection of cities population will be almost five billion people, with 80% of them concentrated in developing nations, especially in Asia and Africa (UNFP 2007). Apparently, water supply sector has focused largely on supply oriented provision through expansion of physical access. However, the objectives of providing a water supply goes beyond just the physical access to also rather to maintain dignity, protect people's health, and avoid the extra costs that could be spent on other basic needs. Poor water supplies have for a long time associated with water-related diseases, exposure to chemical as well as other indirect health impacts caused by reduced productivity and poor personal hygiene (Hunter et al., 2010). Nevertheless, Mehta et al. (2007) argue that it's not enough to enhance physical access as one should also consider "functionality", which refers to the extent to which access makes it possible for people to gain positive personal, economic and social outcomes.

A centralized piped water supply system which supplied premises with potable water is seen as the most ideal in the supply and distribution oriented provision (Furlong, 2014). Piped water, which is used to provide water to densely populated areas, has been proven by far to be the most efficient technological outlet in the water supply sector development and remains the long-term goal. However this infrastructure ideal is a hard earned luxury to more than half of the population of developing countries, where only 48% of the population had access to piped water by 2012 (UNICEF & WHO, 2014). The public sector manages a larger part of many centralized water networks where there also exist many diverse institutional arrangements that make up the "alternative" provision systems.

This research project highlighted what is beyond physical access to potable water in slum areas and focused on the complexity of safe drinking water provision. This included the functionality of water, the outcomes of water provision, and other available diverse range of provision

provided by the non-government organization commonly referred in this research as “multifaceted access to water resources”.

Urban water problems are partly driven by the increasing demographic pressures, including rural to urban migration and distorted rural to urban fringes are to partly blame for the urban water problems. Nairobi has experienced a steady urbanization with a rate of about 4 % annually, which is projected to make up for the 4.5 million urban inhabitants by 2025 (KNBS, 2019; NCWSC Strategic Plan 2014/15 – 2018/19). With a total population of 4,397,073 (KNBS, 2019), it is inevitable for Nairobi City, which attracts tourists and job seekers alike, to experience rapid population growth. This growth must be accompanied by a major improvement in water supply provision, a responsibility that the city government is responsible for. Nevertheless, provision of drinking water service especially for the low income community in urban slums of the city is majorly hindered by poor governance. The evidence of these failures noted by limited available piped water service, illegal connections, lack of adequate quality, quantity, and continuity of water; a high cost burden to the poor; as well as a low trust in public service providers.

There are limited studies linking aversion behaviors with other dimensions of access such as physical access, quantity, continuity, and affordability. Regarding aversion to unsafe water, Um et al. (2002) describes about three steps that emerge at the end of a generic process. First, exposures of household to water supply perceived to contain a high level of contaminants, which may endanger health. Second, household perceptions lead to non-action or choice of actions that may reduce the perceived risks. Finally households may make a decision on the level of action required in order to obtain a level of risk that is acceptable. A study that examined the risk of arsenic exposure came up with a conclusion that risk beliefs are socially constructed and is caused by everyday interactions, personal experience, local knowledge, and social networking (Chappells et al., 2015). However, there are scarce similar studies that provide a broader scope of dimensions of access. It therefore not clear how perceptions emerge, and how (and why) such perceptions lead to decisions that inform particular behaviors to avert risk and loss.

The last decade has seen a lot of discussions regarding bottled water being a direct substitute of piped water. The debate was prompted by the growing distrust of the quality of piped water (Parag & Roberts, 2009 and Saylor et al., 2011). The status of bottled water in northern countries has need elevated to better quality option compared to piped water regardless of them maintaining a robust piped water service. Viscusi et al. (2015), observes that according to some

critics, bottled water consumption was based on the irrational perceptions of consumers and that bottled water wasn't as superior as it was perceived. Contrary to the condition of northern countries, majority of residents in southern countries such as Kenya treat piped water services as a luxury. This is due to the distinct development trajectory where there has been no planning, designing and building network for the majority of the populace (Kooy & Bakker, 2008) and this case is typical of Nairobi. Piped water supply was provided originally for the white European population and other high social classes such as local elites and the colonial civil , while traditional water sources such as surface water and shallow well was used by others who were regarded as people of lower status for domestic purposes, including drinking.

In order to cope with these deficiencies and get adequate supply of water, household can rely on multiple modalities including employing multiple water sources in order to match source with intended use (Neumann et al., 2014). Generally in Nairobi households are forced to combine piped water with (un)improved water sources, including water from vendors, or bottled water. Official statistics fail to capture these facts such that coverage tends to overestimate the number of households having full time access to full time improved water sources on a full time basis, while the number could actually be lower than reported. Secondly, equity doesn't just mean varying levels of access across socioeconomic groups. Abubakar (2016) suggested that it provides a biased level of performance and an exaggerated level of accomplishment when one concentrate only on equity of access. Equity also means access to water, in an economical manner, for the poorest segment of the population. According to the principle of equitable access, it should be affordable to all those paying for water service. According to United Nations, (2017) the poorer households are burdened unlike their richer counterparts and should be protected by subsidizing for them water expenditures and that water related cost shouldn't hinder a person from access to safe water and in the process his/her other basic rights shouldn't be compromised. It's suggested that the poor in urban slum areas pay much more than those in rich household, for a litre of water purchased from private vendors (UNICEF & WHO, 2011; 2013; 2015 & 2017). In order to check on affordability, there is need for a clear measurement of the cost of varying water cost across the different income level to ensure affordability. Water related costs are often measured. The expenditure of connection of water utility as well as water consumption is used to measure water related costs.

Over time, there has been a debate of over the involvement of private actors in water supply. The late 1980s marked a departure that saw involvement and investment of private actors in urban water supply network (Prasad, 2006). Conditions to international financial institutions and donor agencies required that private actors be integrated so as to help achieve efficiency in service as well as better form of governance in comparison to 'low level equilibrium' services offered by the state whereby low efficiency results to low quality service (Prasad, 2006). However, participation of private actors' is perceived to lead to violation of human right to water since the private actors operate to recover full cost by charging user fees and further making profits. For instance, Karanja, (2018) observes that the participation of private sector in supply of water service in the capital city of Nairobi may not automatically influence on the reduction of tariffs and increase water affordability. This results into further exclusion of the poor from basic water services due to their inability to afford paying for the water. For the poor, the small-scale private providers (SSIPs) are seen as increasingly assuming the role as the dominant providers. This water vending methods is no longer a fringe activity since it account for a large proportion of total water revenues (Gulyani et al., 2005).

This research project has based its foundation on a multidisciplinary perspective which included water resources and environmental engineering, project planning & management, psychology, economics and governance studies. Since the 1980s, knowledge bases on water and sanitation technologies have been well established. The first international water and sanitation decade dealt largely on hardware solutions and up to now, the perspective of technocrats has greatly been seen to try and fix universal water problems (Mehta et al., 2007). A multidisciplinary view, as a central issue of this research project, was crucial for better comprehension of the multifaceted access to water supply. The scope of multifaceted access to water, as mentioned earlier, included physical access (together with issues of water quality, quantity, continuity, affordability, and equity dimensions), the several health issues as well as economic impacts resulting from water supply provision and the diverse range of water provision structures and governance.

Application of a diverse and appropriate water and sanitation technologies, water quality and quantity assessment and advanced water purification was seen as a potential way of solving water supply problems through an engineering and project planning and management approach. The perspective adopted in this research project was valuable in digging out issues ranging from the various types of infrastructural access to water, water quality and quantity, as well as

continuity dimensions in water supply. Traditionally, studies related to public health issues of the water challenges focused more on linking health issues to poor water supply service. This perspective was critical in order to have deeper perspectives associated with impact on health of the different types of behavior towards water and its access. Additionally, in assessing water problems, project managers put more focus on choice and aversion behaviours modeling, cost-benefit analysis, as well as water tariffs; in analyzing affordability, water management and expenditure and equity issues, the principle and approach of this discipline was essential in this research project. Moreover, social psychology studies focused more on the motivation, perception, belief, and behaviour in the WASH sector. The socio-psychological and economic perspective was vital to create an understanding of the choices and behaviors of the citizens, which, besides dealing with health and other motives also dealt with economic rationales. Meanwhile, water governance scholars put more emphasize on the political and institutional aspects of water supply, an important aspect when analyzing the treatment & storage, water distribution to users and the general structure of water supply provision,

Provision of drinking water in close proximity to dwellings is an important solution to preventing excessive collection time. Water must be free from contaminants which pose personal health risk to individuals. Water should be sufficient and in continuous supply for drinking and hygienic use. Finally, water costs should not prohibit a person from accessing safe drinking water and shouldn't limit him or her from enjoying other fundamental rights (United Nations, 2007). These are called "the dimensions of access" (Nganyanyuka et al., 2014). Along with any of these dimensions, the lack of access to adequate water supply to meet basic needs of individuals expose households to risk of exposure to preventable diseases as well as impoverishment. This study aims at assessing and gaining a deeper understanding of the complex realities of water supply mechanisms in urban slums through the study of individual households and collective strategies to ensure access to safer and more reliable water provision, water treatment and its storage and distributions.

1.2. Statement of the Problem

Mathare low income settlement, with a population of 206,564 people and 74,967 households has faced a range of social and health problems, ranging from gang violence, cholera outbreaks and collapsed buildings due to unplanned developments which have denied residents access to basic amenities. Though Mathare settlement has been connected to clean drinking water lines to some

extent, and a lack of sewer lines has seen the high-rise buildings emptying their wastewater into Nairobi River. Much of the public spaces including land reserved for road expansion, riverbanks and public amenities have been grabbed and sold off by individuals in collusion with land officials. Its population increase has been largely due to the continued influx of job-seekers in the city due to the cities growing population, which is estimated to be approximately 4.4 million persons and a population growth rate of 4% annually (). This was an indication that unless appropriate and urgent strategic measures taken by the government, then the Kenyan Vision 2030, 2030 Sustainable Development Goals and 2063 Agenda for Africa might not be tenable in the Kenyans' context.

Using the access metric, one hundred and sixteen countries have achieved the global drinking water target set by the Millennium Development Goals (MDGs)' (WHO & UNICEF, 2014). There has been a growing concern that access will not always result into water safety and sustainability as set out in the MDGs Target 7c. Although WHO & UNICEF (2013) reported that 89 percent of the population in the developing world has gained access to improved water sources, service quality issues have yet to be resolved. Access to water is one of the biggest issue facing urban areas. The growth of urban population presents a major challenge to the supply of water by raising the demand for clean water. While 96% of urban populations have access to improve water supplies (WHO & UNICEF, 2013), issues of poor water quality, intermittent supply, inadequate disinfection, and aging and damage to infrastructure remain (Lee & Schwab, 2005). Urban residents are also forced to rely on more expensive sources of water, such as bottled water or more contaminated.

This research project aimed to discover and address questions about how risk attitudes, beliefs and expectations about loss and damage arise and how people operationalize them on daily basis by exploring how households were coping with poor water supply. Inadequate water supply in Mathare urban slum settlements remains one of the primary problems in the city of Nairobi. Water adequacy assessments comprise of the different aspects of water availability, physical access, efficiency, quantity, consistency and affordability of which this study focused on.

1.3. Purpose of the Study

The research project was to assess the level and extent of public water supplies, water policy and management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya.

1.4. Objectives of the Study

The research project was guided by the following objectives:

1. To establish the extent to which sources of water supplies influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya.
2. To determine the extent to which treatment of water and storage influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya.
3. To examine how distributions of water to users influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya.
4. To assess how water policy influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya.
5. To determine the extent to which public water supply influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya.

1.5. Research Questions

1. To what extent do water supplies influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya?
2. To what extent do treatment and storage of water influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya?
3. How do distributions of water to users influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya?
4. How does water policy influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya?
5. To what extent do public water supplies influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya?

The overall aim of this research project was to capture the multifaceted characteristics of the water treatment, supply distribution and storage, with its high proportion of information arrangements and heterogeneous behaviours. This was prompted by Mehta et al. (2007) declaration: “Policy debate often remains disconnected from the everyday experiences of poor and marginalized women and men and was at odds with the framings held by local water users”. Therefore, the focus of the research project was on what is “beyond access”, highlighting users’ perceptual drivers and their everyday experiences in producing their drinking water supply,

through individual strategies or collective efforts and their linkage to monitoring and policy as well as the different side of continuous access to water in the slums.

1.6. Significance of the Study

The study expected to contribute to the development of knowledge on suitable strategies for multifaceted water supply and distribution in the urban slums in terms of water functionality, water supply outcomes and a diverse range of NGOs provision systems in project planning and management. This might enhance the attainment of the Kenyan Vision 2030, 2030 Sustainable Development Goals (SDGs) and 2063 Agenda for Africa. The findings of this research project might be used to make recommendations to the Nairobi City County government and or Nairobi City Water and Sewerage Company (NCWSC) and National government water works development agencies (9) under the Ministry of Water, Sanitation and Irrigation; other policy makers and relevant stakeholders on the appropriate measures that can be instituted to mitigate daily risks with regard to dimensions of inadequate access to and supply of water (Quality, Quantity, Continuity and Affordability), how to mitigate health risks and potential economic losses through slum aversion behavior . Finally, the findings expected to add to the already existing academic and general knowledge documents to the public for purposes of project planning, design, implementation and management.

1.7. Basic assumptions of the Study

It is postulated that the variables of the research study will not vary or change in the course of the research period and hence will inform and ascertain the acceptability and ownership of the findings. Next is that the sample size and sample population must be adequate to help in drawing valid and reliable deductions and the final assumption is that the respondents will be honest, willing and committed in giving the required data and or information for further synthesis.

1.8. Limitations of the Study

The research project collected responses from 398 households in Mathare Slums which were highly/ densely populated with poor accessibility networks and normally worsen when it rains. This called for ample time and competitively recruited four research assistants who were engaged to assist in the administration of the questionnaire. Secondly, Mathare Slums are quite unsecured with numerous cases of mugging and such like crimes happening on daily basis and was mitigated by booking and securing appointment with the local leaders and administration such as assistant chief and chief who provided necessary security and also necessary intelligent

security information. The changing weather conditions as a result of heavy rains and with poor road networks and drainage systems (Sewer lines) in the area that could have impeded effective, efficient and timely gathering of data/ information from the respondents. The study was confined to Mathare slums and generalization of the findings and recommendations might not be applicable or replicable to other parts of Kenya. Finally, another likely limitation was the fear of management staff of the institutions interviewed in giving information about the organization and this was managed by engaging the respondents in verbal discussion to clarify the intention of the study.

1.9. Delimitation of the Study

This research project was conducted in Mathare slums which are the second largest slum after Kibera in Nairobi, Kenya with a population of 206,564 people, 74,967 households and an average household size of 2.7(KNBS, 2019) and the sample size for the project was 398 households with average population of 2.7. The scope of the study was confined to Mathare slums because of its attractiveness to government and non-governmental organizations interventions with focus on water projects. Few studies have been conducted in Mathare as compared to other slums such as Kibra, Korogocho and Mukuru Kwajenga. The research work also mainly focused on the functionality of water, the outcomes of provision and the diverse range of non-government and government provision systems.

1.10. Definition of significant terms used in the Study

The following are the definition of the key terms used in this study:

Sources of Water Supply: Water supply by public utilities, private organizations, community projects or by individuals, usually through a network of pumps and pipes, delivery through push carts with tanks or drums, water bowsers, water kiosks etcetera and as per the JMP classification there are three sources namely improved, other improved and unimproved. The indicators are the numbers of improved, other improved and unimproved sources.

Treatment and Storage of Water: Household water treatment and safe storage (HWTS) is an important public health intervention aimed at improving drinking water quality and reducing water-borne disease, especially among those who rely on water from unimproved sources, and in some cases, unsafe or unreliable supplies of piped (improved and other improved sources). The indicators are the number of households treating (and the treatment method) and safe storage for drinking water.

Distribution of Water to Users: The aim of distribution is to supply water with the proper quality, quantity and pressure to the consumer. Distribution network is used to collectively define the facilities used to transport water from its source to the point of usage. The indicators include a network of pumps, metered and unmetered pipelines connections, storage tanks, and other appurtenances. Also the number of push carts with tanks/ drums, water bowsers/ tankers, water kiosks.

Water Policy: The passage of 2010 Constitution of Kenya has had a range of consequences for the water sector. Constitution primarily recognizes access to clean and safe water as a basic human right and assigns the responsibility for the provision of water supply and sanitation service to 47 existing. The water act of 2002 and reviewed water act of 2016 is key in this study. The indicators here include level of awareness by the residents on the provisions and right to clean and safe water.

Management of multifaceted water resources: These are the practices put in place to ensure proper administration of water resources (Improved, Other improved & Unimproved) such as data related to water; reforms in water governance; coordination of urban (informal settlement) demand; and empowering the poor and women in water resources sector. Management generally is a set of principles relating to the functions of planning, organizing, directing and controlling, and the application of these principles in harnessing physical, financial, human, and informational resources efficiently and effectively to achieve organizational goals.

Access to Water: Access to water is defined as having some types of “improved” water sources at home. Access is often measured by the percentage of the population using improved sources of drinking water.

Aversion Behaviours: Actions households take to mitigate pollution related damages. Here we extend the scope of aversion behaviours not only with actions seeking to avoiding health risk, but also with strategies aimed at reducing uncertainty and avoiding economic loss. This will be measured by the number of households that treat water and use safe storage.

Bottled Water: This is mineralized and demineralized drinking water produced by beverage companies. The bottled water industry is tightly regulated by the GoK and adherence to a quality assurance standard to ensure safety. The measure is the percentage of households using bottled water.

Co-Production: Scholars mostly use the term “co-production” in the context of the partnership between state and non-state actors in the development of public service. Here the notion refers to the partnership between private actors, community actors, and households in providing water supply, treatment, storage and distribution to users.

Dimensions of Access: Different water supply aspects: physical access, efficiency, quality, quantity, continuity, and affordability. Drinking water should be delivered near to dwellings while avoiding unnecessary collection time. Water must be free from contaminants which pose a health risk to a person’s health. Water should be sufficient and continuous for drinking and maintaining hygiene. Water related costs should not prohibit individuals from accessing and consuming safe drinking water and shouldn’t limit them from enjoying other fundamental rights. The concept of equity falls within the notion of the dimensions in the post 2015 water framework.

Other improved Water Source: Other improved drinking water source is defined as one which is likely to be protected from outside contamination, in particular from contamination with faecal matter, by the nature of its construction or by active intervention. Improves water supply, in the JMP water ladder, consist of piped water on-premise piped water, well dug protected well, borehole, rainwater harvesting, and protected spring.

Piped Water on Premises (Improved): This is water provided by the Nairobi City Water & Sewerage Company, which delivers water through a piping network directly to houses/ plots.

Unimproved Water Source: Unimproved water sources include: unprotected dug well, unprotected spring, surface water (river, dam, lake, pond, stream, canal, irrigation channel), vendor-provided water (cart with a small drum or a tanker truck), bottled water (classified as unimproved due to the issue of sustainability, bottled water is considered improved when the household use another improved source for cooking and personal hygiene).

Public Water Supplies: Fundamentally, a water supply system can be described as consisting of three basic components: the source of water supply, water processing or treatment, and water distribution to the users.

1.11. Organization of the Study

This research project was organized into five chapters. Chapter one of the study comprises of background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, assumptions of the study, limitations of the study, delimitations of the study, and definition of significant terms used in the study. Chapter two of the study covers brief introduction, themes of the objectives, theoretical and conceptual framework, summary of literature review and finally knowledge gaps in the literature. Chapter three consists of brief introduction, research design, target population, sample size & sampling procedures, research instruments, data collection procedures, data analysis techniques, ethical consideration and lastly operational definition of the variables. Chapter four of the study focuses on data analysis, presentation, interpretation and discussion. Chapter five is the last chapter and presents the summary of findings, conclusions, recommendations and suggestion for further research. These are then followed by references and appendices sections.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter presents a review and or analysis of both theoretical and empirical studies on the elements of public water supplies, water policy and management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya. The specific variables under study are sources of water supply, treatment & storage of water, distribution of water to users, water policy, and management of multifaceted water resources. Theoretical framework, conceptual; framework, summary of literature and finally knowledge gaps also covered under this chapter.

2.2. Management of Multifaceted Water Resources

Water management has been a challenge in Kenya through decades. One of the main challenges is the perception that water should be a government provided commodity and service for free. What this has generated is the lack of willingness to pay to pay for water that is one of the causes of increase in Non-Revenue Water (NRW) in Kenya. This has caused a situation of unsustainable water institutions in the county and country at large due to the country's lack of or inadequate income from water. It has been reported that NRW accounts for about 42 per cent of the country's water.

Using the Mathare Slums case in Nairobi, this objective aimed to understand the multifaceted management strategies that vulnerable urban households use to secure access to a safe and adequate water supply and distribution. This objective also discussed the two sides of a coin in drinking water supply and distribution to users: access and quality of service. The study was descriptive in nature, and used to investigate multifaceted user strategies and surveillance. Howard et al. (2002) discussed the implications of strategies for mixed water sources and used differentiation for the monitoring programs. This research project addressed further suggestion for integrating user strategies in ensuring access to clean water into the water supply and distribution chain monitoring approach of the post 2014/15-2018/19 NCWSC Strategic Plan implementation framework.

