ASSESSMENT OF THE QUALITY OF WATER SERVICE DELIVERY IN PERI URBAN KENYA

Case study of Githurai Nairobi

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By

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A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Integrated Water Resources Management (MIWRM) of the University of Dar es Salaam

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by the University of Dar es Salaam a dissertation entitled: ***Assessment of the quality of Water Service Delivery in Peri Urban Kenya,*** in Partial fulfillment of the requirements for the degree of Master of Integrated Water Resources Management (MIWRM) of the University of Dar es Salaam**.**

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DECLARATION

AND

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I**, Alice Nyawira Karimi**, declare that this dissertation is my own original work and that it has not been presented to any other University for a similar or any other degree award.

Signature ----------

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DEDICATION

This dissertation is dedicated to my loving husband Titus Kimani Githua for his constant support, patience, understanding and love. God bless you.

LIST OF ABBREVIATIONS

AfDB	Africa Development Bank
AMCOW	African Ministers' Council on Water
AWWARF	American Water Works Association Research Foundation
CWS	China Water Sector
EMCA	Environment Management and Coordination Authority
GWA	Gender Water Alliance
GWP	Global Water Partnership
IDA	International Development Association
IWRM	Integrated Water Resource Management
JMP	Joint Monitoring Program
NCWSC	Nairobi City Water and Sewerage Company
SD	Sustainable Development
TDS	Total Dissolved Solids
UN	United Nations
UNDP	United Nations Development Program
UNICEF	United Nations Children’s Emergency Fund
WGF	Water Governance Facility
WHO	World Health Organization
WOP	Water Operations Partnership
WUP	Water Utility Partnership
WASREB	Water Services Regulatory Board
WSP	Water and Sanitation Program

ABSTRACT

Urbanization in Nairobi has led to increased water stress and challenges for water authorities and planners in Githurai, Kenya to sustainably satisfy the growing demands for water and sanitation. Water for domestic use is scarce for most of the residents due to under designed water supply systems and lack of corresponding planning and infrastructure development despite the growing population thus rely on unsafe water. This research aimed at assessing performance of water service providers and challenges of improving water service delivery.

Data was collected using structured questionnaires in terms of interviews, focus group discussions, desk study, water quality testing, observation and photography. Performance of various indicators varied while water coverage was 80% and others relied on water from kiosks/vendors and unaccounted for water. Some had to economize on the usage thus compromising on their hygiene while others walked for more than 250m in search of water and queued for about an hour. Water quality parameters were within the recommended threshold except chlorine which was above standard. Service level benchmarking and indices showed that the quality of water service delivery was low as infrastructure index indicated that the supply was 2.78 which is basic supply of water resources and accessibility index was 3.98 which is limited access to water resources. Most of the indicators were below the recommended standard due to low water production from the source, increased illegal connections and wastage of water. Proper maintenance of the current system should be done to reduce high levels of bursts and devise measures that deal with illegal water connections. Water users should be educated on water conservation to avoid wastage.

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CHAPTER ONE

INTRODUCTION

1.1 General Introduction

Water is a basic human right and everyone is entitled to it (Rights to Water and Sanitation, 2015). However, numerous number people of people in the world are still lacking access to clean water. The number of people is 663 million, with 6 to 8 million people dying annually as a result of disaster and water related diseases (UN water, 2015). The number of people living under water stress is projected to reach 3 billion in 2035 (Nganga *et al*., 2012). The majority of the people who live in water scarce areas are found in Sub Saharan Africa (UN Water, 2015). High rate of urbanization is the major cause of water scarcity in the continent where the urban population is anticipated to grow from 300 million to 700 million which means 30% to 52% of the entire population by 2025 (WUP, 2003).

In Kenya, millions of people currently lack access to water resulting in them being forced to continue drinking unsafe water or use minimal quantities of water as distance, queuing time, and cost make water inaccessible (Uwazi, 2010). According to Uwazi (2010), inequities in access to water are so evident and the struggle for water by the excluded sections of Kenya's population contrasts sharply with the privileged people, who benefit from water delivered to their homes, often at very low cost. Due to low economic growth in Kenya and across many other countries in Sub-Saharan Africa, many people still migrate to cities in search of a better future. Most of these people end up settling in the sprawling and underserved informal

settlements, where most people live without access to basic water supply, sanitation and electricity service (WSP, 2005). Currently, about two-thirds of the people in African cities live in these types of settlements. In 2011, the population growth rate in Kenya was estimated to be 2.46% while the rate of urbanization between 2010 and 2015 was estimated to be 4.2% thus putting a substantial strain on the water sector of the country (WASREB, 2012).

Githurai is a peri-urban settlement within Kenya's capital Nairobi. It is a highly densely populated area, with a mixture of slum and suburbian settlements. An increase in population in Githurai has led to an increase in demand for water resources with overexploitation of water resources at source points and erratic supply as a result (Ngima, 2015). According to Ngima (2015), development in the area is negatively affected since much of the time that can be used in development activities is wasted in travelling long distances in search of water as well as wasting time in queuing. The same studies indicate that there are waterborne diseases in the area such as typhoid and diarrhoea which have resulted in money being spent in treatment instead of development.