Higher mitigation costs have always been associated with wealthier households because they have more resources to spend on water treatment, storage, and purchases. This then begs the question, to what degree poor or absent public water supply is burdening households. The

researcher assessed the access to water and household water expenditure in different income groups through data extracted from a household survey in Mathare. The researcher considered the impact of the expansion of piped water access, taking into account mitigation costs, on water expenditure as well as affordability.

Strategies adopted to tackle concerns in the access dimensions were referred to as “aversion or mitigation management behaviours”, that were intended to minimize health and economic risks associated with poor access dimensions. The widely evaluated aversion/ management behaviours are bottled water purchase and household water treatment to avoid health risks associated with safe drinking water (Jakus et al., 2009).

The relationships between inadequacy regarding access dimensions and household strategies are often presented as “aversion behaviours” in literature (Jakus et al., 2009). Even though research attempted to establish a clear relationship between aversion behaviours and perceived health risk, it has not adequately shown how households decide among different aversion. Also limited are studies that link aversion behaviours to other access dimensions (physical access, quantity, continuity, and affordability). Um et al. (2002) described the aversion towards unsafe drinking water emerging at the end of a generic process as consisting of three distinctive steps: First, households are exposed to water sources perceived to contain a high level of contaminants that could endanger their health, second, household perceptions lead to non-action or to a set of actions that could minimize the perceived risks and finally, the level of action required to achieve an acceptable level of risk is decided by households. Bottled water is an enigma around the world. Strict water quality control requirements become the main reason people place high trust in this commodity. On the other hand, many negative environmental and socio-economic concerns characterize the development of bottled water industry. Scholars have suggested that bottled consumption result in high environmental impacts related to extraction, processing, packaging, transport, and disposal (Parag & Roberts, 2009). In this context, it is often asked why people, when they can drink tap water, would opt for an environmentally harmful commodity. It's is therefore not surprising that research has tackled the private rationality of bottled water use (Parag & Roberts, 2009 and Olson, 2013). Bottled water has been discussed as a possible substitute for piped water over the last decade. The increasing substitution of piped water with bottled water was connected to the growing mistrust of the quality of piped water (Saylor et al., 2011). In Northern countries, the status of bottled water has been elevated to such a degree which

maintains a robust piped water service, that it is seen as a better quality option than piped water. Some critics believed that bottled water consumption was based on the consumers unfounded belief that bottled water was not in any way superior to piped water (Viscusi et al., 2015). Unlike the Northern countries situation, piped water services are a privilege for most residents in southern countries like Kenya. This difference can be due to a distinct development trajectory where the networks were never planned, configured and developed for the majority (Kooy & Bakker, 2008). Originally, piped water was given to citizens of the higher social classes: the white European population, colonial civil servants and local elites, while people of lower status rely on traditional sources of water such as shallow wells and surface water for domestic purposes, including drinking.

Marks (2012) conducted a study on “*Water System Sustainability in Sub-Saharan Africa: Participation, Sense of Ownership & Performance.*” Empirical data for this investigation were collected in 50 communities throughout rural Kenya. Data sources included in-person interviews with 1,916 households, 312 water committee members and 50 system operators, and technical assessments of each water system. The determinants of households’ sense of ownership for their water system are investigated using regression analysis, with a particular focus on different forms of community participation in the system’s planning and construction. Households’ involvement in making decisions about the level of service obtained and making larger (non-token) cash contributions are each associated with a high sense of ownership for the system. Labor contributions are associated with a moderate sense of ownership. Other significant covariates of sense of ownership include regular use of a working tap on the premises and a household member having served on the water committee. No association is found between sense of ownership and small cash contributions, education level, or broader leadership responsibilities within the community. At the community level, households’ and water committee members’ sense of ownership for the water system is found to be inversely related. Water system sustainability (as measured by infrastructure condition, system management, and users’ satisfaction) is modeled as a function of both group’s sense of ownership for the system. All are held constant; condition of infrastructure is positively associated with the sense of ownership of water committee members, while perceptions of users and system management are positively associated with ownership of households. The study in Kenya provided empirical framework for sense of ownership of communal water system, and demonstrated that some (but

not all) types of community participation are associated with greater sense of ownership. These findings also show that that sense of ownership of the system is heterogeneous across different groups within a the society, and the sense of ownership of different groups for different aspects of sustainability of the system. The results contradict the bulk of existing rural and slum water planning literature, which indicates a strong and optimistic relationship between community engagement, the sense of ownership of households for the system and sustainability of the system.

Another study by Priyan (2009) on data was collected through household surveys, interview and personal observations. The focus of the study was to attempt to investigated how collective action by various actors especially women influenced project effectiveness in community-managed urban water supply systems in three Indian cities. Participation operationalization was based on Community Water and Sanitation Committee (CWASC) that was established in each city with support of various organizations responsible for the planning, design and implementation of water supply system. The user committee was also responsible for collecting user fee for O&M. The progress operationalization was tied to attitudes, behaviors and experiences of both providers and users; evaluation of water supply situation in the three study areas; agency user relations; as well as the level of involvement of women. The key findings were institutional management that either impedes or facilitates community-level collective action and thus influences project effectiveness; government and community partnership does lead to a boost in project effectiveness; and women involvement was found to be critical within collective action institutions such as user committees.

Sara and Katz (1998) also reviewed 125 community based water projects in 6 countries and the focus of the study was on Primary hypothesis “water supply services which are demand responsive are more likely to be sustainable than services which are less demand responsive”. The operationalization of participation was operationalized as willingness to pay on demand responsiveness, priority making and informed decisions. The successful operationalization was based on physical condition, consumer satisfaction, operation and maintenance (O&M) practices, financial management and ultimately the willingness to sustain the system. The main findings were demand-responsiveness increases sustainability and that when projects followed a demand-responsive approach, sustainability is higher in communities if put differently.

An empirical study conducted by Otieno (2010) on access to water in Huruma area and one of his findings was that high water costs is posing greatest challenge affecting water access and provision to the residents. The researcher also further identified leaking water pipes, illegal water connections and harassment by the administrative authorities. This could be localized problem but cuts across most of the neighboring estates and even other estates in Nairobi City.

Based on these empirical studies and the theoretical reviews which are relevant to this study, the researcher assessed the underlying issues in management of multifaceted water resources in Mathare Slums in Nairobi City County, Kenya.

2.3. Sources of Water Supply and Management of Multifaceted Water Resources

In this research project objective, physical access to water sources refers to the WHO classification and Joint Monitoring Programme (JMP) of UNICEF, the mechanism for monitoring progress in the water and sanitation sector of the United Nations. The three step ladder of the JMP which indicates the classification of water access levels (UNICEF & WHO, 2008). Bottled water is considered “improved” only if water originates from some kind of improved source for domestic purposes. The JMP classifies in-house water supply into piped water, other improved as well as the unimproved sources. The layman language of accessing water involves providing certain types of “improved” sources of water at home. “Access level” is also measured by the percentage of the population utilizing enhanced or improved sources of water. At the global level, the current monitoring framework focuses on measuring the level of access: the proportion of unserved, underserved to be served by improved source of water. These classifications merely serve as a proxy indicator and only encapsulate household water technological outlets and do not equal safe water (UNICEF & WHO, 2011). Physical access may not necessarily result in the continued use of improved water sources nor bring the intended development outcomes such as health and economic benefits.

Access dimensions come in with different quality, quantity, continuity, and affordability range (Nganyanyuka et al., 2014). Even if people have access to piped water, it often has inadequate quality and quantity, is intermittent, or cannot be afforded (Tshikolomo et al., 2012). The question of water quality is the most widely studied factor. As shown in the empirical studies cited below, these studies show that water supply does not meet the requirements of good access dimensions even in the improved form. Meanwhile, since the United Nations General Assembly explicitly recognized the human right to water and sanitation through Resolution 64/292 and the

ratification of SDGs (Sustainable Development Goals) in September 2015, equity has entered the "playing ground." The question about inequality lies primarily in the unequal development across populations, based on income, location, type of area (rural / urban), and the marginalization of the poorest (UNICEF & WHO, 2011). Drinking water supply and distribution in low and lower middle income countries such as Kenya often fails to meet physical access, quality, quantity, continuity and affordability requirement (Bain et al., 2014). The lack (or absence) of an adequate centralized water supply and distribution inevitably shifts the responsibility for obtaining a safe and reliable supply to households.

Chepchirchir, Janezic & Leuchner (2015) conducted an empirical study on “*Sustainable Supply of Safe Drinking Water for Underserved Households in Kenya: Investigating the Viability of Decentralized Solutions.*” The authors noted that water quality and safe water sources are pivotal aspects of consideration for domestic water. Focusing on underserved households in Kenya, the study compared user perceptions and preferences on water-service provision options, particularly investigating the viability of decentralized models, such as the Safe Water Enterprise (SWE), as sustainable safe drinking water sources. Results showed that most households regularly imported their domestic from more than one source among the variety of water-service provision options available and majority of households perceived their source of water sources as unfit for drinking. Drinking water was primarily chlorinated or boiled for this reason. However also found that Kenyan households did not consistently apply these methods of treating household water, thus indicating inconsistency in water use consumption. The SWE idea, a community-wide decentralized safe source of drinking water, was favored choice for household that viewed it as time-saving and less difficult than boiling and chlorination. Willingness to pay for SWE water has also seen a good predictor of underserved households’ desire for it. However, the long-term applicability of such decentralized water supply models needs to be further explored in the context of wider water supply

Sumila et al (2005). Conducted an empirical study on “*Water for the Urban Poor: Water Markets, Household Demand, and Service Preferences in Kenya.*” The author compares how inadequate the urban poor are served by public utilities and small-scale private water suppliers compared to the non-poor. The study analyzed water usage and unit costs in three Kenyan towns, based on a survey of 674 households, and also evaluated the ability of the unconnected to pay for piped water, yard connections, or an enhanced water kiosk (standpipe) service. By

examining the water-use behavior of poor and non-poor households, the study questions a long-standing notion in literature that the poor are underserved, use small amount of water, and pay a higher unit price for it. It also suggest that the standard prescription for “price water and create water markets” is inadequate in itself to improve service delivery and that without adequate institutional arrangements, technological solutions such as water kiosks that fail to deliver an affordable service to the poor.

Another study by Karanja (2018) focusing on *Factors Influencing Water Services Provision in Kenya: A Case of Nairobi City Water and Sewerage Company*. The study investigated factors that influence water service provision in Nairobi County. The research design used was descriptive survey. The target population was the staff working in Technical Directorate and specifically those in production and distribution departments. A sample size of 267 staff members from the company was selected. The study used stratified random sampling techniques due to the nature of population studied. The study used primary data in the form of questionnaire and secondary data from literature, articles, books and internet sources. The collected data was analyzed by use of SPSS. The study established that there are various sources of water in Nairobi City including dams, rainwater, boreholes, river runoff, weir intakes and springs. However, water treated at the production plant is sufficient only for 68% of the customers in the City. The study found that increase in water sources, efficient water management and improved water supply infrastructure would lead to increase in water services provision while good environmental conditions has a positive relationship with water service provision. The study recommended that the government should consider increasing the water sources, clarity in resources management, increase infrastructure investments in water provision, care of the changing environment in order to continually improve water source provision to enable the Nairobi residents to have access to sustainable safe drinking water and sanitation.

Informed by the three empirical studies above and the theoretical reviews, the researcher proposed to study the underlying issues in sources of water supply and management of multifaceted water resources in Mathare Slums, Nairobi County.

2.4. Treatment & Storage of Water and Management of Multifaceted Water Resources

Lack of dimensions of access may lead to a variety of strategies that households employ (Howard et al., 2002). Boiling, filtrations, application of chlorine as well as ultraviolet (UV) disinfection are considered appropriate treatment methods to improve water quality (WHO &

UNICEF, 2011). Water within households is also common practice if water is not directly delivered or if there is not guarantee of water flow. The unreliable provision of piped water can also force households to construct capital intensive storage tanks which provide reserves of tap water or rainwater (Adekalu et al., 2002). When no other alternative is open, buying water from small scale enterprises becomes a last resort for those who urgently need a safe water supply (Njiru & Albu, 2004).

The relationships between inadequacy over dimensions of access and household strategies were also described as “aversion behaviors” in the available literature (Jakus et al., 2009). Although research has established a clear relationship between aversion behaviours and perceived health risk, it is understood how households decide among various aversion behaviors also limited are studies that link aversion behaviours to other dimensions of access including; physical access, quantity, continuity, and affordability. Um et al. (2002) explained how, at the end of a generic process composed of three distinctive steps aversion to unsafe drinking water emerges. First, households are exposed to a water supply that is considered to contain a high level of pollutants that may endanger health, second, household perceptions lead to non-action or to a selection of actions that may threaten perceived risks and finally, households make a decision regarding the level of action that needs to be taken at an acceptable level of risk. Bottled water is an enigma around the world. Strict requirement for water quality control become the main reason people place high trust in this commodity. On the other hand, many negative environmental and socio-economic concerns generally define the growth of the bottled water industry. According to Scholars, bottled water consumption results in high impact related extraction, processing, packaging, transport, and disposal (Parag & Roberts, 2009). In this context, it is often asked why people, when they can drink tap water, would opt for environmentally harmful commodity.

The lack of physical access does not just affect citizens’ health, but the shortcomings of other dimensions of access may expose urban citizens to various health and economic risks related to water. The problems in the dimensions of access have led to households adopting various strategies. In the use of point strategy, citizens may adopt a broad range of individual and collective strategies in order to achieve safe and reliable water for their daily needs (Allen et al., 2006). Consequently, this research project focused on individualized or household market based strategies and collective strategies. Meanwhile, dependence-based strategies (extending patron client relationships between citizens and government officers), exclusion strategies (related to

crime), and social movement strategies (involving politicized mass action collectively undertaken by citizens) were outside the scope of this research since those strategies are too broad to be discussed in a single research study. Individual strategies consist of individual progress within the opportunities offered by existing structures and systems, whereas collective self-help strategies occur when neighborhood residence facing a common need come together to provide collective goods and services, usually without government. The discovery of multiple water sources, rescheduling activities based on water availability, home water treatment and storage, and even moving to another house with better water services, is classified as individual household strategies for maintaining access to a more secure water supply (Neumann et al., 2014). Citizens in Nairobi are carrying out various methods to acquire water, such as purchasing water from sales kiosks, tanks, vendors; walking long distances; buying from water trucks; buying many storage vessels; harvesting rainwater; domestic water budgeting; and making illegal connections (Rugemalila & Gibbs, 2015).

Using the indicator of access, one hundred and sixteen countries have achieved global drinking water target set by the Millennium Development Goals (MDGs) (WHO & UNICEF, 2014). There has been a widespread concern that access does not always result in water safety and sustainability as set out in the MDGs Target 7c. While WHO & UNICEF (2013) recorded that 89% of the developing world's population has access to improved water sources, there are still unresolved issues with service quality. Water shortage is one of the big problems facing urban areas. The size of urban population poses a huge challenge to the provision of water supply hence increasing the demand for clean water. Ninety-six percent of urban populations have access to improved water sources (WHO & UNICEF, 2013), but the problems of poor water quality, interrupted service, inadequate disinfection, and aging and damage to infrastructure remain (Lee & Schwab, 2005). Urban residents are forced to do make do with more expensive water sources, such as bottled water, or more polluted sources.

Kimani & Ngindu (2007) conducted a study on "*Quality of Water the Slum Dwellers Use: The Case of Kenya Slums.*" Owing to rapid urbanization in a context of economic constraints, the majority of urban residents in sub-Saharan Africa still live in slums characterized by a shortage of basic services including water and sewerage. This study aimed to evaluate sanitary practices of residents of urban slums in Kenyan as well as fecal contamination of their domestic water sources. 192 respondents from Langas slums, Kenya, participated in this cross-sectional study..

Forty water samples were collected from the water sources that respondents used to analyze coliforms in laboratory. Of these 40 samples, 31 came from shallow wells, 4 from deep wells, and 5 from taps. Multiple-tube fermentation technique was employed to enumerate coliform bacteria in water. The study found that majority people in Langas slum (91%) used wells as the main source of domestic water, while the rest used tap water. While most people used excreta disposal pit latrines, a substantial percentage (30%) of children excreted in the open field. Fecal matter heavily polluted the main domestic water sources. The analysis indicates the pit latrines were a major source of fecal matter pollution for wells. Contamination through surface runoff during rains, however, is also plausible, as indiscriminate disposal of excreta was also common, especially by children. The presence of disease pathogens in the water is highly possible due to fecal contamination; thus, the water from the wells in Langas may not be suitable for human consumption. Recommended for addressing this problem is water treatment at community or household level as well as intensive behavioral change in sanitary practices. This community and other slums in sub-Saharan Africa where tap water is not accessible should be provided with regulated tap water. However, it is recommended that more sampling to be done on various water sources

Chepchirchir, Janezic & Leuchner (2015) conducted an empirical study on “*Sustainable Supply of Safe Drinking Water for Underserved Households in Kenya: Investigating the Viability of Decentralized Solutions.*” The authors noted that water quality and safe water sources are pivotal aspects of domestic water consideration. Focusing on underserved households in Kenya, the study compared user perceptions and preferences on water-service provision options, particularly investigating the viability of decentralized models, such as the Safe Water Enterprise (SWE), as sustainable safe sources of drinking water. Results showed that most households regularly source their domestic water from more than one source among a number of water-service provision available. A majority of households perceived their source of water as unsafe for drinking. Drinking water was mainly chlorinated or boiled for this purpose. However, the study also found that Kenyan households did not consistently apply these methods of treating household water, thus indicating inconsistency in safe water consumption. The SWE concept, a decentralized source of safe drinking water on a community scale, was a preferred option among households that perceived it as time-saving and less cumbersome compared to boiling and chlorination. Willingness to pay for SWE water has also been a good indicator of the underserved households.

However, the long-term applicability of such decentralized water supply models needs to be further investigated in the broader context of water supply.

Cook, Kimuyu, and Whittington (2016), also *studied the costs of coping with poor water supply in rural Kenya*. As the disease burden of inadequate access to water and sanitation diminish worldwide, the non-health benefits mainly the time burden of collecting water would likely increase in significance in sector funding decisions and investment analyses. We measure the costs of coping among households in one area of rural Kenya. Sixty percent of the 387 households interviewed collected water outside the home and households spent an average of 2 - 3 hours per day. Cost estimates also include capital costs for storage and collection of rainwater, money paid either to water vendors or volumetric sources, diarrhea treatment costs and drinking water treatment expenditures. Median total cost of coping per month is around US\$20 per month, higher than average household water bills in many US utilities, or 12 per cent of reported monthly cash income. We estimate that coping costs for more than half of households in our sample are greater than 10% of income. They are higher in larger and more affluent households, and households whose primary source is not at home. Even households with unprotected private wells or connections to an intermittent piped network spend money on water storage containers and on treating water they recognize as unsafe.

Informed by these empirical studies and the theoretical reviews, the researcher studied the underlying issues in treatment and storage of water and management of multifaceted water resources in Mathare Slums, Nairobi County.

2.5. Distribution of Water to Users and Management of Multifaceted Water Resources

In the 21st century piped water coverage increased significantly, although from a very low level. While the United Nations celebrated achieving the Millennium Development Goals (MDGs) target on drinking water in 2012, some issues surrounding the water supply sector remain unresolved (Goff & Crow, 2014). Equity poses one of the remaining obstacles. Different parts of society face massive and sometimes persistent inequities. But, what is equity? Previously, Goff and Crow (2014) challenged the notion of equity by emphasizing that the commonly used concept of equity focuses only on water portability, without taking into consideration the full spectrum of uses of domestic water supply and delivery to consumers. Domestic water is not just 'drinking' water, but it also includes water that is needed for living and keeping the home. We must examine the question of inequity in relation to two concerns: access inequity and inequity

in relation to water cost burden. Firstly, on the issue of inequity, there is a persistent exclusion of the poor in accessing improved water sources despite the millions of people who have gained access within the last 15 years (UNICEF & WHO, 2015). Since 2011, the Joint Monitoring Programme for Water and Sanitation (JMP) of WHO-UNICEF has begun to disaggregate water and sanitation data by wealth quintiles to understand how they differ across socioeconomic level (Satterthwaite, 2015). Improving access is mostly experienced by the high quintile populations, and it is reported that poorer households are more likely to rely on unimproved or unsafe sources of water (UNICEF & WHO, 2011). At the same time access to piped water is often restricted to the richest population quintile, while the poor continue to rely on non-piped sources of water, such as hand pumps (UNICEF & WHO, 2011). The regional averages mark these disparities in access to improved and safe water sources (UNICEF & WHO, 2011). However, considering the multifaceted nature of access in developing countries like Kenya, these disparities are often difficult to measure. For example, having access to certain types of improved sources in many developing countries does not automatically mean that water from those sources is clean or continuous. Piped water services, the most enhanced mode of supply, often fail to deliver drinking water or continuous water directly to dwellings (Lee & Schwab, 2005). A household can rely on multiple ways to cope with these shortcomings and get adequate water for their daily uses. Households often use multiple sources of water in an attempt to match source to intended use (Neumann et al., 2014). In Nairobi households generally, piped water often combines with unimproved sources of water, such as vendor water, or bottled water. These facts are often undetected in official statistics so coverage may actually be lower than recorded overestimating the number of households accessing improved water sources on a full-time basis. Secondly, equity is not just about varying levels of socioeconomic access across groups. Abubakar (2016) indicated that relying on access equity alone would give a skewed output image and exaggerate the degree of achievement. Equity also concerns whether water for the poorest segment of the population is economically available. The theory of equal access demands that any water service payment should be accessible to everyone. It calls for poorer households not to be disproportionately burdened with water spending as compared to their richer counterparts (United Nations, 2007). Affordability demands that water-related costs do not prohibit an individual from receiving clean water, and should not impair their ability to enjoy other fundamental rights. In urban areas it is observed that the poor pay far more than the wealthier

households for a liter of water purchased from private vendors (UNICEF & WHO, 2011). Water transport to slums has been a challenge since the early history of urban development. Population growth in the outskirts of cities is occurring faster in the post-colonial region of the South than in urban centres, but development of infrastructure is inconsistent. Centralized water infrastructure development has focused primarily on urban centers and has not reached sprawling areas on the outskirts of towns. Peri-urban residents remain underserved if any, as neither networked public utilities nor large-scale private water companies are able (or, indeed, willing) to efficiently service these areas (Allen et al., 2006). During the characterization of active engagements between non-state actors it is evident that the co-production concept is rarely applied.

Existing empirical studies of household demand for urban slums and rural water services show that households often prioritize improved water supply to such an extent that they are willing to pay more for service improvements. For example, just prior to the installation of communal water points in Lugazi, Uganda, Whittington et al. (1998) conducted a rapid appraisal of household demand for improved water services, including a contingent valuation survey of their willingness to pay for different types and levels of service. The authors found out that household consider a safe and reliable water supply to be their top priority within the community, and that many were willing and able to pay the full cost of private connections to their homes (Whittington et al., 1998). They conclude that, had the implementing agency adopted a more flexible and collaborative approach to planning, a broader set of design options would have been revealed based on households' preferences. Another empirical study was illustrated by Isham and Kähkönen (2002) in their study of 44 Indonesian communities that had received water supply systems under the auspices of a demand responsive program. Contrary to program specifications, the authors found that project implementers had largely cut corners during the planning phase by consulting with village leaders instead of households. The village leaders were more likely to choose communal water points (the most inexpensive service option) from the menu of technology choices, whereas households most often chose private piped connections. The authors concluded that village leaders assume, just as external parties had done in the Lugazi project, that poor households prefer the cheapest technology options. In fact, these households expressed demand for the more convenient, more expensive option. For those villages where the installed scheme matched users' felt needs and preferences, households were on average more

satisfied with the project, more likely to report improved health since its installation, and the infrastructure was better maintained in the short run.

Water supply programs are made up of three basic components: technology, peoples and institutions. Such aspects interface defines whether a given scheme is sustainable. The study emphasizes variations in the maintenance and operation of water supply systems in Nepal's rural villages and rural market centres. The analysis takes into account disparities between the willingness of users to pay based on data gathered through surveys of 205 households and representatives of 12 water user committees. Because of the varying geographical positions and socio-economic conditions between rural villages and regional market centres, core operations and maintenance problems for sustainability of drinking water are vastly different. Weak institutional capacity is the primary obstacle to the provision of drinking water in the rural villages while the major issues in rural market centers are technicalities such as insufficient water quality and inconvenient water-point locations. In addition, levels of user satisfaction influence both types of system operation and maintenance. This study considers parameters of user satisfaction and the overall influence of satisfaction on the willingness of the users to pay, Betman & Miriam (2007).

Based on these empirical studies and the theoretical analyses, in Mathare Slums, Nairobi County, the researcher studied the fundamental issues of water delivery to users and management of multifaceted water supplies.

2.6. Water Policy and Management of Multifaceted Water Resources

Water management has long remained a government preserve, and water and water resource management remained largely under government until recently when private entities entered the water sector, especially water supply in gated communities. Here they have boreholes, and distribution of water to households. Before the Water Act 2002 was passed, water resources had been consolidated under the National Water Management and Pipeline Company (currently the National Water Harvesting and Storage Authority) and a few other agencies that were created in 1992. There was a decentralization of water services to 91 local water service providers (WSPs) in 2002 when the Water Act was enacted. A new Water Act was enacted in 2016, resulting in the 47 counties being further decentralized in water services. 47 developments of water works was created as part of this act's operationalization. Development of water policies was left to the Ministry of Water and Irrigation as the preserve of the national government. Various bodies,

apart from the autonomous board, have been set up in compliance with this act, which includes the Water Services Regulatory Board (WASREB), whose key function is to establish and implement rules in the water sector, and work towards ensuring access to reliable, accessible and sustainable services. The Water Sector Trust Fund (WSTF) was also created under the Act and restructured from the Trust Fund for Water Services to the Trust Fund for the Water Sector (WSTF). WSTF's mandate is to finance the country's water and sanitation systems. Establishing these institutions seeks to organize the country's water sector and to ensure realization of the anticipated universal access to water

The lack of a state-led water supply program (inadequate and unsuccessful strategies) creates business incentives for private players to fill the water supply void. Local private actors serve as the main provider of basic services in many of the areas underserved by government-owned water authorities and companies, rather than national / county actors. We will examine the provision of public and commercialized water in Mathare slums of Nairobi with reference to Government policy provisions i.e. Water Act 2002, Water Act 2016 and the 2014/15 - 2018/19 Strategic Plan for Nairobi City Water and Sewerage Company Limited. The aim is to analyze the mechanism of private and citizen co-production water commercialization framework. Specifically we will address the questions of how freshwater service provision is co-produced in Mathare, Explore citizens' engagement not only as users but also as (co)producers along the value chain of drinking water production, a variety of processes where, through abstraction, transportation, treatment and distribution, they are seen to add value to raw water sources. In this process, value addition lies in the fact that freshwater is usable for citizens; people will not be able to enjoy the benefits of freshwater daily without these processes. Second, is service delivery improved through co-production? Who has the most convenient social and geographical access to water? Who has the most convenient social access to water, and geographical access? These questions enquire on whether innovations and equitable access along the provision of services are produced as the results of the processes of co-production and the influence of existing policies on the water sector. Shaheed et al. (2014) pointed out that a better understanding of the complex behavioral factors surrounding how water is produced and handled at the household level could help inform future measures to promote optimum water use. At the same time, a full definition of actions will also direct WASH (water, sanitation, and hygiene)-related actions change strategies (Dreibelbis et al., 2013). Grafton et al. (2011) indicated that understanding

expenditure related to volumetric water usage could inform policymakers about the most effective policy levers for controlling household water usage. Policymakers need information on the awareness of the households about water quality from various sources before attempting to control the choice of water for households. Hurlimann et al. (2009) provided a comprehensive review of water-related behaviour, which he claims is essential to give insight into water sources and water-related behaviour. There is a dire need to improve awareness on the multifaceted nature of access in Nairobi City with special focus to the slum dwellers which eventually informs both new policies and new approaches in the sector.

Study conducted by WASREB, (2018) titled “*A Performance Report of Kenya’s Water Services Sector 2015/16 & 2016/17.*” On the new institutional framework based on the Water Act of 2016, anticipating the formation and transformation of various water sector institutions to align with the new constitution. The findings of the new framework are: First, the Water Services Regulatory Board (WASREB), although with an enhanced mandate, retains its name and role as water services regulator. This improvement relates in particular to monitoring and the fact that the Regulator will now play a more direct role in licensing water service providers (WSPs.). Secondly, the Water Resources Management Authority (WRMA) changes its name to the Water Resources Authority (WRA) with the mandate to regulate water resource management and utilization at national level. At the regional level, Catchment Areas Advisory Committees (CAACs) are changing their name to Basin Water Resources. Water Services Boards (WSBs) are expected to turn into Water Works Development Agencies (WWDAs) with a mandate on a needs-based basis for cross-county municipal water works and committees with the responsibility of water resources management at basin level. Third, Water Services Boards (WSBs) are expected to turn into Water Works Development Agencies (WWDAs) with a mandate on a needs-based basis for cross-county municipal water works. Fourthly, National Water Conservation and Pipeline Corporation changes the name of the National Water Harvesting and Storage Authority (NWHSA) with the mandate to undertake the development of national public water storage and flood control works on behalf of the national government. Existing water service providers (services) continue to act as providers of county water services or as providers of cross county water services, as the case may be. County governments may establish other water service providers as public limited liability companies under the 2015 Companies Act, but must comply with WASREB’s commercial viability standards. This also

applies to any other bodies providing water services to the public. Fifth, the Water Services Trust Fund (WSTF) changes from a funding mechanism to a funding institution and is renamed the Water Sector Trust Fund, with an expanded mandate to cooperate with County Governments and Water Resource Users Associations (WRUAs) on the provision of water services in areas that are underserved as well as catchment management. In addition, the WSTF has the authority to mobilize private investors' financial capital for onward lending to creditworthy utilities as promoting research on water infrastructure and water supplies. The core mandate is to assist in funding water resources development and management in marginalize areas or in any underserved region. Sixth, the Court of Appeals for Water has its name changed to Water Tribunal. It has the powers to hear and decide appeals from any person or entity directly impacted by the decision or order responsible for matters relating to water, Water Resources Authority and the Water Services Regulatory Board. The tribunal also has authority to consider and resolve any dispute over water resources or water facilities where a business contract exist, unless the parties have agreed otherwise to an alternative dispute settlement mechanism.

Ngugi (2012) conducted a study on “*Incentives for Water and Sanitation Services Provision to the Peri-Urban Poor: the Case of the Nakuru and Oloolaiser Water Utilities, Kenya.*” The research aimed at assessing the presence and investigating the impact on the provision of water and sanitation services by Nakuru and Oloolaiser water utilities in the Rift Valley and Tanathi Water Services Boards in Kenya in terms of strength and effectiveness of the proposed incentives.. The data collection methods included semi-structured interviews, focus group discussion, and primary data review of secondary data as well as field observations. An assessment was made on the strength of the proposed incentives offered using a five option scale graduated from a low of strong disincentive to a high of strong incentive. Further, investigation was conducted to determine the (potential) effectiveness of the proposed incentives by considering Sanchez's set of eight pro-poor factors (2010) for each incentive. The study suggested that pro-poor watsan opportunities are currently present in Kenya and used by different actors in varying degrees. National actors, WSTF and WASREB, seem to be effectively applying poor incentives whilst local actors, WSBs and WSPs lag behind. The study showed that actors' use of incentives also impacted customers and water utilities. The incentives that were considered to be both strong and so effective e were: corporate planning, benchmarking, public pressure, regulations & laws, easy access to funds, partnerships,

performance contracts, poor people-oriented fund, and subsidies for connections and community initiatives. However, unlawful connections, flat rate incentives, land tenure system and negative perception on pro-poor services have been considered as disincentives, however. In particular, the WSTF's pro-poor financing scheme, "ease of access to funds" and "funds aimed at the vulnerable" incentives were found to be highly effective. The study not only recommends a deliberate effort to introduce internal pro-poor Watsan incentive systems for local actors but also to enhance those external incentives that are being applied by national actors specifically for the sanitation component. Therefore, a process evaluation needs to be performed to evaluate the proportions in which impacts are due to which attributable to incentives that promote the optimum selection in opportunities for actors to apply.

Another empirical study by Fuente et al (2016), *Water and sanitation service delivery, pricing, and the poor: An empirical estimate of subsidy incidence in Nairobi, Kenya*. The study noted that rising block tariff (IBT) is among the tariffs most widely used by water utilities, especially in developing countries. This is partly due to the perception that the IBT is able to target subsidies effectively for low-income households. The research was intended to fill some holes in existing literature on subsidy incidence. The empirical strategy follows three analytical steps. In the first step of the analysis, socioeconomic and demographic data from a survey of 656 households were combined with data from NCWSC billing records about metered water use. Data used to estimate the distribution of subsidies among private metered households and to analyze the degree to which reported expenditure is an effective proxy for metered water usage. Our survey sample excluded households who shared a relation with another household or family. According to the most recent census, less than a quarter of households in Nairobi reported using a private connection to the piped water network as their primary drinking source (Kenya National Bureau of Statistics, 2009). Approximately half of households used piped water that is not delivered into their dwelling (e.g., a shared tap) as their primary drinking water source. Thus, in the second step of the analysis examined the distribution of subsidies among all NCWSC's residential customers, which included residential customers with shared connections. In the third, final, step, the scope of analysis examined the distribution of subsidies among residential and nonresidential customers in Nairobi. Combining data on households' socioeconomic status and metered water use, the study examined the distributional incidence of subsidies delivered through the IBT in Nairobi, Kenya. Contrary to conventional wisdom, the study found out that

high-income residential and nonresidential customers receive a disproportionate share of subsidies and that subsidy targeting the poor even among households with a private metered connection. The study also found that the stated expenditure on water, a commonly used means of estimating water use, is a poor proxy for metered use and previous studies on subsidy incidence underestimated the magnitude of the subsidy delivered through water tariffs. These findings have implications for both the design and evaluation of water tariffs in developing countries.

Informed by these empirical studies and the theoretical reviews, the researcher studied the underlying issues in water policy and management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya.

2.7. Public Water Supplies & Management of Multifaceted Water Resources

Generally there are four elements of public water supply and distribution strategies. These are sources of supply; treatment and storage of water; distribution of water to users; and raw water quality and treatment analysis. In this research project, researcher focused on how the first three combined elements and how they are managed within a slum set up of Mathare Slums in Nairobi City. In coping with the demand for potable water services that is rapidly increasing in the rapidly growing urban slum areas has been a prominent issue for the century. The water problems facing many cities has not been limited to just transporting water, but extending to water supply delivered to urban citizens in order to contribute to positive economic social and personal outcomes. More focus in water supply and distribution has been place on supply oriented provision and more specific expansion of physical access. This research highlight went beyond physical access to water services and delved into the complexity of water provision in the urban settlement and its ecosystems. In this study, physical access to water services referred to the classification of the WHO and UNICEF's Joint Monitoring Programme (JMP) the United Nations' mechanism that monitor achievement in sector of the water and sanitation . Classification of water supply sources as per JMP includes piped water in premises as well as other improved and unimproved sources .The present assessment framework places its focus on measuring the access levels: the proportion that is served/ unserved by improved water sources. Taking an examples of the city of Nairobi , the aim of this research was to get a deeper understanding of the complexity of mechanism of water provision in low urban settlements and the ecosystem, by finding out what's "beyond access": the multifaceted realities in the provision

of water supply, from physical access of water, the dimension of access (the quality, quantity, continuity and affordability), perceptual drivers of users, the strategies, impacts of provision of water supply and water provision structures. The connection between these multifaceted aspects and sector monitoring mechanism shall also be discussed. Aversion behaviours are the measures taken by households today to prevent the uncertainty, potential economic loss, and the health impact, both positive and negative experienced on a daily basis. The study employed qualitative analysis approach to have an understanding on households' perception and explore options of reducing risks by employing different strategies.

The issue of bottled water is inevitable when discussing access to water in Mathare Slum, Nairobi City. Bottled water business is rapidly growing in Kenya; there are a multiple products on the market ranging from multi-national brands to the ones refilled in the local water kiosks. However, in the Kenyan context, there is not comparison between the piped water and bottled water. Acceptance level for tap water has for a long time been low due to the perception that it comes with not guarantee of purity and safety. Despite the myriad negative social and environmental effect that is associated with bottled water, bottled water is becoming “the” drinking water in Kenya and is closely associated with modern life.

The evaluation of access to water and water expenditure across households of different income groups and inequity in the type of access among different groups in which higher income households are more likely to use piped water, bottled water, or the combinations thereof is also an important aspect to be studied.

Karimi (2011) conducted a study on the “*Influence of Water Provision on the Quality of Life for Urban Slum Dwellers: The Case of Kosovo-Mathare Pilot Water Project, Nairobi.*” The variables studied were water affordability, water access, water quality and pro-poor focus by NCWSC in water supply. The main findings showed that there has been a reduced reliance on informal water vendors which has seen the cost of water decrease by 50%. Daily supply of water supply regularity has improved by 51% for slum dwellers; addition the study showed that 92.9% walk less than 50 metres distance to have physical access to water sources even as 87.8% of the same populace recording reduced time to get water from the source. There has been 36% improvement to health situation for slum dwellers, a situation attributed to improved access to safe drinking water. However, 91.8% of the Kosovo community residences were unaware of the pro-poor policy by NCWSC despite an awareness campaign and sustainable operation campaign by the

water supply body. Descriptive survey design was used as a research methodology and questionnaires used to collect data. Questionnaires were administered to 98 respondents selected through stratified random sampling in order to realize proportionate representation of people all the ten Clusters of Kosovo. A focus group discussion with 9 participants was involved to in Kosovo help collect additional qualitative data. In analyzing, presenting and interpreting data, correlational and descriptive statistics were employed. Study came up with recommendations that findings could be used as benchmark for formalizing water services provision in other urban slums in the city. Additionally, it was recommended that communities operating such projects be empowered. A similar study also conducted in Tanzania by Lucas et al, 2008 on “*The Citizens’ survey*” revealed that dissatisfaction with water supply was quite widespread ; less than one quarter (23 %) of the respondents were contented water supply quality, and 28% reporting an improvement in in recent years. 60% of the respondents indicated that the major problem in the area was water shortage, especially during the dry season. This view was corroborated by whose people surveys, where 63% of the respondents saying that water shortages problems were common during dry areas in urban and rural areas The survey further showed that high dissatisfaction with supply of water especially when it comes to cleanliness, distance, queuing time as well as the cost. Citizens indicated that the water problems have for long been experienced and the authorities notified but no help has been forthcoming. Most respondents indicated that rather than see an improvement, all they have experienced in deterioration of water supply, cleanliness, queuing time and cost, they have been disappointed by the situation.

Coombes (2016) carried a study on the “*Intermittent Domestic Water Supply: A Critical Review and Analysis of Causal – Consequential Pathways.*” People in many parts of the world, and in particular developing countries, face a lot of challenges relating to continuous water supply to their households. Water scarcity is easily cited by the authorities as the cause, but this study has demonstrated that environmental constraints only constitute one aspect of a multi-dimensional problem. When asked to state the causes of intermittent domestic water supply, the study reviewed literature available that suggested that intermittent systems and the causal-consequential pathways between them reinforce intermittency. These pathways span across various disciplines among them engineering, anthropology and government administration and when analyzed together they emphasized the human drivers of intermittency; suggested

generalized interventions; a study gap revealed in form of meaningful categorizations of the reliability of intermittent supplies. Based on the consumers' water access reliability, the study that intermittency be categorized into three namely: predictable, irregular, and unreliable in order to facilitate comparisons between transfers of solutions and case studies

Based on the empirical studies above and the theoretical reviews, the researcher studied the underlying issues in combined elements of public water supplies and management of multifaceted water resources in Mathare Slums, Nairobi County.

2.8. Theoretical Framework

This study is guided by the theory of participation. According to Fawlett et al (1995) in the theory of participation, he defined community participation as the process of collaboratively working with and through groups of people within an affiliated geographic proximity, special interests or people within a similar situation in addressing issues affecting people's wellbeing. Community participation is a powerful tool used to bring about environmental and behavioral changes which will see an improvement of the living standards of the community and its people. It utilized mechanism such as partnership and coalitions which would help mobilize resources and influence systems, enhance relationships among partners and work as catalysts for changing policies, programs and practices (Fawlett et al 1995). The real value of participation stems from the finding that mobilizing the entire community. Rather than engaging people on individualized basis or not changing them all, leads more effective results (Fawlett et al, 1995) stated change is more likely to be successful and permanent where the people it affects are involved in initiating and promoting it. The crucial element of community engagement is participation by individuals, CBOs and institutions that will be affected by the effort (Fawlett et al, 1995). People anywhere have the purpose and the potential to shape and transform their own lives. However, the ability of ordinary people to shape their reality is firstly, often crushed by the social forces around them; and secondly, is largely determined by their historical context.

Freire (1973) postulates that to get out of this trap, marginalized people needed to achieve what he calls a critical level outlook on their world. Such an outlook would do two things; first, it would enable them read their reality correctly and second, it would help them move from a reactionary to a progressive position where they can shape that reality they have read correctly. Paulo Freire (1973) hypothesizes that people live at three levels of awareness and that they act differently at each level. The three levels of awareness are the magic level, the naive level, and

the critical level. An empowered community possesses the ability to understand their reality and to analyze the factors that shape that reality; the ability to decide what they want to be; the willingness to act to change the situation for the better; and the ability to ensure sustainability of those efforts. Government and donor support should be determined by the people; people must get only what they need, not what others think they should get. The ownership concept for government and donor projects should be such that the community will protect the project from vandalism, ensure the completion of the started project, and ensure that the project is sustained (Hedayat et al, 2010). The concept of elements of public water supplies, water policy and management of multifaceted water resources that entails water supply, treatment, storage services to end users may be produced through various institutional arrangements hypothesized by the stated theories. The Kenyan regulation implies that water supply must be managed by the state through state owned authorities and companies'- devolved function to the county government (GoK Constitution, 2010). County water companies are responsible for providing water services in the 47 county governments in Kenyan; however, these companies face high operation and maintenance costs of large scale centralized piped water systems, limited budgets, and managerial problems, lack of effective research and development unit, leaving a large proportion of the Kenyans population underserved and some totally not served.

Despite of all these efforts, Nairobi City County, also the capital city of Kenya, water privatization schemes have not been successful in solving the problems of water accessibility and service quality, particularly with respect to access for the underprivileged especially to the slum dwellers in the city. In the ordinary settings, citizens' access water through multiple modalities, in most instances combining government led and privately led provisions. Most often, these provision systems are outside the scope of the formal system. The urban slum poor generally rely on needs driven forms of supply, which results from poor people's efforts to gain access to what the formal system could not supply. The focus will be mostly directed on measuring the time, cost and treatment and trying to seek cost related to waterborne diseases. Studies focusing on costs related to user behaviour in coping with poor water supply are limited. Two studies, conducted by Cook et al. (2016), estimated the coping costs, which in this research proposal are called the aversion or mitigation costs, resulting from a poor water supply.

2.9. Conceptual Framework

The study is guided by a conceptual framework on the public water supplies, water policy and management of multifaceted water resources in Mathare slums. A conceptual framework is a hypothetical model identifying the concepts under study and relationship between independent, dependent, moderating and intervening variables. Independent variables include sources of water supply, treatment and storage of water, and distribution of water to users. Dependent variable is management of multifaceted water resources in Mathare slums. The moderating variable is government policy provision while the intervening variable is the socio-economic factors especially the attitude that water is a free resource. All these are schematically represented below.

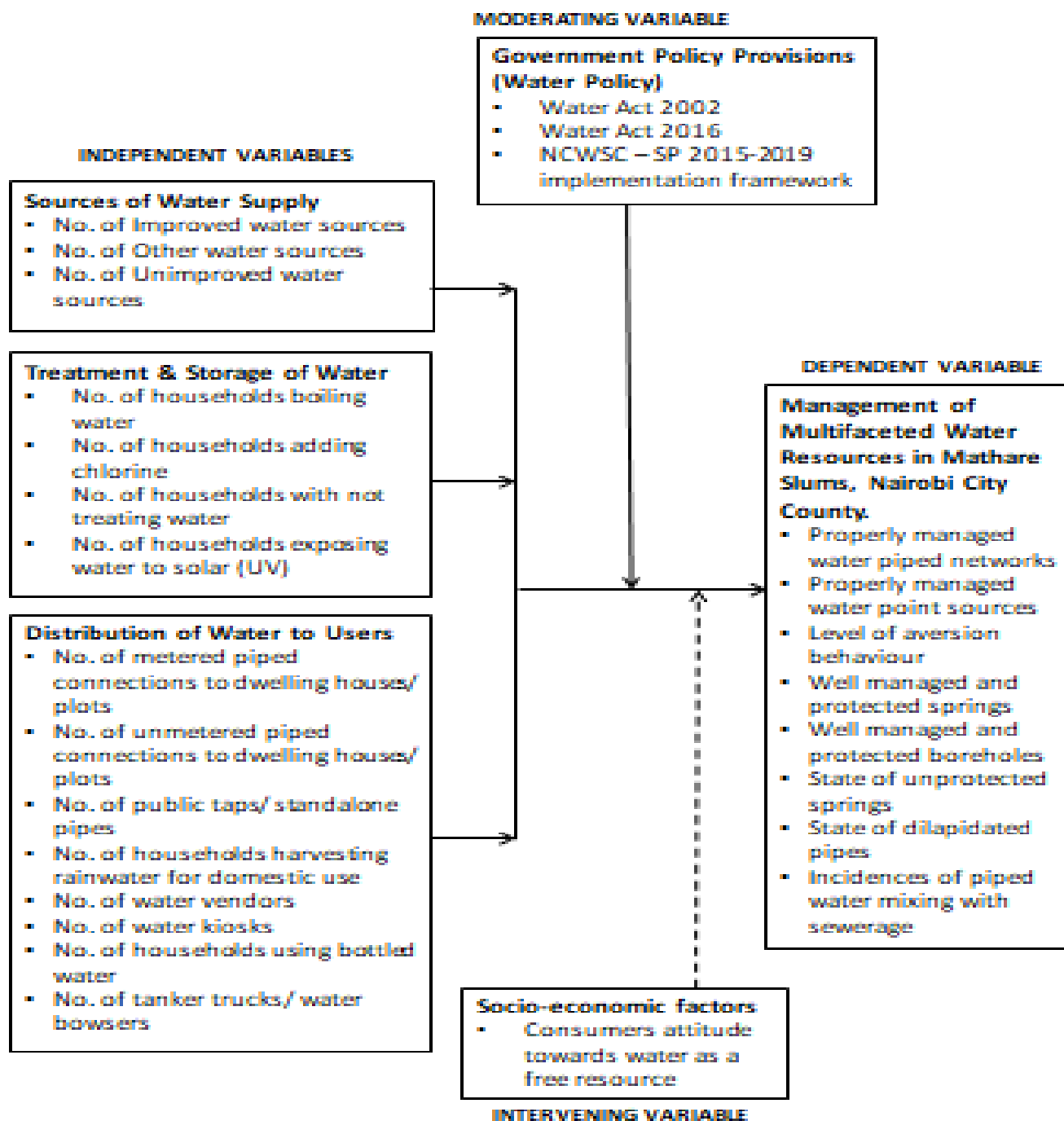


Figure 1: *Conceptual Framework for Public Water Supplies, Water Policy & Management of Multifaceted Water Resources in Mathare Slums, Nairobi City, Kenya.*

2.10. Summary of the Literature Reviewed

Studies done in the USA shows that consumers of bottled water are “victims of hype” since bottled water, as compared to piped water , is not necessarily better regulated, purer or safer (Olson, 2013). For water consumers in Nairobi, their demand for assurance for water safety, bottled water is not necessarily “hype”, but for them it’s the only choice of sources of hydration source that is readily available and safe. Additionally, the amount efforts that go in marketing bottled water makes them look appealing in terms of good water quality, provide better physical health in addition to great taste, convenience, mental health, and social and environmental values. Due to this, bottled water is perceived to be more trusted drinking water source and had become part of the inextricable modern life despite of the many negative social and environmental problems associated to them.

Equity of access to water, within the water supply sector, is entered in the framework of Sustainable Development Goals (SDGs) (UN Water et al., 2015). The United Nations (2007) advices that the poor households should not be over-burdened by higher water expenditure but instead get some subsidies. SDGs also asks that the poor and vulnerable be allowed to negotiate from below" and demand more accountability and transparence in its conception of equity (UN Water et al., 2015). The researcher analyzed the case of a commercialized freshwater source supplied by local, small scale private actors (Mathare – Kosovo Water Model), and investigated potentially emerging institutional innovations and the impact that comes with a cost to equity.

Access to improved water sources, service quality and supply are some of the main problems in the urban slum areas. Increase in urban population and the resulting demand for increase in water consumption is causing an enormous challenge to water provision. 96% of urban populations have access to improved water sources (WHO & UNICEF, 2013), but the problems of poor water quality, interrupted service, insufficient disinfection, and infrastructure ageing and damage remain (Lee & Schwab, 2005). Urban dwellers are often forced to rely on more expensive water sources, such as bottled water, or more polluted sources. Although the United Nations celebrated achieving the drinking water target of the Millennium Development Goals (MDGs) in 2012, some issues surrounding the water supply sector remain unsolved (Goff & Crow, 2014). Equity is one of the remaining challenges. Bradley and Bartram (2013) suggested that there are large and often consistent inequities experienced by different segments of society.

Despite the fact that research has established a clear relationship between aversion behaviours and perceived health risk, how households decide among different aversion behaviours is understudied. One study examining the risk of arsenic exposure concluded that risk beliefs are socially constructed, as a result of everyday interactions, personal experience, local knowledge, and social networking (Chappells et al., 2015). However, similar studies on a broader scope of dimensions of access are scarce. It remains unclear exactly how perceptions emerge, and how & why these perceptions result in decisions that lead to particular behaviours to avert risk and loss. Deficiencies in data availability and limitation of methodology calls for need of better data to better understand access and service levels for the poor, much more household survey data are required. This should cover more variables such as reliability, adequacy, and affordability. This robust dataset would allow for the use of econometric analysis to examine the extent to which utility management effectiveness and cost recovery drive service to the poor across the slums as a whole (Chris et al., 2016). Lack of data on national estimates of the population using safely managed drinking water services. Household surveys, regulators and administrative sources all produce relevant data on accessibility, availability and quality of drinking water, but this is not yet standardized or available in Kenya. Water safety plans (WSPs) are a systematic risk assessment and risk prevention approach encompassing all steps in the water supply system, from the catchment through to the consumer. By identifying the greatest risks and putting in place barriers, WSPs offer water suppliers a tool for managing the risks related to water and a framework to achieve water quality targets included in national standards and regulations (WHO & UNICEF, 2017).

Case studies have illuminated many aspects about how cities serve the poor relatively well in their particular contexts. This study in Mathare slums added to the rich body of knowledge. In particular, political economy analysis for Nairobi City that do not serve the poor well could uncover what drives bad service to the poor, and how that contrasts with the political economy dynamics in city with relatively good service. Knowledge of why some of the alternative methods have worked elsewhere, and in what contexts, could inform the reform plans of typical city like Nairobi looking to serve the poor better.

The need to align to an enabling policy framework: access to safe piped water declined in the past due to a lack of pro-poor focus. The politicians and utilities ignored areas where population was growing the fastest (urban low income areas) and where access to basic services was the

lowest. The positive reversal in trends now observed is only happening because utilities are obliged to move services into these areas and they partner with NGOs in doing this. The Bill of Rights in the new constitution leaves no other option than to offer sustainable services that meet the criteria of human rights thus formalized service provision (Celestine et al, 2010). Although much work is still required to ensure the long-term sustainability of some of the schemes, the project preparation and implementation phases have clearly shown that it is indeed possible for a licensed utility with professionalism to introduce formal and regulated service provision in an urban slum with a rather complex water supply history.

As predicted by the poverty penalty literature, low-income households in Nairobi's informal settlements are facing both quality and price-related poverty penalties. Policy interventions need to ensure the safety of water. A recent report by the Water Services Regulatory Board identifies institutional weaknesses in the quality assurance system. For instance expand of connections to fixed-point water suppliers such as public taps and water kiosks. This would allow more households to shift from a reliance on mobile vendors to fixed-point sources that are safer and more affordable. Credit, tax and subsidy incentives could encourage fixed-point suppliers to enter the market. Thirdly tackle water rationing by repairing decaying infrastructure to reduce leaks, and by investing in the expansion of catchment capacity to increase supply. Rationing has economic consequences such as interruptions in the production of goods and services, a worsening of hygiene standards and the proliferation of diseases due to water storage and use of alternative unsafe sources (Degol et al 2011) .Strengthen the synergies between utilities, mainly between the water and electricity sector. A reliable electricity supply allows water and sanitation facilities to operate for longer hours and improves continuity, reliability and safety.

2.11. Knowledge Gaps

Table 2.1: Knowledge Gaps in the Literature Reviewed

Variable	Author (Year)	Title of the study	Findings	Knowledge gaps
Treatment of water and storage	Chappell's et al. (2015)	Study on examining the risk of arsenic exposure	Risk beliefs are socially constructed, as a result of everyday interactions, personal experience, local knowledge, and social networking	Similar studies on a broader scope of dimensions of access are scarce.
Management of multifaceted water resources	UNICEF and WHO. (2017)	Safely Managed Drinking Water – Thematic report.	Examination of SDGs vision for universal access. Examination of availability of data on different elements of safely managed drinking water services	Scarce reliable data on Accessibility, Availability and Quality of drinking water in the slums
Distribution of water to users	Allen A. et al (2006).	The peri-urban water poor: citizens or consumers?	Contaminated and poor water supply connection networks	Lack of data/ information on the coping strategies of the poor slums on access to safe water
Distribution of water to users	Bain, R.; Wright, J et al. (2012)	Improved but not Necessarily safe: water access and the MDGs	Categorization of the water sources available	Lack of consistency in classification of water supply and distribution to end users
Treatment & storage of water	Grafton, R. et al. (2011)	Determinants of residential water consumption:	Availability and Accessibility of water for domestic use	Lack of data on treatment and storage methods for the slums households
Management of multifaceted water resources	Hurliman A, et al, (2009).	Understanding behaviour to inform water supply management	Access to water and risks exposures i.e. poor quality & poor continuity of water exposes households to risks of illness and economic loss	Lack of multifaceted approaches in the management of the water resources
Treatment of water and storage	Jakus, P.M et al. (2009)	Risk perceptions of arsenic in tap water and consumption of bottled water	An aversion to piped water not connected to the network based on allegations – unreality and high costs	Lack of concrete aversion / mitigation measures
Distribution of water to users	UNICEF and WHO. (2011)	Drinking Water Equity, Safety & Sustainability: JMP Thematic Report.	Quality of drinking water availability and continuity influences management of waterborne related ailments	Few studies on management of quality, equity, availability and continuity of drinking water in the slums
Distribution of water to users	UNICEF and WHO.	Progress on Drinking Water and Sanitation	Household surveys, regulators and administrative sources all produce relevant data on	Lack of/ scarce reliable data on Accessibility, Availability and Quality of

	(2012)	2012 update	accessibility, availability and quality of drinking water	drinking water in the slums
Distribution of water to users	UNICEF and WHO. (2014)	Progress on Drinking Water and Sanitation 2014 Update	Cities in different countries are at different levels in universal access to safe drinking water for their citizens especially the vulnerable population.	Progress towards safely managed drinking water is a big challenge in some countries than others, due to lack of data
Distribution of water to users	UNICEF and WHO. (2015).	Progress on sanitation and drinking water - 2015 update and MDG Assessment	Increased trends in uptake of safe drinking water and sanitation measures at different levels across the globe, region and countries	More case studies required to be conducted especially in the informal settlements
Management of multifaceted water resources	Yang, Het al. (2013).	Water safety and inequality in access to drinking-water between rich and poor households	In the absence of water quality information, actual risks do not directly shape households' perceptions of risks, nor do these risks promptly lead to the adoption of aversion behaviours	Few studies on the aversion behaviour in the informal settlements
Sources of water supplies	Chris, H. et al. (2016).	Providing water to poor people in African cities effectively.	Reforms in the sector are clear. Delegation of water supply to private operators in the informal areas. Improved connections, reliability and review of tariff - affordability	Need for more household survey data to cover variables such as reliability, adequacy and affordability. More study on management of utility to deliver effective services to the poor
Sources of water supplies	Kaseve, C...et al. (2010).	Formalizing water supply through partnerships	When a centralized drinking water is inadequate, the responsibility for obtaining access to water and securing the safety of drinking water falls to the consumer by default	Need to align to an enabling policy frameworks
Management of multifaceted water resources	IBRD/WB. (2016)	Kenya urbanization review	Rapid population growth in the cities putting pressure on the already strained water resources	Few studies on how to cope with the ever increasing demand for water supply and distribution
Water policy	Dagol H, et al (2011)	Small-scale water providers in Kenya	Low income households in Nairobi's informal settlements are facing both quality and price related poverty penalties	Policy intervention needed to ensure safety of water, expand connection to fixed point water supplies, tackling water rationing, formalize partnerships, extend regulation to apply to small scale providers, and strengthen the synergies

				between utilities.
Management of multifaceted water resources	Marks S.J. (2012)	Water System Sustainability in Sub-Saharan Africa: Participation, Sense of Ownership & Performance.	Sense of ownership for a communal water system, and shows that some (though not all) forms of community participation are associated with greater feelings of ownership. Also show that sense of ownership for the system is heterogeneous across different groups	Lack of consistency and positive relationship between community participation, households' sense of ownership for the system and system sustainability.
Management of multifaceted water resources	Priyan D (2009)	Collective action by different actors especially women influenced project effectiveness in community managed urban water supply systems in three cities in India	Institutional management either impedes or facilitate collective action at the community level thus influencing project effectiveness; government and community partnership does lead to a boost in project effectiveness; and women participation was found to be crucial within collective action institutions such as user committees	Similar studies lacking in Mathare slums, Nairobi City
Sources of water supplies	Chepchir chir et al (2015)	Sustainable Supply of Safe Drinking Water for Underserved Households in Kenya.	Majority of households perceived their water sources to be unsafe to drink. Households in Kenya did not apply these household water treatment methods consistently, thus indicating inconsistency in safe water consumption.	Long term applicability of decentralized water provision models on a larger water service provision context needs to be investigated further
Sources of water supplies	Sumila G, et al (2005)	Water for the Urban Poor: Water Markets, Household Demand & Service Preferences in Kenya.	Price water and create water markets is in itself insufficient to improve service delivery and that without appropriate institutional arrangements, technical solutions such as water kiosks may not succeed in delivering an affordable service to the poor.	Lacking facts on the notion in the literature that the poor are underserved, use small quantities of water, and pay a higher unit price
Sources of water supplies	Karanja J (2018)	Factors Influencing Water Services Provision in Kenya: A Case of Nairobi City Water and Sewerage Company.	Increase in water sources, efficient water management and improved water supply infrastructure would lead to increase in water services provision while good environmental conditions has a positive relationship with water service provision.	Lack of clarity on water resources management and strategies on continuous improvement of water source provision to ensure sustainable access to safe drinking water and sanitation.

Treatment & storage of water	Kimani E.W., et al (2007)	Quality of Water the Slum Dwellers Use:	Main domestic water sources were found to be highly contaminated with fecal matter	Lack of concrete facts why slum residents do not prefer water treatment for domestic use at home
Treatment & storage of water	Cook J, et al (2016)	Costs of coping with poor water supply in rural Kenya	High costs among larger & wealthier households, & households whose primary source is not at home. Households with unprotected private wells or connections to an intermittent piped network spend money on water storage containers & on treating water – unsafe water.	Lack of evident on the hidden costs of water treatment and storage at home or household level especially in the informal settlements
Water policy	Ngugi M.D. (2012)	Incentives for Water and Sanitation Services Provision to the Peri-Urban Poor.	Pro-poor watsan incentives are actually present in Kenya and are being utilized in varying degrees by various actors. National actors, WSTF and WASREB, appear to be the ones applying pro-poor incentives effectively while local actors, WSBs and WSPs, are lagging behind.	Effort to introduce internal pro-poor watsan incentive systems to the local actors and also enhancement of those external incentives being applied by the national actors especially for the sanitation component
Management of multifaceted water resources	Chepyegon C & Kamiya D (2018)	Challenges Faced by the Kenya Water Sector Management in Improving Water Supply Coverage.	Root causes of the challenges that are of technical, economic and social in nature were identified. As they evolved, they conjoined into other problem scenarios characterized by: unsustainability of water supply systems, low social acceptance of interventions, low investment in the sector and water-related conflicts	Strategies on how water sector management can improve the current situation through adoption of elaborate monitoring strategies for water services and water resources, embracing sustainable technologies and involving target beneficiaries in water supply development.
Sources of water supplies	Golf & Crow, (2014)	What is water equity? The unfortunate consequences of a global focus on drinking water.	Some issues surrounding the water supply sector remain unsolved	Equity is one of the challenges - consistent inequities experienced by different segments.
Water policy	GoK Water policy provisions	Water Act 2002 Water Act 2016 NCWSC – SP-2014/15-2018/19	Ownership, use and management of water resources; regulation of the management and use of water resources	Devolved provision of water services still facing teething challenges as a result of lack of harmonized functions and transfer of functions to other authorities/ agencies

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter gives an explanation and justification on the choice of project research methodology approaches to be used/ adopted in order to answer the research questions posed. The chapter outlines the project's research design, target population, sample size & sampling procedures, research instruments used in data collection, data collection procedures, data analysis techniques, ethical considerations and lastly operationalization of the variables.

3.2. Research Design

This research project used a descriptive survey design, where questionnaires were used to collect data. It also relied on a qualitative approach by capturing detailed information about the perceptions that end users or beneficiaries have on their living conditions with regard to formalized water services. According to Mugenda and Mugenda (1999), a descriptive survey design determines and reports the way things are or answers questions concerning the current status of the subjects in the study. Kothari (2004) describes descriptive surveys as fact-finding enquiries, involving asking questions (often in the form of a questionnaire) of a large group of individuals, adding that the major purpose is description of the state of affairs as it exists at present and represent the findings/ information statistically. This strategy is useful for gaining statistical knowledge of individual, organizational, social and real life occurrences thereby allowing retention of the holistic and meaningful characteristics of the real life events.

The study employed descriptive analysis to establish opinions and knowledge about the public water supplies, water policy and management of water resources in Mathare Slums, Nairobi City County, Kenya.

3.3. Target Population

The target population was 398 households drawn from 74,967 numbers of households in Mathare Slums (KNBS, 2019). The households were stratified into six strata (presented in table 3.1 below) thus Mathare Valley (Kosovo area), Mrandi area, Mathare North area 1, 2, 3 & 4. The researcher also interviewed those who are managing water resources (focused groups) that included 4 staff from Nairobi City Water & Sewerage Company (NCWSC), 2 staff from Water Resources Authority (WRA), 3 staff from Mathare – Kosovo Water Supply (NGO), 1 staff from

Water Service Trust Fund (WSTF), 1 staff of Pamoja Trust (NGO), Area Chief/ Assistant Chief and 4 water kiosks owners/ operators. According to Mugenda and Mugenda (1999), target population is the entire group a researcher is interested in or the group about which the researcher wishes to draw conclusion. Mugenda and Mugenda (1999) further states that a population is any set of persons or objects that possesses at least a common characteristic.

3.4. Sample Size and Sampling Procedures

Sampling techniques provide a range of methods that enable the researcher to reduce the amount of data needed to collect by collecting data from a sub-group rather than all possible cases or elements (Kish, 2011). Stratified random sampling will be considered for this study.

3.4.1. Sample size

A sample is part of the target population that was procedurally selected to represent it (Oso & Onen, 2009). The researcher targeted 398 respondents of the households and 15 respondents from the four institutions/ organizations managing water resources. According to Mugenda and Mugenda (2003), a descriptive study of 10% or above of the accessible population is enough for the study, while Cochran (1977) postulates that a sample of 30% is sufficient for a study. The numbers of samples were determined based on Yamane's formula, a commonly used simplified approach in representative sampling, assuming 95% of confidence level with a 5 % of margin of error (Yamane, 1967). A two-stage cluster method was be used to select samples (Lehtonen & Djerf, 2008). This corresponded to the sample size obtained by employing the sampling formula advanced by Yamane (1967) to obtain a representative sample size from the population size: The sampling frame therefore consisted of 398 households selected from the targeted population of 74,967 households and 15 respondents from the identified institutions/ organizations.

Key

n = total sample size

N = total households size

e = error margin = 0.05

n_b= sample size for the stratum

N_b = Households size for the stratum

$$n = \frac{N}{1+N(e)^2}$$

$$n = \frac{74,967}{1+74,967(0.05)^2} = 398 \text{ respondents.}$$

Cluster/ Strata Size = n_b

$$n_b = \frac{N_b}{N} \times n$$

$$n_b = \frac{12,432}{74,967} \times 398 = 66 \text{ respondents.}$$

3.4.2. Sampling Procedure

Sampling procedure involved selecting a number of households for the research project in such a way that the households selected represented the entire households' population of the study area. The study also adopted stratified random sampling techniques to select respondents who were representatives of the targeted households' population in the study. This method was used as it involved dividing the target population into various strata based on the unifying management. According to Kothari (2004), a stratified random sampling is used where the population embraces a number of distinct categories, the sample frame can be organized by these strata. Stratified sampling as noted by Mugenda and Mugenda (2003) is a method applied if the population from which a sample is to be drawn does not constitute an identical group, and hence requires comparisons between various sub-groups.

The population was divided into six strata, representative of the six clusters of Mathare slum settlement. The table shows the population of each cluster and the sample size from each cluster, for purposes of this research study. The researcher developed a questionnaire and administered to the 398 households' respondents and 15 focus group respondents.

Table 3.1: Sampling Frame for the Study

Cluster/ Strata	Number of households per Strata	Sample size (Households)
Mathare North Area 1	12,432	66
Mathare North Area 2	15,069	80
Mathare North Area 3	16,387	87
Mathare North Area 4	11,678	62
Mathare Valley (Kosovo Area)	9,041	48
Mrandi Area	10,360	55
TOTAL	74,967	398

Data was collected by use of a focused group discussion. According to Best and Kahn (2006), focus groups are group discussions centered on a single or narrow range of topics. The information collected was qualitative (opinions, insights and personal responses) as opposed to quantitative (uniform facts), as it provided an opportunity to gather and probe insights of participants. A typical focus group session lasted for 90 to 120 minutes, including a summing up session at the end; and an ideal group normally have 6-10 participants thus if too few, one does not get the interaction that adds value over individual interviews and the other hand when too many, people will not participate fully (Best and Kahn, 2006). The focus group for this research project comprised of the following categories of respondents: Nairobi City Water & Sewerage Company representative; Mathare – Kosovo Water Supply representative; Pamoja Trust representative; Water Kiosk owners/ operators representative; Area Chief/ Assistant Chief; Water Service Trust Fund representative; Landlord/ structure owners representative; Water Resources Authority; Water Services Regulatory Authority; and Public health worker representative

3.5. Research Instruments

In this study, the researcher used primary data collected with the help of a questionnaire, which was administered to the sampled population of Mathare Slums, Nairobi City County. The researcher used open and closed ended techniques whereby open ended questionnaire helped to elicit a lot of information from the respondents without restricting their responses. Face to face interviews were used as well to clarify any ambiguities in information gathered using the instruments. Questionnaire designed consists of six sections thus the first section is about the general information of the study, second section is about management of multifaceted water

resources, third section is on sources of water supply, fourth section is on treatment and storage of water, fifth section is on distribution of water to users and sixth is on water policy. According to Kothari (2004), data collection is the means the study uses to collect the required data/information. Finally the questionnaire were prepared and delivered to the respondents by the help of four research assistants and collection fast-tracked.

3.5.1. Pilot testing of the instruments

Pilot testing of the instrument was realized through pre-testing of research instrument in order to control quality and give assurance that the anticipated quality of results weren't biased and compromised. A pilot test is a stage where research instrument is administered to a number of individuals in the target population who aren't included in the sample size so as to test reliability and validity of the instrument, Mugenda and Mugenda (2003). The instrument was pilot tested at Korogocho Slums and the questionnaire was pre-tested by administering it to a sample size of 40 households' respondents, which is 10% of the study sample size of 398 households. Information gathered through the instrument was used to modify, improve and reconstruct the set of items in the instrument before actual data collection in Mathare Slums commenced/ rolled out.

3.5.2. Validity of the instruments

Validity of the research instruments is the degree to which results obtained from analysis of the data actually represents the phenomena under the investigation or study Bridget et al, (2005). Content validity was ensured by the researcher through extensive research and engaging the services of the research project supervisor who is a professional in the field of project planning and management. The supervisor assessed the concept of the instrument by trying to measure and determine whether the set of items were accurate and able to represent the concept under study. Making of necessary amendments were then conducted/ instituted to ensure questions got the right responses Mugenda and Mugenda (2003).

3.5.3. Reliability of the instruments

A minimum reliability of 70% is required for research purposes (Siegle, 2002). Research instruments reliability was vital as it enabled the researcher to identify the inadequacies and ambiguities of items in the research instrument. The inadequacies and ambiguities were measured through test retest technique where the same test is given to a group of respondents in similar characteristics as the actual sample i.e. Korogocho slum and Mathare slum. These tests were then repeated after two weeks interval and results obtained were correlated to get the

coefficient of reliability. In this research project, reliability was ensured through pilot test where 40 households in Korogocho were subjected to test and as stated or suggested by Siegle (2002), Cronbach Alpha closer to 1 (100%) and greater than 0.7 (70%) is acceptable.

3.6. Data collection procedure

Data collection is a process of gathering factual materials as a basis of analysis and this necessary for the achievement of the research objectives. Both primary and secondary data were collected and analyzed. Primary data was gathered with the help of a closed and open ended structured questionnaire. Secondary data was collected from various study reports, government documents, journals, books, manuals and other online sources. The researcher conceptualized a research proposal over a period of four to five months under the supervision and guidance of the research supervisor. The researcher then obtained permission to collect data from the National Commission for Science, Technology and Innovation (NACOSTI) by granting research permit and subsequently informed the County Commissioner, County Governor and County Director of Education. As earlier indicated, the research instrument was first pilot tested to ensure its validity and reliability. Thereafter raw data gathered with the help of a competitively recruited four research assistants after which the raw data further processed or analyzed, interpreted and presented using the recommended format by the University of Nairobi.

3.7. Data analysis techniques

The raw data that was gathered from the study area was cleaned up through thorough and careful scrutiny of the completed questionnaires to ensure that the data was accurate and uniformly consistent. Editing of the data was done in order to correct errors and omissions where possible. There was appropriate categorization and coding of information into frequency distribution tables in order to allow further analysis. The closed ended questions were designed to obtain data on the characteristics of respondents, their access to water, water use, and sanitation. Descriptive statistics and correlational analysis was used to analyze the data. The researcher used Microsoft Excel and Power Point for analysis and presentation respectively. The open-ended questions were used to explore key themes relating to how participants perceive risks and choose between different water sources and management strategies.

Descriptive statistics such as mean, standard deviation, frequency distribution and percentages were used to interpret the findings. Inferential statistics such as regression and correlation analysis were considered to establish how the elements of public water supplies, water policy

and management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya.

3.8. Ethical consideration

Prior arrangements and or appointments were made with the respondents on the day/ date and time the questionnaires and surveys were administered and conducted. The respondents were informed of the purpose of the study and as per the requirement not coerced or forced to give their responses but a friendly and conducive environment to participate and contribute voluntarily to the study. More importantly, the objectives of the study were explained before and after undertaking the research to aid in attaining an informed consent from the respondents. As per the law, the researcher is obliged to maintain high level confidentiality about the respondents' responses by way of keeping all responses secure and using them only for academic purposes. As also earlier stated that before embarking on any research, permission must be sought from the National Commission for Science, Technology and Innovation (NACOSTI) and this is a mandatory regulation/ requirement by the government of Kenya.

The survey was voluntary and did not contain information that would personally identify the respondents. Informed consent was given prior to the interview, and respondents who were willing to participate had also their right to withdraw at any time during the interview.

3.9. Operational definition of the variables

The research project provides an introductory context, specifically the concept of multifaceted access to water resources and management, research objectives, research questions, and brief methodological approaches. Finally a synthesis of the research and interlinks of findings from the five objectives of the study.

Table 3.2: Operationalization of Variables

Research Objectives	Variable	Indicators	Level of scale	Data Collection Tool	Data Analysis Technique	Tools of Data Analysis
To establish the extent to which sources of water supplies influence management of water resources in Mathare Slums, Nairobi City County, Kenya.	Sources of water supplies	No. of improved water sources No. of other water sources No. of unimproved water sources	Ordinal Nominal	Questionnaire / FGD	Descriptive statistics/ Correlation / Regression	SPSS MS. Excel
To determine the extent to which treatment of water and storage influence on the management of water resources in Mathare Slums, Nairobi City County, Kenya.	Treatment of water and storage	No. of households boiling water No. of households adding chlorine/ water guard No. of households with not treating water No. of households exposing water to solar (UV)	Ordinal Nominal	Questionnaire /FGD	Descriptive statistics/ Correlation / Regression	SPSS MS. Excel
To examine how distributions of water to users influence management of water resources in Mathare Slums, Nairobi City County, Kenya.	Distribution of water to users	No. of metered piped connections to dwelling houses/ plots No. of unmetered piped connections to dwelling houses/ plots No. of public taps/ standalone pipes No. of households harvesting rainwater for domestic use No. of water vendors No. of water kiosks No. of households using bottled water No. of tanker trucks/ water bowsers	Ordinal Nominal	Questionnaire / FGD	Descriptive statistics/ Correlation / Regression	SPSS MS. Excel
To assess how water policy influence management of water resources in Mathare Slums,	Water policy (Act 2002, Act 2016)	No. households aware of government policy on water access No. of households satisfied with NCWSC	Nominal	Questionnaire / FGD	Descriptive statistics/ Correlation /	SPSS MS.

Nairobi City County, Kenya.	NCWSC SP – 2015-2019	services			Regression	Excel
To determine the extent to which combined elements of public water supply and distribution influence management of water resources in Mathare Slums, Nairobi City County, Kenya.	Management of multifaceted water resources (Combined elements of public water supply & distribution)	No. of piped networks properly managed. No. of point sources properly managed. Level of aversion behaviour No. of protected springs. No. of protected boreholes/ tube wells No. of unprotected springs No. of dilapidated pipes Incidences of piped water mixing with sewerage	Nominal Ordinal	Questionnaire / FGD	Descriptive statistics/ Correlation / Regression	SPSS MS. Excel

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION, INTERPRETATION AND DISCUSSIONS

4.1. Introduction

This chapter presents and interprets findings of the study on Public Water Supplies, Water policy and Management of Multifaceted Water Resources in Mathare Slums, Nairobi city, Kenya which have been discussed under thematic areas and sub-thematic sections in line with the study objectives and research questions. The thematic areas include: Demographic characteristics, Sources of water supply and Management of Multifaceted Water Resources, Treatment and storage of water and Management of Multifaceted Water Resources, Distribution of water to end users and Management of Multifaceted Water Resources and finally Water policy and Management of Multifaceted Water Resources

4.2. Questionnaire Return Rate

Questionnaires with both open and close-ended questions to collect qualitative and quantitative data, respectively, were administered to a sample size of 398 of which 398 questionnaires were issued and all questionnaires were duly filled and returned. This constituted a response rate of 100% which was possible since the questionnaires were personally administered by 4 research assistants. The second group of respondents from the focus group discussion which was conducted after administration of questionnaires also returned a response rate of 86.7 % as 13 out of the expected 15 participants took part in the discussion. This return rate was in line with Nachimias and Nachimias, 1976, 2005 and Coopers and shiendler, 2000 who asserts that questionnaire return of 75% and above is adequate for social sciences to proceed. Given that the return rate was over and above the required rate, the study proceeded.

The results are presented in Table 4.1.

Table 4.1: Questionnaire Return Rate

Research Instrument - Questionnaire	Sample Size	Percent
Questionnaires issued	398	100
Questionnaires returned	398	100
Questionnaires not returned	00	00
Total	398	100
Research Instrument – Interview Guide for FGD		
No. of participants invited	15	100

No. of participants attended	13	86.7
No. of participants not attended	02	13.3
Total	15	100
Total – (Residents and FGD)	413	100

The response rate (93.35% on average) was adequate to derive the inferences regarding the objectives of the study and as stated by Nachimias and Nachimias, 1976, 2005 and Coopers & Shindler, 2000 who asserts that questionnaire return of 75% and above is adequate for social sciences to proceed and therefore given that the return rate was over and above the required rate, the study proceeded.

4.3. Demographic Characteristics of Respondents

Data for the study was gathered from both the residents of Mathare Slums and focus group discussion respondents and their demographic characteristics presented below.

4.3.1. Distribution of respondents by Gender, Age, Academic qualifications, Marital status, Average household income and Number of dependents

During the data collection exercise, respondents were asked to state their demographic characteristics and or alternatively the research assistants noted down the respondent's demographic characteristics. The resulting distributions are presented in Table 4.2.

Table 4.2: Demographic characteristics

Gender	Frequency	Percent
Male	149	37.4
Female	249	62.6
Total	398	100
Age		
18 - 28	159	40
29 - 39	106	26.7
40 - 50	80	20
51 - 61	40	10
Over 62	13	3.3
Total	398	100
Academic qualifications		
Primary	103	26
Secondary	139	35
Certificate	72	18
Diploma	52	13
Bachelors	32	8
Masters	0	0

Others	0	0
Total	398	100
Marital status		
Married	243	61
Single	103	26
Divorced	08	02
Others (Widowed)	44	11
Total	398	100
Average monthly household income (Kes)		
Less than 6000	48	12
6,001 – 9,000	83	21
9,001 – 15,000	90	22.5
15,001 – 24,000	107	27
Above 24,001	70	17.5
Total	398	100
Number of dependents		
1 - 2	111	28
3 - 4	140	35
5 - 6	119	30
7 - 8	28	7
Total	398	100

The findings on gender shows that out of the 398 respondents who took part in the study, 249(62.6%) were female while 149(37.4%) were male. The results show that the majority were female. This implies that female gender still dominate in knowledge about water for domestic use.

The results on age also shows that out 398 respondents who participated in the study 159 (40%) fell in the age bracket of 18-28 years, 106 (26.7%) were in the age bracket of 29-39 years, 80 (20%) were in bracket of 40-50 years, 40 (10%) were in age bracket of 51-61 years, while 13 (3.3%) fell in the age bracket of 62 years and above. This implies that the majority of the population in the study area are youthful thus 66.7% of respondents are below 40 years of age.

The findings on academic qualification indicates that out 398 respondents who participated in the study 103 (26%) had in primary level, 139 (35%) had secondary level, 72 (18%) had post-secondary certificate level, 52 (13%) had diploma level and 32 (8%) had bachelor degree as the highest qualification level of education. The implication of this on the focus of the study is that most of the residents are secondary school graduates and below and hence justify their level of income and their choice to reside in low informal settlement localities.

The results on marital status shows that out 398 respondents who participated in the study majority are married with 243 (61%), followed by single 103 (26%), then widowed 44 (11%) and the least was divorced with 8 (2%) of the total sample size. The implication is that the focus of the study was right and both gender and inclusion strategy considered.

From the results reveal that households that had an average monthly income below Kes. 6,000 were 48(12%), 83(21%) were getting income between Kes. 6,001- 9,000, 90 (22.5%) got between Kes.9, 001- 15,000, 107(27%) were getting between Kes. 15,001 – 24,000 which constituted the majority and 70 (17.5%) had an average monthly income above Kes.24, 001. The implication of these results confirmed that the focus group or respondents are of low income level hence justifying the slum or low income settlement locality.

Respondents from the study with 1-2 dependents in their households were 111 (28%), 3-4 dependents in their households had 140 (35%), 5-6 dependents had 119 (30%) and 28 (07%) had 7-8 dependents in their households.

4.4. Sources of Water Supply and Management of Multifaceted Water Resources

The researcher sought to establish respondents’ perception on the sources of water supplies and their influence on management of multifaceted water resources in Mathare Slums. The results are presented in table 4.3..

Table 4.3: Classification of main sources of water supply

Category	Frequency	Percent
Improved sources	52	13
Other improved sources	83	21
Unimproved sources	263	66
Total	398	100

The study established that the main source of water supply in the area is classified under unimproved sources with 263 (66%), followed by other improved sources 83 (21%) and then improved sources 52 (13%).

Table 4.4: Main sources of water supply at the residence

Main source	Frequency	Percent
Public/ stand-alone taps	80	20
Metered piped water supply connections	163	41
Unmetered piped water supply connections	12	03
Water kiosks	111	28
Water tankers/ carts	32	08

Total	398	100
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The study revealed that respondents with metered piped water supply connections were 163 (41%), unmetered piped water supply connections were 12 (03%), public taps were 80 (20%), water kiosks were 111 (28%) and water tankers/ carts were 32 (08%). This implies that most parts of Mathare slums are already connected with piped water and water kiosks.

4.4.1. Sources of water supply influence management of multifaceted water resources

The respondents were asked to give their opinion on their level of agreements or disagreements with the statements based on a likert scale of 1-5, where: 1 = strongly disagree, 2= disagree, 3=Neutral, 4= Agree and 5=Strongly Agree. Based on the results obtained, mean and standard deviation were also computed and the results are presented in table 4.5.

Table 4.5: Sources of water supply influence management of multifaceted water resources

Statements	1	2	3	4	5	Mean	SD
Classification of various Sources of water supply is distinctive and clear	48 (12%)	187 (47%)	28 (7%)	127 (32%)	8 (2%)	2.65	1.11
Improved sources of water supply such as piped water connection located inside user's house, plot or yard may not be necessarily safe for drinking	32 (8%)	48 (12%)	16 (4%)	231 (58%)	71 (18%)	3.66	1.14
Public water supply to the residents of Mathare slum is not adequate	12 (3%)	40 (10%)	4 (1%)	279 (70%)	63 (16%)	3.86	0.91
Other improved sources of water supply such as public taps, standalone pipes, protected boreholes and protected springs may be safe for drinking	75 (18.9%)	203 (51%)	76 (19.1%)	28 (7%)	16 (4%)	2.26	0.98
Unimproved sources of water supply such as unprotected borehole, unprotected spring, cart with small tanks, bottled water and surface water are or is the main source of water available in Mathare slum	80 (20%)	159 (40%)	0 (0%)	87 (22%)	72 (18%)	2.78	1.45
Improved sources of water supply is the main source and easily accessible	83 (21%)	247 (62%)	20 (5%)	48 (12%)	0 (0%)	2.1	0.86

The results in Table 4.5 shows that out of 398 respondents who participated in the study, 48(12%) strongly disagreed that classification of various sources of water supply is distinctive and clear, 187(47%) disagreed, 28(7%) were neutral, 127(32%) agreed, while 8(2%) strongly agreed that classification of various sources of water supply is distinctive and clear. This line statement had a mean score of 2.65 and standard deviation of 1.11 and therefore a clear indication that the majority of the respondents 187(47%) were not able to classify various sources of water appropriately as per the UNICEF / WHO Joint Monitoring Program classification hence implies that the line item influences management of multifaceted water resources negatively. Therefore there is need for this to be reviewed and adequate sensitization conducted.

On statement that improved sources of water supply such as piped water connection located inside user's house, plot or yard may not be necessarily safe for drinking, 32(8%) strongly disagreed with the statement, 48(12%) disagreed, 16(4%) were neutral, 231(58%) agreed, while 71(18%) strongly agreed with the statement. This line item had a mean score of 3.66 and standard deviation of 1.14 with a clear indication that majority of the respondents 231 (58%) agreed with the statement hence implies that the line item influences management of multifaceted water resources positively.

On statement that that, public water supply to the residents of Mathare slum is not adequate, 12(3%) strongly disagreed with the statement, 40(10%) disagreed, 4(1%) were neutral, 279(70%) agreed, while 63(16%) strongly agreed with the statement that public water supply to the residents of Mathare slum is not adequate. This has a mean score of 3.86 and standard deviation of 0.91 thus the majority of the respondents 279(70%) agreed with the statement implying that the line item influences management of multifaceted water resources positively.

On statement that other improved sources of water supply such as public taps, standalone pipes, protected boreholes and protected springs may be safe for drinking , 75(18.9%) strongly disagreed with the statement, 203(51%) disagreed, 76(19.1%) were neutral, 28(7%) agreed, while 16(4%) strongly agreed. This had a line item mean score of 2.26 and standard deviation 0.98 which portrayed that majority of the respondents 203(51%) did not agree with statement implying that the line item influences management of multifaceted water resources negatively.

On statement that unimproved sources of water supply such as unprotected borehole, unprotected spring, cart with small tanks, bottled water and surface water are or is the main source of water

available in Mathare slum, 80(20%) strongly disagreed with the statement, 159(40%) disagreed, 0(0%) were neutral, 87(22%) agreed, while 72(18%) strongly agreed. This had a line item mean score of 2.76 and standard deviation 1.45 which revealed that majority of the respondents 159 (40%) disagreed with the statement implying that the line item influences management of multifaceted water resources negatively.

On statement that improved sources of water supply is the main source and easily accessible, 83(21%) strongly disagreed with the statement, 247(62%) disagreed, 20(5%) were neutral, 48(12%) agreed, while 0(0%) strongly agreed. This had a line item mean score of 2.1 and standard deviation 0.86 which demonstrated that majority of the respondents 247(62%) disagreed with the statement implying that the line item influences management of multifaceted water resources negatively.

The general analysis of the means and standard deviations for the statements depict that the distribution of the response were stable and concentrated around the mean with small standard deviations.

4.5. Treatment and Storage of Water and Management of Multifaceted Water Resources

The researcher sought to determine water treatment and storage practices from the respondents. The results were as below.

Table 4.6: General perceptions of the respondents on water treatment and storage

Sources of water for drinking	No. of respondents	percentage
Piped water supply to households/ plots	163	41
Public taps and water kiosks	191	48
Other sources	44	11
Safety of the sources of water for drinking	No. of respondents	percentage
Yes	155	39
No	171	43
Don't know	72	11
Reasons for lack of trust on the quality sources of water for drinking	No. of respondents	percentage
Dilapidated pipes	107	27
Burst pipes	235	59
Mixture with sewerage	40	10
Contamination during and on-delivery	16	4
Methods of water treatment for drinking	No. of respondents	percentage
No treatment	294	73.8
Boiling	84	21.3
Adding water guard	20	4.9

Adding chlorine/ filtering/ exposing to solar	0	0
Methods of storage of water for drinking	No. of respondents	percentage
Jerricans	275	69
Superdrums	111	28
Pales	12	3

Majority of respondents indicated that their main source of water is public taps and kiosks with 191(48%), followed by household water supply/ pipe with 163(41%) while others constituted 44(11%).

On the question of whether the main source of water supply is safe for drinking, 155(39%) said yes, 171(43%) said no while 72(18%) responded that they don't know.

On the question why the respondents think the main source of supply is not safe for drinking, the following were the results: dilapidated pipes 107(27%), burst pipes 235(59%), mixture with sewerage 40(10%), contamination on-site 0(0%) while contamination during and on-delivery 16(4%).

On the method of water treatment at the household level, the respondents indicated that 294(73.8%) had no treatment, 84(21.3) were boiling, 20(4.9%) were adding water guard while adding chlorine, filtering and exposure to solar reported 0(0%).

On the method of storage, majority of the respondents were using Jerrican with 275(69%), superdrum 111 (28%) while pale 12(3%).

The respondents were also asked to give their opinion on their level of agreements or disagreements with the statements based on a likert scale of 1-5, where: 1 = strongly disagree, 2= disagree, 3=Neutral, 4= Agree and 5=Strongly Agree. Based on the results obtained, mean and standard deviation were also computed and presented.

Table 4.7: Treatment and storage of water influence management of multifaceted water resources

Statements	1	2	3	4	5	Mean	SD
Majority of the households in Mathare Slums are not aware of methods of water treatment and storage at home	116 (29.2%)	126 (31.7%)	76 (19%)	64 (16.1%)	16 (4%)	2.34	1.17
Majority of households in Mathare treat their water before drinking by either boiling, adding chlorine,	59 (14.8%)	252 (63.4%)	20 (5%)	52 (13%)	15 (3.8%)	2.28	0.99

adding water guard, or exposing to solar							
There are adequate household water storage equipment for treated water to mitigate against water shortages and eventualities	46 (11.5%)	167 (42%)	84 (21%)	91 (23%)	10 (2.5%)	2.63	1.39
Notable improvement in decrease in number of residents affected by water borne related ailments/ diseases	56 (14%)	175 (44%)	20 (5%)	103 (26%)	44 (11%)	2.76	1.28

The results in Table 4.6 shows that out of 398 respondents who participated in the study, 116(29.2%) strongly disagreed that majority of the households in Mathare Slums are not aware of methods of water treatment and storage at home, 126(31.7%) disagreed, 76(19%) were neutral, 64(16.1%) agreed, while 16(4%) strongly agreed. This line statement had a mean score of 2.34 and standard deviation of 1.17 thus majority of the respondents 126(31.7%) disagreed with the statement implying that the line item influences management of multifaceted water resources negatively.

On statement that majority of households in Mathare treat their water before drinking by either boiling, adding chlorine, adding water guard, or exposing to solar, 59(14.8%) strongly disagreed with the statement, 252(63.4%) disagreed, 20(5%) were neutral, 52(13%) agreed, while 15(3.8%) strongly agreed with the statement. This line item had a mean score of 2.28 and standard deviation of 0.99 hence majority 252(63.4%) disagreed with the statement. This implies that the line item influences management of multifaceted water resources negatively.

On statement that that there are adequate household water storage equipment for treated water to militate against water shortages and eventualities, 46(11.5%) strongly disagreed with the statement, 167(42%) disagreed, 84(21%) were neutral, 91(23%) agreed, while 10(2.5%) strongly agreed with the statement that public water supply to the residents of Mathare slum is not adequate. This has a mean score of 2.63 and standard deviation of 1.39 implying that the line item influences management of multifaceted water resources negatively as majority of the respondents 167(42%) disagreed with the statement.

On the last statement that notable improvement in decrease in number of residents affected by water borne related ailments/ diseases, 56(14%) strongly disagreed with the statement, 175(44%)

disagreed, 20(5%) were neutral, 103(26%) agreed, while 44(11%) strongly agreed. This had a line item mean score of 2.76 and standard deviation 1.28 which means that most of the respondents 175(44%) disagreed with the statement implying that the line item has negative influences on management of multifaceted water resources.

4.6. Distribution of Water to End Users & Management of Multifaceted Water Resources

The researcher sought to examine how distributions of water to users influence management of multifaceted water resources and the responses were recorded as explained below:

Respondents were asked to indicate on how water is distributed to them and 92(23%) mentioned through public taps, 158(39.7%) indicated metered piped connection to dwelling houses/ plot, 25(6.3%) indicated unmetered piped connection to dwelling plots while 123(31%) indicated water kiosks.

For the case of sources of drinking water to the households, only two category were mentioned with 236(59.4%) depended on public taps and water kiosks while 162(40.6%) depended on piped water supply to the plot/ house.

On the question on distribution breakdown, all the respondents said yes thus 398(100%) while on the frequency of distribution breakdown, majority indicated often 263(66%), every time 83(21%) while rarely 52(13%). On whether the breakdown is fixed promptly, all the respondents said no i.e. 398(100%). Responses for the frequency of water supply, revealed that 295(74%) get water supply once in three days, 91(23%) get supply once in two days while 12(3%) get water supply on daily basis. They also indicated that on the days they get water, it flows for 8 – 12 hours represented by 318(80%) while 12 – 16 hours represented by 80(20%). On rating the existing water supply infrastructure, 32(8%) indicated very good, 195(49%) indicated good while 171(43%) indicated poor. Finally on the approximate distance to the nearest water point, 231(58%) indicated 1-50 meters, 126(31.8%) indicated 51-100 meters, while 41(10.2%) indicated over 100 meters.

The respondents were also asked to give their opinion on their level of satisfactions or dissatisfactions with the statements based on a likert scale of 1-5, where: 1 = Very satisfied, 2= Satisfied, 3=Neutral, 4= Dissatisfied and 5=Very dissatisfied. Based on the results obtained, mean and standard deviation were also computed and the results are presented in table 4.7.

Table 4.8: Distribution of water to end users influence management of multifaceted water resources

Statements	1	2	3	4	5	Mean	SD
The source of water points are conveniently located	0 (0%)	80 (20%)	8 (2%)	310 (78%)	0 (0%)	3.58	0.805
There are effective maintenance practices for the water infrastructure systems in Mathare slums	29 (7.3%)	68 (17%)	76 (19%)	179 (45%)	46 (11.7%)	3.36	1.12
Water is continuously accessible, available and affordable to the residents	10 (2.4%)	28 (7%)	51 (12.8%)	106 (26.6%)	203 (51%)	4.17	1.059
NCWSC has adequate water distribution systems in the area	16 (4%)	111 (28%)	26 (6.5%)	135 (34%)	110 (27.5%)	3.53	1.27
There are inadequate water supply equipment serving the area	116 (29.3%)	133 (33.4%)	40 (10%)	97 (24.3%)	12 (3%)	2.39	1.22
The specific dimensions such as accessibility, affordability, quality, quantity, continuity and equity in water distributions to users in Mathare slums is assured and observed by NCWSC	8 (2%)	123 (31%)	56 (14%)	147 (37%)	64 (16%)	3.34	1.14
I am happy and satisfied with the NCWSC Ltd services	0 (0%)	100 (25%)	91 (23%)	171 (43%)	36 (9%)	3.36	0.96

The results in Table 4.7 shows that out of 398 respondents who participated in the study, none of the respondents were very satisfied that the source of water points are conveniently located, 80(20%) were satisfied, 8(2%) were neutral, 310(78%) dissatisfied, while none were very dissatisfied. This line statement had a mean score of 3.58 and standard deviation of 0.805 which revealed that majority of the respondents 310(78%) were dissatisfied with the statement hence this implies that the line influences management of multifaceted water resources negatively.

On statement that there are effective maintenance practices for the water infrastructure systems in Mathare slums, 29(7.3%) were very satisfied with the statement, 68(17%) were satisfied, 76(19%) were neutral, 179(45%) dissatisfied, while 46(11.7%) very dissatisfied with the statement. This line item had a mean score of 3.36 and standard deviation of 1.12 which indicate

that majority of the respondents 179(45%) were dissatisfied with the line statement. This implies that the line item influences management of multifaceted water resources negatively.

On statement that water is continuously accessible, available and affordable to the residents, 10(2.4%) were very satisfied with the statement, 28(7%) were satisfied, 51(12.8%) were neutral, 106(26.6%) dissatisfied, while 203(51%) were very dissatisfied with the statement. This has a mean score of 4.17 and standard deviation of 1.059 which indicated that majority of the respondents 203(51%) were very dissatisfied with the statement hence implying that the line item influences management of multifaceted water resources negatively.

On the statement that NCWSC has adequate water distribution systems in the area, 16(4%) were very satisfied with the statement, 111(28%) were satisfied, 26(6.5%) were neutral, 135(34%) were dissatisfied, while 110(27.5%) were very dissatisfied. This had a line item mean score of 3.53 and standard deviation 1.27 showing that most of the respondents 135(34%) were dissatisfied with statement implying that the line item influences management of multifaceted water resources negatively.

On the statement that there are inadequate water supply equipment serving the area, 116(29.3%) were very satisfied with the statement, 133(33.4%) were satisfied, 40(10%) were neutral, 97(24.3%) were dissatisfied, while 12(3%) were very dissatisfied. This had a line item mean score of 2.39 and standard deviation 1.22 which revealed that majority of the respondents 133(33.4%) were satisfied with the line statement implying that the line item influences management of multifaceted water resources positively.

On the statement that the specific dimensions such as accessibility, affordability, quality, quantity, continuity and equity in water distributions to users in Mathare slums is assured and observed by NCWSC, 8(2%) were very satisfied with the statement, 123(31%) were satisfied, 56(14%) were neutral, 147(37%) were dissatisfied, while 64(16%) were very dissatisfied. This had a line item mean score of 3.34 and standard deviation 1.14 which portrays that majority of the respondents 147(37%) implying that the line item influences management of multifaceted water resources negatively.

On the statement that I am happy and satisfied with the NCWSC Ltd services, none were very satisfied with the statement, 100(25%) were satisfied, 91(23%) were neutral, 171(43%) were dissatisfied, while 36(9%) were very dissatisfied. This had a line item mean score of 3.36 and standard deviation 0.96 which means majority of the respondents 171(43%) were dissatisfied

with the statement implying that the line item influences management of multifaceted water resources negatively.

4.7. Water Policy and Management of Multifaceted Water Resources

The researcher sought to assess how water policy influence management of multifaceted water resources. Respondents opinion were sought on the quality of life due to formalization of water supply by NCWSC, 48(12%) felt that health has improved, 142(35.6%) felt that expenditure on water has reduced, 152(38.2%) felt that less time used to fetch water, 48(12.1%) felt that better relationship has been established with NCWSC, while 8(2.1%) were not for any of the options. On rating on access to water, water quality, affordability and pro-poor focus, 44(11%) respondents indicated that life has improved, 123(31%) life is the same, while 231(58%) indicated that life has not improved. Interrogating respondents awareness of the pro-poor water policy, 52(13%) confirmed they were aware and narrated that people should have access to clean and affordable water and good sanitation services while majority 346(87%) confirmed they were not aware of the pro-poor water policy. On the incidences reported to NCWSC regarding their services to the residents, 84(21.1%) reported burst pipes, 12(3%) reported illegal connections, 7(1.7%) reported cartels, 36(9%) reported vandalism of pipes, 67(16.9%) reported water disruption, 24(6%) reported over-priced water bills, while 168(42.3%) do not report anything. The respondents were also requested to give their opinion on their level of satisfactions or dissatisfactions with the statements based on a likert scale of 1-5, where: 1 = Very satisfied, 2= Satisfied, 3=Neutral, 4= Dissatisfied and 5=Very dissatisfied. Based on the results obtained, mean and standard deviation were also computed and presented.

Table 4.9: Water policy influence management of multifaceted water resources

Statements	1	2	3	4	5	Mean	SD
There are adequate regulations and policy on management of multifaceted water resources	14 (3.4%)	72 (18%)	91 (23%)	191 (48%)	30 (7.6%)	3.38	0.98
Residents of Mathare slums are aware of the pro-poor water policy	17 (4.3%)	52 (13.1%)	127 (32%)	145 (36.3%)	57 (14.3%)	3.43	1.03
The residents of Mathare slums are aware of their constitutional rights to clean, affordable & access to water	92 (23%)	157 (39.5%)	96 (24%)	38 (9.6%)	15 (3.9%)	2.31	1.05

The institutions mandated to provide policies and guidelines to ensure adequate public water supply are doing effective and efficient services	36 (9.1%)	111 (27.8%)	78 (19.7%)	121 (30.4%)	52 (13%)	3.11	1.21
Devolved functions in public water supply and distributions are clear to the concerned agencies and stakeholders	31 (7.7%)	92 (23%)	57 (14.3%)	119 (30%)	99 (25%)	3.41	1.29
Decision making process on water management are effective	40 (10.1%)	56 (14%)	63 (15.7%)	115 (29%)	124 (31.2%)	3.57	1.33

The results in Table 4.7 shows that out of 398 respondents who participated in the study, 14(3.4%) were very satisfied that there are adequate regulations and policy on management of multifaceted water resources, 72(18%) were satisfied, 91(23%) were neutral, 191(48%) dissatisfied, while 30(7.6%) were very dissatisfied. This line statement had a mean score of 3.38 and standard deviation of 0.98 which indicates that majority of the respondents 191(48%) were dissatisfied with the statement hence implying that the line influences management of multifaceted water resources negatively.

On statement that residents of Mathare slums are aware of the pro-poor water policy, 17(4.3%) were very satisfied with the statement, 52(13.1%) were satisfied, 127(32%) were neutral, 145(36.3%) dissatisfied, while 57(14.3%) very dissatisfied with the statement. This line item had a mean score of 3.43 and standard deviation of 1.03 which means that majority 145(36.3%) were dissatisfied with the statement. This implies that the line item influences management of multifaceted water resources negatively.

On statement that the residents of Mathare slums are aware of their constitutional rights to clean, affordable & access to water, 92(23%) were very satisfied with the statement, 157(39.5%) were satisfied, 96(24%) were neutral, 38(9.6%) dissatisfied, while 15(3.9%) were very dissatisfied with the statement. This has a mean score of 2.31 and standard deviation of 1.05 implying that the line item influences management of multifaceted water resources positively as majority of the respondents were satisfied with the statement.

On the statement that the institutions mandated to provide policies and guidelines to ensure adequate public water supply are doing effective and efficient services, 36(9.1%) were very

satisfied with the statement, 111(27.8%) were satisfied, 78(19.7%) were neutral, 121(30.4%) were dissatisfied, while 52(13%) were very dissatisfied. This had a line item mean score of 3.11 and standard deviation 1.21 implying that the line item influences management of multifaceted water resources negatively as most of the respondents 121(30.4%) were dissatisfied with the statement.

On the statement that devolved functions in public water supply and distributions are clear to the concerned agencies and stakeholders, 31(7.7%) were very satisfied with the statement, 92(23%) were satisfied, 57(14.3%) were neutral, 119(30%) were dissatisfied, while 99(25%) were very dissatisfied. This had a line item mean score of 3.41 and standard deviation 1.29 implying that the line item influences management of multifaceted water resources negatively as most of the respondents 119(30%) were dissatisfied with the statement.

On the statement that decision making process on water management are effective, 40(10.1%) were very satisfied with the statement, 56(14%) were satisfied, 63(15.7%) were neutral, 115(29%) were dissatisfied, while 124(31.2%) were very dissatisfied. This had a line item mean score of 3.36 and standard deviation 0.96 which implying that the line item influences management of multifaceted water resources negatively as majority of the respondents 124(31.2%) were dissatisfied with the line statement.

Finally, on the general ranking of the variables on their levels of influence in regards to public water supplies, water policy and management of multifaceted water resources in the study location, the respondents were asked to rank the statements based on a likert scale of 1-5, where: 1 = Very low, 2= Low, 3= Average, 4= High and 5=Highest. Based on the results obtained, mean and standard deviation were also computed and results are presented in table 4.9.

Table 4.10: Ranking of variables

Statements	1	2	3	4	5	d ²	r
Sources of water supply influence to management of multifaceted water resources	12 (3%)	12 (3%)	55 (14%)	239 (60%)	80 (20%)	3	+0.85
Treatment and storage of water influence to management of multifaceted water resources	8 (2%)	68 (17%)	282 (71%)	40 (10%)	0 (0%)	26	-0.3
Distributions of water to users influence to management of multifaceted water resources	0 (0%)	7 (1.7%)	64 (16%)	215 (54%)	112 (28.3%)	2	+0.9
Water policy influence to	29	80	131	105	53	14	+0.3

management of multifaceted water resources	(7.3%)	(20%)	(33%)	(26.4%)	(13.3%)		
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The results in Table 4.9 shows that out of 398 respondents who participated in the study, on the first variable, 12(3%) ranked very low, 12(3%) ranked low, 55(14%) ranked average, 239(60%) ranked high, while 80(20%) ranked highest.

On the second variable, 8(2%) indicated very low with the statement, 68(17%) low, 282(71%) were average, 40(10%) high, while none ranked highest.

On third variable, none ranked very low, 7(1.7%) ranked low, 64(16%) ranked average, 215(54%) ranked high, while 112(28.3%) ranked highest.

On the fourth and last variable, 29(7.3%) ranked on very low, 80(20%) ranked on low, 131(33%) ranked on average, 105(26.4%) ranked on high, while 53(13.3%) ranked on highest.

The results indicated that there exist stronger and significant positive correlations between sources of water supply influence to management of multifaceted water resources as $r = +0.85$ and also distributions of water to users influence to management of multifaceted water resources as $r = +0.9$ while there exist weaker negative and positive correlations between treatment and storage of water influence to management of multifaceted water resources as $r = -0.3$ and water policy influence to management of multifaceted water resources as $r = +0.3$ respectively.

4.8. Discussion

This section of the report discusses the findings in detail and compares with the empirical and theoretical studies under literature review in chapter two.

4.8.1. Demographic Characteristics

The findings on gender revealed that most of the respondents were female (62.6%) which was 25.2% more than male (37.4%). This confirmed that female gender still dominates in knowledge about water for domestic use and the distribution is skewed. The age bracket of the majority of population is between 18 – 39 years old constituting 66.7% of the respondents; 61% of the respondents were either primary or secondary school graduate as their highest academic qualification level of education and by coincidence, 61% are married followed closely by singles at 26% of the total sample size. Majority of Mathare Slums get monthly average income of between kes. 15001 – 24000 which was represented by 27% of the sample size and followed by

22.5% which falls between kes. 9001–15000 monthly and dependency was between 3-4 per household represented by 35% and followed by 5-6 which constituted 30% of the total sample size.

4.8.2. Water Supply and Management of Multifaceted Water Resources

The descriptive analysis of the results revealed remarkable trends about the assessment of the extent to which sources of water supply influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya. First, it confirmed that majority of the populace in low settlement areas aren't aware of the JMP classification of three sources of water supply and this could have contributed to the majority of the respondents (66%) categorizing their sources as unimproved, followed by other improved (21%) and lastly improved sources (13%). The study also revealed that 41% of the piped water supply connections in the area are metered while those served through public taps and water kiosks constituted 48%. These are supported by the empirical studies that confirmed that JMP classifies in-house water supply into piped water, other improved as well as the unimproved sources. The layman language of accessing water involves providing certain types of “improved” sources of water at home. “Access level” is also measured by the percentage of the population utilizing enhanced or improved sources of water. At the global level, the current monitoring framework focuses on measuring the level of access: the proportion of unserved, underserved to be served by improved source of water. These classifications merely serve as a proxy indicator and only encapsulate household water technological outlets and do not equal safe water (UNICEF & WHO, 2011). Physical access may not necessarily result in the continued use of improved water sources nor bring the intended development outcomes such as health and economic benefits.

Access dimensions come in with different quality, quantity, continuity, and affordability range (Nganyanyuka et al., 2014). Even if people have access to piped water, it often has inadequate quality and quantity, is intermittent, or cannot be afforded (Tshikolomo et al., 2012). Also from the empirical study conducted by Chepchirchir et al (2015) on the undeserved households in Kenya showed that most households regularly imported their domestic water from more than one source among the variety of water-service provision options available and majority of households perceived their source of water sources as unfit for drinking. This is strongly in line with the study findings. Sumila et al (2005) study on water for the urban poor where he compared how inadequate the urban poor are served by public utilities and small-scale private

water suppliers compared to the non-poor and the result indicated that “price water and create water markets” is inadequate in itself to improve service delivery and that without adequate institutional arrangements, technological solutions such as water kiosks that fail to deliver an affordable service to the poor. Another study by Karanja (2018) focusing on factors influencing water services provision in Kenya found that increase in water sources, efficient water management and improved water supply infrastructure would lead to increase in water services provision while good environmental conditions has a positive relationship with water service provision.

Further analysis of the various statements on the extent to which sources of water supply influence management of multifaceted water resources in Mathare Slums, Nairobi City County, gave line means of 2.65, 3.66, 3.86, 2.26, 2.78 and 2.1 and standard deviations of 1.11, 1.14, 0.91, 0.98, 1.45 and 0.86 which were good reflection that distribution of the responses were stable as the means and standard deviations were small. The variable also portrayed existence of stronger and significant positive correlations between sources of water supply influence to management of multifaceted water resources as $r = +0.85$ and the statement supported by the majority of the respondents 239(60%). Finally, these results are backed up by Meeks (2012) who stated that water sources play a significant and key role in influencing adequate supply of water to residents in different localities.

4.8.3. Treatment and Storage of Water & Management of Multifaceted Water Resources

The results from the study showed that the main source of water for the is public taps and water kiosks with 48%, followed by household water supply/ pipe with 41% while confirming that the sources of water supply aren't safe supported by 43% of the respondents. On the status of the infrastructure, 59% of the respondents mentioned burst pipes while 27% mentioned dilapidated pipes as the major causes of water contamination hence making it not potable while at the same time confirming that majority also do not treat their water for drinking with 73.8% respondents supported the statement and the method of storage is generally by use of Jerrican (69%) and super-drum (28%).

As clearly noted in the literature review, lack of dimensions of access may lead to a variety of strategies that households employ (Howard et al., 2002). Boiling, filtrations, application of chlorine as well as ultraviolet (UV) disinfection are considered appropriate treatment methods to improve water quality (WHO & UNICEF, 2011). Study conducted by Neumann et al (2014)

discovered that multiple water sources, rescheduling activities based on water availability, home water treatment and storage, and even moving to another house with better water services, was reported as individual household strategies for maintaining access to a more secure water supply and also study by Rugemalila & Gibbs (2015) confirmed that Nairobi residents are carrying out various methods to acquire water, such as purchasing water from sales kiosks, tanks, vendors; walking long distances; buying from water trucks; buying many storage vessels; harvesting rainwater; domestic water budgeting; and making illegal connections. Another study by Kimani & Ngindu (2007) on quality of water the slum dwellers use indicated that water contamination is via surface runoff and possible faecal contamination. Cook et al (2016) studied on the costs of coping with poor water supply in rural Kenya and found that households with unprotected private wells or connections to an intermittent piped network spend money on water storage containers and on treating water they recognize as unsafe. Finally a study by Chepchirchir et al (2015) on sustainable supply of safe drinking water for undeserved households in Kenya revealed that majority of households perceived their source of water as unsafe for drinking and further reiterated that drinking water was mainly chlorinated or boiled for this purpose. However, the study also found that Kenyan households did not consistently apply these methods of treating household water, thus indicating inconsistency in safe water consumption.

All these findings are in line with the findings of this research study as supported by the statement on the extent to which treatment and storage of water influence management of multifaceted water resources and obtained lines means of 2.34, 2.28, 2.63, & 2.79 and lines standard deviations of 1.17, 0.99, 1.39 & 1.28 which shows that distributions of the responses were stable. It is also further confirmed by the weaker and insignificant negative correlations between treatment and storage of water influence to management of multifaceted water resources as $r = - 0.3$.

4.8.4. Distribution of Water to End Users & Management of Multifaceted Water Resources

The study established that there exist three major water distribution channels in Mathare Slums of which 39.7% indicated they get their water through metered piped connection to plots, 31% indicated water kiosks and 23% mentioned through public taps and further analysis revealed that drinking water is sourced from public taps and water kiosks (59.4%) and piped water supply to plots constituting 40.6% of the respondents. Further study showed that water distribution is not reliable because of frequent water distribution breakdown and not fixed promptly supported by

66% of the respondents; 74% of the respondents indicated that water supply is once in three days in which water flows between 8 – 12 hours when it is available supported by 80% of the respondents; poor state of water infrastructure in the area confirmed by 43% and the approximate distance covered to get water is between 1 – 50 meters supported by 58% of the population sample size.

Improving access is mostly experienced by the high quintile populations, and it is reported that poorer households are more likely to rely on unimproved or unsafe sources of water (UNICEF & WHO, 2011). At the same time access to piped water is often restricted to the richest population quintile, while the poor continue to rely on non-piped sources of water, such as hand pumps (UNICEF & WHO, 2011). Piped water services, the most enhanced mode of supply, often fail to deliver drinking water on continuous basis directly to dwelling plots (Lee & Schwab, 2005). A household can rely on multiple ways to cope with these shortcomings and get adequate water for their daily uses. Households often use multiple sources of water in an attempt to match source to intended use (Neumann et al., 2014). In Nairobi households, piped water often combines with unimproved sources of water, such as vendor water, or bottled water. Water transport to slums has been a challenge since the early history of urban development. Population growth in the outskirts of cities is occurring faster in the post-colonial region of the South than in urban centres, but development of infrastructure is inconsistent. Centralized water infrastructure development has focused primarily on urban centers and has not reached sprawling areas on the outskirts of towns and low settlement areas. Peri-urban and slum residents remain underserved if any, as neither networked public utilities nor large-scale private water companies are able (or, indeed, willing) to efficiently service these areas (Allen et al., 2006). All these literature reviewed highly support the above findings and the means and standard deviations obtained based on the statement on how distribution of water to end users influence management of multifaceted water resources, which were 3.58, 3.36, 4.17, 3.53, 2.39, 3.34 & 3.36 and lines standard deviations of 0.805, 0.112, 1.059, 1.27, 1.22, 1.14 & 0.96 clearly demonstrated that the distributions of the responses were stable. This was further backed up by stronger and significant positive correlations between distribution of water to end users influence to management of multifaceted water resources as $r = +0.90$.

4.8.5. Water Policy and Management of Multifaceted Water Resources

The study findings indicated that 38.2% of the respondents spent less time to fetch water while 35.6% felt that expenditure on water has reduced when were asked to give their opinion regarding quality of life due to formalization of water supply by NCWSC. On access to water, water quality, affordability and pro-poor focus; 58% of the respondents indicated that life has not improved while 31% indicated that life is the same. On pro-poor water policy revealed that majority of the respondents 87% confirmed they were not aware of the pro-poor water policy and only 13% indicated they were aware and narrated that people should have access to clean and affordable water and good sanitation services and on reporting incidences to NWCSC, majority 42.3% of the respondents mentioned that do not report anything.

Cross-checking the results of the study with study conducted by WASREB (2018) on performance report of Kenya's water services sector focusing on the new institutional framework based on the Water Act of 2016, anticipating the formation and transformation of various water sector institutions to align with the new constitution and also the focused group discussion conducted bringing onboard all the water stakeholders within the study area, concurred and confirmed the findings as follows. The findings of the new framework were: First, the Water Services Regulatory Board (WASREB), although with an enhanced mandate, retains its name and role as water services regulator. This improvement relates in particular to monitoring and the fact that the Regulator will now play a more direct role in licensing water service providers (WSPs.). Secondly, the Water Resources Management Authority (WRMA) changes its name to the Water Resources Authority (WRA) with the mandate to regulate water resource management and utilization at national level. At the regional level, Catchment Areas Advisory Committees (CAACs) are changing their name to Basin Water Resources. Water Services Boards (WSBs) are expected to turn into Water Works Development Agencies (WWDAs) with a mandate on a needs-based basis for cross-county municipal water works and committees with the responsibility of water resources management at basin level. Third, Water Services Boards (WSBs) are expected to turn into Water Works Development Agencies (WWDAs) with a mandate on a needs-based basis for cross-county municipal water works. Fourthly, National Water Conservation and Pipeline Corporation changes the name of the National Water Harvesting and Storage Authority (NWHSA) with the mandate to undertake the development of national public water storage and flood control works on behalf of the national government.

Existing water service providers (services) continue to act as providers of county water services or as providers of cross county water services, as the case may be. County governments may establish other water service providers as public limited liability companies under the 2015 Companies Act, but must comply with WASREB's commercial viability standards. This also applies to any other bodies providing water services to the public. Fifth, the Water Services Trust Fund (WSTF) changes from a funding mechanism to a funding institution and is renamed the Water Sector Trust Fund, with an expanded mandate to cooperate with County Governments and Water Resource Users Associations (WRUAs) on the provision of water services in areas that are underserved as well as catchment management. In addition, the WSTF has the authority to mobilize private investors' financial capital for onward lending to creditworthy utilities as promoting research on water infrastructure and water supplies. The core mandate is to assist in funding water resources development and management in marginalize areas or in any underserved region. Sixth, the Court of Appeals for Water has its name changed to Water Tribunal. It has the powers to hear and decide appeals from any person or entity directly impacted by the decision or order responsible for matters relating to water, Water Resources Authority and the Water Services Regulatory Board. The tribunal also has authority to consider and resolve any dispute over water resources or water facilities where a business contract exist, unless the parties have agreed otherwise to an alternative dispute settlement mechanism. Another empirical study by Karimi (2011) on the influence of water provision on quality of life for urban slum dwellers revealed that 91.8% of the respondents were not aware of the pro-poor policy on water and sanitation as per the new constitution while only 8.2% were knowledgeable about the policy. Another study by Fuente et al. (2016) on water and sanitation services delivery, pricing and the poor in Nairobi, Kenya found that contrary to conventional wisdom, high-income residential and nonresidential customers receive a disproportionate share of subsidies and that subsidy targeting the poor even among households with a private metered connection. The study also found that the stated expenditure on water, a commonly used means of estimating water use, is a poor proxy for metered use and previous studies on subsidy incidence underestimated the magnitude of the subsidy delivered through water tariffs.

These findings are found to conform to the findings of the study in addition to the obtained means and standard deviations on the statement on how water policy influence management of multifaceted water resources which were 3.38, 3.43, 2.31, 3.11, 3.41 & 3.57 and 0.98, 1.03, 1.05,

1.21, 1.29 & 1.33 respectively further confirming that the distributions of the responses were stable. Correlation depicted weaker and insignificant positive relationships between water policy influence to management of multifaceted water resources as $r = + 0.3$.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

Chapter five provides summary of key findings, discussion, conclusions and recommendations and also suggestions for possible further research.

5.2. Summary of Findings

The findings of the study have been summarized according to the four variables of the study namely sources of water supply, treatment & storage of water, distribution of water to end users and water policy.

5.2.1. Sources of Water Supply and Management of Multifaceted Water Resources

The first research objective of the study was to establish the extent to which sources of water supplies influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya. The results obtained established that the main source of water supply in the area is classified under unimproved sources with 263 (66%), followed by other improved sources 83 (21%) and then improved sources 52 (13%). The research also revealed that respondents with metered piped water supply connections were the majority 163 (41%), followed by water kiosks were 111 (28%) and public taps were 80 (20%). On the statements on the extent to which sources of water supply influence management of multifaceted water resources, line means of 2.65, 3.66, 3.86, 2.26, 2.78 and 2.1 and standard deviations of 1.11, 1.14, 0.91, 0.98, 1.45 and 0.86 were obtained reflecting that distribution of the responses were stable as the means and standard deviations were small.

Finally, on ranking the variable, the results indicated that there exist stronger and significant positive correlations between sources of water supply influence to management of multifaceted water resources as $r = +0.85$ and the statement supported by the majority of the respondents 239(60%).

5.2.2. Treatment and Storage of Water and Management of Multifaceted Water Resources

The second research objective of the study was to determine the extent to which treatment of water and storage influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya. From the responses, majority indicated that their main source of

water is public taps and water kiosks with 191(48%), followed by household water supply/ pipe with 163(41%) while confirming that the sources of water supply aren't safe supported by 171(43%) of the respondents. On the status of the infrastructure, majority indicated that burst pipes 235(59%) and dilapidated pipes 107(27%) were majorly contributing to water contamination hence making it not safe for drinking (not potable) while at the same time confirming that majority also do not treat their water for drinking with 294(73.8%) respondents supported the statement and the method of storage is by use of Jerrican with 275(69%) and superdrum 111 (28%).

On the statement on the extent to which treatment and storage of water influence management of multifaceted water resources, lines means of 2.34, 2.28, 2.63, & 2.79 and lines standard deviations of 1.17, 0.99, 1.39 & 1.28 were obtained showing that the distributions of the responses were stable. On ranking of the variable, the results indicated that there exist weaker and insignificant negative correlations between treatment and storage of water influence to management of multifaceted water resources as $r = - 0.3$ and the statement supported by the majority of the respondents 282(71%).

5.2.3. Distribution of Water to End Users & Management of Multifaceted Water Resources

The third research objective of the study was to examine how distributions of water to users influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya. From the findings, there exist three major distribution channels; 158(39.7%) indicated they get their water through metered piped connection to plots, 123(31%) indicated water kiosks and 92(23%) mentioned through public taps and further analysis revealed that drinking water is sourced from public taps and water kiosks (59.4%) and piped water supply to plots constituting 40.6% of the respondents. There are frequent water distribution breakdown in Mathare supported by 263(66%) of the respondents; they aren't fixed promptly; water supply is once in three days 295(74%) of respondents; in which water flows between 8 – 12 hours supported by 318(80%) of the respondents; poor state of water infrastructure in the area confirmed by 171(43%) and the approximate distance covered to get water is between 1 – 50 meters supported by 231(58%). On the statement on how distribution of water to end users influence management of multifaceted water resources, lines means of 3.58, 3.36, 4.17, 3.53, 2.39, 3.34 & 3.36 and lines standard deviations of 0.805, 0.112, 1.059, 1.27, 1.22, 1.14 & 0.96 were obtained showing that the distributions of the responses were stable. On ranking of the variable, the results indicated that

there exist stronger and significant positive correlations between distribution of water to end users influence to management of multifaceted water resources as $r = +0.90$ and the statement supported by the majority of the respondents 215(54%) of the respondents.

5.2.4. Water Policy and Management of Multifaceted Water Resources

The fourth research objective of the study was to assess how water policy influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya. The findings from the analysis shows that many respondents 152(38.2%) felt that less time used to fetch water and 142(35.6%) felt that expenditure on water has reduced when were asked to give their opinion on the quality of life due to formalization of water supply by NCWSC. On access to water, water quality, affordability and pro-poor focus; 231(58%) of the respondents indicated that life has not improved and 123(31%) indicated that life is the same. Findings on pro-poor water policy revealed that majority of the respondents 346(87%) confirmed they were not aware of the pro-poor water policy and only 52(13%) indicated they were aware and narrated that people should have access to clean and affordable water and good sanitation services and on reporting incidences to NWCSC, majority 168(42.3%) of the respondents do not report anything.

On the statement on how water policy influence management of multifaceted water resources, lines means of 3.38, 3.43, 2.31, 3.11, 3.41 & 3.57 and lines standard deviations of 0.98, 1.03, 1.05, 1.21, 1.29 & 1.33 were obtained showing that the distributions of the responses were stable. On ranking the variable, the results indicated that there exist weaker and insignificant positive correlations between water policy influence to management of multifaceted water resources as $r = + 0.3$ and the statement supported by the majority of the respondents 131(33%).

5.3. Conclusions

The study deduced that sources of water supplies, treatment and storage of water, distribution of water to end users and water policy influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya.

Objective one on sources of water supply and management of multifaceted water resources concludes that modes of water delivery, through state-centric and primarily public approaches are gaining positive trend even though more efficient and effectively strategies needed to address growing demand for water in the poor informal settlements where poverty and overcrowding continue to exacerbate water insecurity. There is also notable interest by both public and private water

supply systems to improve access for poor urban communities demonstrated by more attention turned to alternatives involving diverse partnerships and arrangements among public, private, non-governmental organizations (NGOs), civil society organizations, and water-user committees. **Objective two** on treatment and storage of water and management of multifaceted water resources concludes that population growth, changing lifestyles, increasing pollution and accelerating urbanization continues to widen the gap between the demand for water and available supply in Mathare Slums and disproportionately affecting the residents. Distribution and allocation of water already affected by climate-induced water stresses, poor institutions, ineffective governance, and weak political good-will to address scarcity and mediate uncertainties in future supply. SDG 6 aims for the delivery of safe drinking water to all inhabitants including safe distribution networks; however, the relevant government agencies should also ensure adequate treatment of storm and runoff water to prevent pollution of water bodies for the ecosystem. However, challenges still remain for the future, particularly in informal settlements where the indicators seem to underestimate an already insufficient and critical access to a safe drinking water. Context matters, of course, and ill-informed knowledge of urban slum dynamics, ways of conceptualizing urban space, and estimations of effective access to water will most likely impede service delivery, which can have substantial economic, social and health consequences. In this sense, urban planning and water governance can be instrumental in mediating urban slum water demand and supply and for meeting the necessarily contextual trade-offs between visions of water as an economic value and water as a common good.

Objective three on distribution of water to end users and management of multifaceted water resources deduces that Nairobi City, Kenya, continues to experience one of the most rapid urbanization process in the region and this unprecedented urban growth is likely to be absorbed in large part by spontaneous settlements where access to water and other basic services are already inadequate and creating conflict amongst users. Consequently, unplanned urban population growth especially in Mathare Slum remains a serious threat to water security and even in other informal settlements and hence increase in water demand. It is a real challenge for the sustainability of the water resource itself, but also for the existing infrastructure and the capacity of government institutions to deliver safe drinking water to each household, which goes hand in hand with the issue of concentration and spatial distribution of consumer demand versus the reliability, continuity, quantity and quality of supply. On the concern of greater access to

water for urban slums populations, significant and positive progress has been made over the last few years from the point of view of the respondents.

Objective four on water and management of multifaceted water resources of the study concludes that extending access to piped water requires data for coordinated low settlement urban planning, increased investment in water infrastructure and maintenance and good governance. This can be realized through extending formal piped network with the goal of meeting universal access to piped water to the slums resident plots; addressing context-specific of intermittent water supply, using technology to detect leaks, and improving regular infrastructure maintenance to reduce leaks; pursuing diverse strategies to make water affordable with special consideration to the slum dwellers (pro-poor policy); and lastly, supporting informal settlement upgrading to improve water access.

Objective five on public water supply and management of multifaceted water resources deduces that it is necessary to focus on an holistic urban water management strategy which remains critical one by focusing not only on biophysical and engineering dimensions of water but also pays sufficient attention to water governance, including politics, financing, urban planning, infrastructure, technology transfer, architecture and stakeholder involvement. Relevant stakeholders, including households, should be involved to make urban low settlement water management sustainable. Good governance, leadership and good political will is needed in Mathare Slums to exploit the opportunities for sustainable urban water management that brings urban development, economic and environmental benefits, and ultimately improvements to the quality of life of the urban population. It is important and best management practice that National and County governments call on all stakeholders to collaborate and cooperate while setting water prices that will enable long-term investment in and maintenance of their water infrastructure, and provide incentive for more efficient use of water.

5.4. Recommendations

In line with the above aforementioned findings with the reference to the five objectives of the study, the following recommendations are made:

1. Water resources management should be prioritized to increase the amount and quality of available water but good water resources management is essential to ensuring continuity, sustainability and resilience.

2. Good water governance to ensure adequate supply of water where interventions such as strengthening policy, institutional and regulatory frameworks.
3. Access to funding and support from government institutions, international bodies, and coordination with other regional initiatives and policy processes are important motivations.
4. Both Country-level and County-level metrics on access to improved water sources should be strengthened; there is also a need for targeted research and improved data on urban low settlement areas so as to improve policies aimed at universal and equitable access to water. This research should not only document disparities and the facts related to access, but also identify the paths forward for expanding access to this vital resource.
5. Connecting poor people to utility water supplies through kiosks and other measures can reduce the price they pay for water however caution should be taken to ensure these access modalities do not increase their vulnerability.
6. Finally, appropriate interventions to strengthen water security for the low settlement Mathare Slums community should focus on four major areas such as acceptable water quality (potable), affordable access to WASH services, adequate water availability, and good water resources management to guarantee sustainable access, continuity, reliability and availability.

5.5. Suggestions for Further Research

The implications of the study findings show that sources of water supply, treatment and storage of water, distribution of water to end users, and water policy positively influence management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya hence more detailed further research studies required:

1. There is a lot of potential for new research to understand opportunities and prospects of different policies and institutional arrangements for improving urban slums water access. As we have demonstrated with the case of Mathare Slums, alternatives to orthodox, centralized approaches could help advance sustainable water access in the context of growing population and urbanization in Kenya.
2. More case studies are needed to understand how context may shape outcomes, how social and power relations between different actors' influence who has access to water in low settlement urban spaces, documenting who is excluded, and who participates in decision

making. Future research directions should include how alternative, syncretic, hybrid arrangements are driven by the modalities of participation.

3. Another area of future research is on the concerns of worsening water quality and water pollution that reduce the suitability of low water levels. County government of Nairobi, Nairobi Water and Sanitation Company, and Athi water works development agency should promote these water resources. While attempts have been made by many scientists to examine different dimensions of water scarcity and urban population dynamics, there are few comprehensive reviews on the same.
4. Further studies on the diverse sources of water supplies, water policy and management of multifaceted water resources with focus to urban slums and peri-urban localities in Kenya also required or needed to delve deep on the challenges being faced and appropriate actions that can be instituted to address the associated issues.
5. Lastly, study on possible catalysts for sustainable water security in Kenyan urban slums through use or adoption of science, technology and innovations.

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APPENDICES

APPENDIX I: LETTER OF TRANSMITTAL

Patrick O. Obunga

P.O. Box 45917 – 00100

Nairobi, KENYA.

Dear Respondent,

RE: ACADEMIC RESEARCH

I am a postgraduate student at the University of Nairobi pursuing a Master of Arts Degree in Project Planning and Management. I am conducting academic research on the elements of public water supplies, water policy and management of multifaceted water resources in Mathare Slums, Nairobi City County, Kenya.

I therefore humbly request you to fill in / provide feedback on the enclosed questionnaire. The questionnaire has four sections that will focus on sources of water supply, treatment and storage of water, distribution of water to end users, and water policy.

Kindly note that all the data/ information provided for this study will be treated with utmost confidentiality and shall strictly be used for academic research purposes. Feel free to answer all the questions comprehensively and to the best of your ability and knowledge.

I sincerely appreciate and thank you for your time, honest feedback and co-operation in advance.

Yours faithfully,

Patrick Obunga

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APPENDIX II: QUESTIONNAIRE

Section I: Demographic Characteristics

1. Indicate your gender by use of ()

Male () Female () Don't know ()

2. Indicate your age (in years) in the appropriate box

18 – 28 () 29 – 39 () 40 – 50 () 51 – 61 () Over 62 ()

3. What is your highest academic qualification?

Primary () Secondary () Certificate () Diploma () Degree () Masters () Others ()

If others specify

4. What is your marital status?

Married () Single () Divorced () Others () if others, specify

5. What is your average household income per month?

Less than Ksh. 6,000 () Between Ksh. 6,001 – Ksh. 9,000 () Between Ksh. 9,001 – Ksh. 15,000 () Between Ksh. 15,001 – Ksh. 24,000 () Above Ksh. 24,001 ()

6. What is the number of dependents in your house?

1 – 2 () 3 – 4 () 5 – 6 () 7 – 8 ()

Section II: Sources of Water Supply

7. How would you classify your main source of water supply?

Improved sources () Other improved sources () Unimproved Sources ()

8. Which are the main sources of water supply in your residence? Please tick all that are relevant

Borehole well/ hand pump () Public/ standalone tap () Metered piped water supply connection
 () Unmetered piped water supply connection () Water kiosks () Spring () Runoff the river ()
 Rainwater harvesting () Bottled water () Water tankers/ bowsers () Others () specify

9. Indicate based on the statements below the extent to which sources of water supply influence management of multifaceted water resources in Mathare Slums, Nairobi County, Kenya?

(Where 1- Strongly disagree, 2- Disagree, 3 – Neutral, 4 – Agree, 5 – Strongly agree)

Statement	1	2	3	4	5
Classification of various Sources of water supply is distinctive and clear					
Improved sources of water supply such as piped water connection located inside user's house, plot or yard may not be necessarily safe for drinking					
Public water supply to the residents of Mathare slum is not adequate					
Other improved sources of water supply such as public taps, standalone pipes, protected boreholes and protected springs may be safe for drinking					
Unimproved sources of water supply such as unprotected borehole, unprotected spring, cart with small tanks, bottled water and surface water are or is the main source of water available in Mathare slum					
Improved sources of water supply is the main source and easily accessible					

Section III: Treatment and Storage of Water

10. What is your main source of water?

Borehole well/ hand pump () Public tap () Household water supply/ piped () Others (),
 specify

11. In your opinion, is water from your main source of supply safe for drinking?

Yes () No () Don't know ()

12. If water from your main source of supply is not safe for drinking, why do you think so?
 Dilapidated pipes () Burst pipes () Mixture with sewage () Contamination on-site ()
 Contamination during and on-delivery () Others () specify

13. How are you treating water for your household use?

No treatment () Boiling () Adding to water guard () Adding chlorine () Filtering () Exposing
 to solar () Others () specify

14. How are you currently handling or storing your treated water?

Jerrican () Super drum () Pales () Others () specify

15. Indicate based on the statements below the extent to which treatment and storage of water influence management of multifaceted water resources in Mathare Slums, Nairobi County, Kenya?

(Where 1- Strongly disagree, 2- Disagree, 3 – Neutral, 4 – Agree, 5 – Strongly agree)

Statement	1	2	3	4	5
Majority of the households in Mathare Slums are not aware of methods of water treatment and storage at home					
Majority of households in Mathare treat their water before drinking by either boiling, adding chlorine, adding water guard, or exposing to solar					
There are adequate household water storage equipment for treated water to mitigate against water shortages and eventualities					
Notable improvement in decrease in number of residents affected by water borne related ailments/ diseases.					

Section IV: Distribution of Water to End Users

16. Which of the following sources of water are distributed and or available in your neighborhood? (Multiple responses allowed)

Water tankers/ bowsers () Borehole well/ hand pump () Public tap () Metered piped connection to dwelling house/ plot () Unmetered piped connection to dwelling house/ plot () Water vendors () Water kiosks () Others (), specify

17. Which of the following sources of drinking water does your household use? (Multiple responses allowed)

Borehole well/ hand pump () Public tap () Household water supply/ piped () Bottled water () Others (), specify

18. From your water sources, have you experienced distribution break down in the past one month? Yes () No ()

19. How frequent do you experience distribution break down?

Never () Rarely () Often () Every time ()

20. Is it fixed promptly when it breaks down? Yes () No ()

21. What is the frequency of water supply?

Daily () Once in two days () Once in three days () Once a week () Others (), specify

22. On the days that you get water, how many hours do you usually get water continuously?

0 – 4 hours () 4 – 8 hours () 8 – 12 hours () 12 – 16 hours () 16 – 20 hours () 20 – 24 hours ()

23. How would you rate the existing water supply infrastructure in your area?

Excellent () Very good () Good () Poor ()

24. What is the approximate distance to your nearest water supply point?

1-50 metres () 50- 100 metres () Over 100 metres ()

25. Indicate based on the statements below how distributions of water to users influence management of multifaceted water resources in Mathare Slums, Nairobi County, Kenya?

(Where 1- Very satisfied, 2- Satisfied, 3 – Neutral, 4 – Dissatisfied, 5 – Very dissatisfied)

Statement	1	2	3	4	5
The source of water points are conveniently located					
There are effective maintenance practices for the water infrastructure systems in Mathare slums					
Water is continuously accessible, available and affordable to the residents					
NCWSC has adequate water distribution systems in the area					
There are inadequate water supply equipment serving the area					
The specific dimensions such as accessibility, affordability, quality, quantity, continuity and equity in water distributions to users in Mathare slums is assured and observed by NCWSC					
I am happy and satisfied with the NCWSC Ltd services					

Section V: Water Policy

26. How do you think the quality of your life has changed due to formalization of water supply by Nairobi City Water & Sewerage Company Limited (NCWSC)?

Health has improved () Reduced expenditure on water () Less time used to get water () Better relationship with Nairobi City Water & Sewerage Company () None of the above ()

27. Please rate if access to water, water quality, its affordability and pro-poor focus, has affected your life.

Life has improved () Life is the same () Life has not improved ()

28. Are you aware of pro-poor water policy? Yes () No ()

29. If yes, briefly narrate what you know about the pro-poor water policy.

.....

30. What do you normally report to Nairobi City Water & Sewerage Company (NCWSC) about their services to you?

Pipe bursts () Illegal connections () Cartels () Vandalism of pipes () Water disruption () Over-priced water bill () I don't report anything ()

31. Indicate based on the statements below how water policy influence management of multifaceted water resources in Mathare Slums, Nairobi County, Kenya?

(Where 1- Very satisfied, 2- Satisfied, 3 – Neutral, 4 – Dissatisfied, 5 – Very dissatisfied)

Statement	1	2	3	4	5
There are adequate regulations and policy on management of multifaceted water resources					
Residents of Mathare slums are aware of the pro-poor water policy					
The residents of Mathare slums are aware of their constitutional rights to clean, affordable & access to water					
The institutions mandated to provide policies and guidelines to ensure adequate public water supply are doing effective and efficient services					
Devolved functions in public water supply and distributions are clear to the concerned agencies and stakeholders					
Decision making process on water management are effective					

32. How would you rank the following variables on their levels of influence in regards to public water supplies, water policy and management of multifaceted water resources in Mathare slums? (Where 1- Very low, 2- Low, 3 – Average, 4 – High, 5 – Highest)

Statement	1	2	3	4	5
Sources of water supply influence to management of multifaceted water resources					
Treatment and storage of water influence to management of multifaceted water resources					
Distributions of water to users influence to management of multifaceted water resources					
Water policy influence to management of multifaceted water resources					

APPENDIX III: MAIN THEMES FOR FOCUS GROUP DISCUSSIONS

1. What do the residents of Mathare Slums know about the Water Sector Reforms, especially about the pro-poor focus in water service provision?
2. Compare the residents' views on access, affordability and quality of water supplied by NCWSC now, and their views on access, affordability, equity, continuity, quantity and quality of water when previously supplied by cartels and other private providers.
3. How have the formalized water systems within Mathare Slums are operated and preferred by the residents?
4. What are some of the challenges now and anticipated in the water supply systems in the area and how the risks can be mitigated?
6. What are some of the feasible/ viable suggestions/ recommendations that would make Nairobi City Water & Sewerage Company improve the current system and services to the residents?
7. What is the residents' relationship with the Nairobi City Water & Sewerage Company Ltd?
8. Any notable contribution of the NGOs operating in Mathare slums and their impact on public water supply and management in the area?

APPENDIX IV: PROJECT TIME SCHEDULE & BUDGET

TIME	ACTIVITIES	BUDGET ITEMS	COST (Ksh.)
November/December 2019 to May 2020	<ul style="list-style-type: none"> • Conceptualization of the research ideas • Review of relevant literatures • Consultation with research supervisor • Writing of draft research proposals and sharing with the supervisor • Writing of final research proposal and sharing with the supervisor 	<ul style="list-style-type: none"> ○ Internet access ○ Communication ○ Transport ○ Printing ○ Binding ○ Other logistics 	15,000
June to July 2020	<ul style="list-style-type: none"> • Submission of final research proposal for defense • Defense of research proposal • Working on the recommendations and suggestions 	<ul style="list-style-type: none"> ○ Communication ○ Transport ○ Printing ○ Binding ○ Other logistics 	5,000
July to August 2020	<ul style="list-style-type: none"> • Administration of pilot test in Korogocho slum • Recruitment and deployment of research assistants • Administration of Questionnaire in Mathare slum (Actual data collection) • Data analysis and consultations 	<ul style="list-style-type: none"> ○ Internet access ○ Communication ○ Transport ○ Printing + Binding ○ Other logistics - NACOSTI ○ Research assistants (4) 	35,000
September 2020	<ul style="list-style-type: none"> • Compilation of draft and final research project report • Consultation with the supervisor • Submission of final research project report 	<ul style="list-style-type: none"> ○ Internet access ○ Communication ○ Transport ○ Printing + Binding 	5,000
SUB-TOTAL			60,000
Miscellaneous costs		10% of Sub-Total	6,000
GRAND TOTAL			66,000

APPENDIX V: CHECKLIST FOR INTERROGATING THE WATER POLICY, WATER SUPPLY AND MANAGEMENT

	Yes	I.P	No
Is there a comprehensive water services policy in force that integrates the human rights to water and sanitation and their legal content?			
Is the policy reviewed regularly to track discriminatory effects; if it is found to discriminate, is it repealed or amended?			
Are existing inequalities in accessing water and sanitation currently assessed?			
Are there plans and policies developed that use indicators and benchmarks to assess both the steps taken and the results achieved in the elimination of inequalities in water and sanitation service provision?			
Are there enough public facilities in place and planned to ensure that people without domestic access to water can use these as intermediate solutions?			
Does the government provide for measures raising awareness of the possibility of obtaining information; for example, information about water and sanitation services, management and infrastructure?			
Are there programmes and policies in place that guarantee and encourage the participation of all stakeholders?			
Do policy level documents plan for clear assessments of current accessibility standards?			
Are there any mechanisms or programmes to train local authorities in how to manage budgets, tariffs and the operation and maintenance of facilities?			
Are the people who are least able to pay identified, and are there specific targeted programmes to ensure that water services are made affordable for them?			
Is there a policy that outlines processes for ensuring water safety?			
Are there policy-level documents that outline methods and plans for raising awareness and changing behaviour, especially with regard to hygiene practices?			
Do policy level documents set clear targets and timelines for reaching a basic level of service for all?			
Do policy level documents set clear targets and responsibilities for meeting general acceptability standards?			
Are there policies in place that effectively organize awareness raising and education programmes to eliminate unacceptable practices?			
Are there policies in place that plan to improve services continually over time?			
Does the Constitution guarantee water and sanitation as clearly defined human rights that can be claimed by all?			
Does the Constitution guarantee that equality and non-discrimination status of overarching legal principles?			
Does the Constitution also include the concept of affirmative action?			
Do laws and/or regulations define the human rights to water and sanitation, using the legal content of availability, accessibility, quality, affordability and acceptability, as guaranteed under international human rights law, as a basis			

to give substance to these rights?			
Are there building requirements and regulations in place that cover general standards for water and sanitation facilities; for example, toilets in rented accommodation, the provision of single-sex toilets in public places?			
Is there an independent regulatory body in place that operates on the basis of human rights and is tasked to set standards based on the legal content of the human rights to water services?			
Has the State undertaken any measures to regulate water supply by informal vendors?			
Do the State and/or providers give access to formal water and sanitation services to households regardless of their tenure status?			
Are there laws and/or regulations in place to ensure that everyone, including people who live far from centres of information and people who cannot read, is able to access information relating to water and sanitation services, in relevant languages and formats?			
Are there laws and/or regulations in place that guarantee that full, free and meaningful participation takes place before any decision is finalized?			
Do laws regulations set out precise rules on participation in matters of infrastructure, service levels, tariffs, and the operation and maintenance of water services?			
Do regulations provide for mechanisms that ensure the affordability of services for all, while considering connection costs, operation and maintenance; do regulations establish subsidies, payment waivers and other mechanisms to ensure affordability?			
Do regulations provide opportunities for users to pay their arrears, or to receive services for free, when they are unable to pay?			
Is there an independent regulatory body in place that operates on the basis of human rights and is tasked to determine the affordability of services, including the setting of tariffs?			
Where people do not have access to a networked water supply system, do laws and/or regulations provide for the right of everyone to use natural resources for domestic and personal uses?			
Do laws and/or regulations take into account the maximum distance and time it takes to reach a facility, as well as the location of the facility, in order to ensure the physical security of users; do these standards consider the barriers faced by particular individuals and groups?			
Is the State and/or service providers obliged to give access to formal water services to households regardless of their tenure status?			
Are there laws and/or regulations in place that protect the quality of water resources; for example, by prohibiting the dumping of sewage and waste and demanding the containment of any seepage of fertilizers, industrial effluents and other pollutants?			

APPENDIX VI: INTERVIEW GUIDE

We adopted two types of interview guide to help in keeping clarity and focus on the intent of the questions in the questionnaire i.e. general interview guide and standardized, open-ended guide. General interview guide approach was intended to ensure that the same general areas of information are collected from each interviewee; which provided more focus than the conversational approach, but still allowed some degree of freedom and adaptability in getting information from the interviewee while standardized, open-ended interview in which the same open-ended questions were asked to all interviewees and this approach facilitated faster interviews and were easily analyzed and compared.

Preparation for Interview

1. Choose a setting with little distraction. Avoid loud lights or noises, ensure the interviewee is comfortable. Often, they may feel more comfortable at their own places of work or homes
2. Explain the purpose of the interview.
3. Address terms of confidentiality. Note any terms of confidentiality. Explain who will get access to their answers and how their answers will be analyzed.
4. Explain the format of the interview. Explain the type of interview you are conducting and its nature. If you want them to ask questions, specify if they're to do so as they have them or wait until the end of the interview.
5. Indicate how long the interview usually takes.
6. Tell them how to get in touch with you later if they want to.
7. Ask them if they have any questions before you both get started with the interview.
8. Don't count on your memory to recall their answers. Ask for permission to record the interview or bring along someone to take notes.

Types of Topics in Questions

Questions will be asked about the following topics with reference to public water supply, water policy and management of multifaceted water resources in Mathare slums, Nairobi city.

1. Demographic characteristics
2. Sources of water supply
3. Treatment and storage of water
4. Distribution of water to end users

5. Water policy

Sequence of Questions

1. Get the respondents involved in the interview as soon as possible.
2. Before asking about controversial matters (such as feelings and conclusions), first ask about some facts. With this approach, respondents can more easily engage in the interview before warming up to more personal matters.
3. Intersperse fact-based questions throughout the interview to avoid long lists of fact-based questions, which tends to leave respondents disengaged.
4. Ask questions about the present before questions about the past or future. It's usually easier for them to talk about the present and then work into the past or future.
5. The last questions might be to allow respondents to provide any other information they prefer to add and their impressions of the interview.

Wording of Questions

1. Wording should be open-ended. Respondents should be able to choose their own terms when answering questions.
2. Questions should be as neutral as possible. Avoid wording that might influence answers.
3. Questions should be asked one at a time.
4. Questions should be worded clearly. This includes knowing any terms particular to the project or the respondents' culture.
5. Be careful asking "why" questions. This type of question infers a cause-effect relationship that may not truly exist. These questions may also cause respondents to feel defensive.

Conducting Interview

1. Occasionally verify the tape recorder (if used) is working.
2. Ask one question at a time.
3. Attempt to remain as neutral as possible. That is, don't show strong emotional reactions to their responses.
4. Encourage responses with occasional nods of the head.
5. Be careful about the appearance when note taking. That is, if you jump to take a note, it may appear as if you're surprised or very pleased about an answer, which may influence answers to future questions.

6. Provide transition between major topics, e.g., "we've been talking about (some topic) and now I'd like to move on to (another topic)."
7. Don't lose control of the interview. This can occur when respondents stray to another topic, take so long to answer a question that time begins to run out, or even begin asking questions to the interviewer.

Immediately After Interview

1. Verify if the tape recorder, if used, worked throughout the interview.
2. Make any notes on your written notes.
3. Write down any observations made during the interview. For example, where did the interview occur and when, was the respondent particularly nervous at any time? Were there any surprises during the interview?

APPENDIX VII: IMAGES OF WATER INFRASTRUCTURE IN MATHARE SLUMS



Suspected illegal connections and abandoned water network



Water supply improvement services by NMS and Athi Water Works



Car wash by private investor



Public water point



Water hawking by cart operators



APPENDIX VIII: RESEARCH PERMIT


REPUBLIC OF KENYA


**NATIONAL COMMISSION FOR
SCIENCE, TECHNOLOGY & INNOVATION**

Ref No: 130084 **Date of Issue: 11/September/2020**

RESEARCH LICENSE



This is to Certify that Mr., Patrick Ouma Obunga of University of Nairobi, has been licensed to conduct research in Nairobi on the topic: Public Water Supplies, Water Policy and Management of Multifaceted Water Resources in Mathare Slums, Nairobi City County, Kenya, for the period ending : 11/September/2021.

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