Water supply in Githurai is done through piped connections and water kiosks by Athi Water Services Board, Nairobi water and Sewerage Company and private boreholes operators. In addition, door to door vending, rainwater harvesting, private wells and rivers are used (Dobsevage *et al*., 2006).

1.2 Problem Statement and Justification

Githurai is a mixture of slum and suburb. Most of the residents do not obtain enough water to cater for their domestic demands and therefore have to rely on water vendors to meet the deficit (Nganga *et al*., 2012). The existing water supply system is not enough to serve the current population as it was intended to supply water for a population of 30,000 people, but now the residents have increased rapidly to over 100,000 (Nganga *et al*., 2012). This rapid population growth has exerted pressure on the existing water supply. The current water supply cannot meet the needs of the population. This area has experienced population increase without corresponding planning and infrastructure development (Kaluli *et al*., 2011).

Water scarcity in the region has also resulted from degradation of water sources such as boreholes not being protected thus making the water unfit for human consumption (Ngima, 2015). According to the Office of Public Health in Ruiru District, where Githurai is located, in year 2010 the majority of cases with diarrheal diseases such as amoebiasis and typhoid ranged between 30 and 40% of all the patients seeking medical care (Kaluli *et al*., 2011).

There is a need to have improved provision of water services for the people thus the need for the research. It may help to achieve the 6th sustainable development goal that aims at ensuring availability and sustainable management of water and sanitation for all (SD Solutions Network, 2015).

1.3 Objectives

1.3.1 Main objective

To assess the current water service delivery in Githurai 44, Nairobi, Kenya and the challenges to improve services in terms of physical accessibility, availability, reliability, and water quality.

1.3.2 Specific Objectives

- To assess the current performance of water service providers in Githurai 44 in terms of service hours, water quality, coverage, customer's satisfaction and willingness to pay.
- To assess the challenges of improving water service delivery to domestic household users in terms of water availability, reliability, physical accessibility and quality in Githurai 44.

1.4 Significance of the Study

The research assessed the current situation on water service delivery and the challenges of improving water service delivery in Githurai thus filling the gaps by providing more information on the challenges that hinder the improvement of water service delivery. The findings of this research would help Nairobi City Water and Sewerage Company and the government by providing them with information on the challenges and how to cope with them to improve water service delivery in the area and the country at large. The research provides information from the primary water users on what may help to improve the service delivery which is very essential. This may also help in achieving the sustainable development goal 6 on increasing water

accessibility and improve the general health of the people. In addition, it may help reduce the infant mortality rates related to water borne diseases and vector borne diseases if the provision of water services is improved. Development may also be improved as water is vital to development and this will help in reduction of poverty.

1.5 Research questions

- What is the performance of water service providers in Githurai 44 terms of service hours, water quality, coverage, customer's satisfaction and willingness to pay?
- What are the challenges of improving water service delivery to domestic household users in terms of water availability, reliability, physical accessibility and quality in Githurai 44?

1.6 Scope of the study

The study was limited on the domestic water uses only of the community. This included water used for household uses such as cooking, bathing, cleaning and drinking as well as outside household uses such as washing cars. In regard to water service delivery, it focused on the performance of the existing water service delivery and the challenges of improving the service delivery as described above. The major focus in data collection was the household water users. However, secondary data was also obtained from Nairobi City Water and Sewerage Company.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual Framework

There have been many discussions in the past in regard to measuring access to water services in terms of service levels. Lloyd and Bartram's (1991) conducted one of the earliest researches where they identified coverage, reliability, availability, quantity, cost and quality as indicators for reviewing access to water. World Health Organization (WHO) approved the service level concept in 1997 and 2003.

Moriarty *et al*. (2011) defined reliability of a water service as "the proportion of the time it functions to its prescribed level while quality is composed of one or more separate indicators looking at chemical and biological quality" also referred by Lloyd and Bartram's (1991) as analytical and sanitary inspection". Physical accessibility implies that safe, acceptable and water of sufficient quantities must be accessible within or in the closest vicinity of each household, educational institution and work place (UN, 2008). Water availability is the amount of water accessible in litres per capita per day (Moriarty *et al*., 2011).

2.2 Water Service Delivery Performance

Water is very essential in life as it helps to nurture the ecosystem, used for agricultural production, industries and making life possible (Falkenmark and Rockström, 2004). However, fresh water resources are now growing scarce day by day which has resulted in conflicts among states and territories and also communities (Falkenmark and Rockström, 2004). The developing world requires an improvement

in access to water and service delivery in order to fight with diseases, hunger and poverty (UN, 2003).

According to WUP (2003), in the whole world, the lowest supply to water and sanitation coverage is found in Africa. Currently, more than 1 in 3 Africans living in urban areas lack access to adequate services and facilities at present (WUP, 2003). The findings by Water and Sanitation Program (2005) indicate that many people in low income areas rely on more than one source to acquire the water they need for survival. In the findings, majority of households obtain water from intermediaries who include landlords, water kiosks or vendors.

Urbanization has contributed to water stress in urban and peri urban areas since it leads to rapid increase in population, insufficient planning, pollution, poverty and competing demands on the water resource thus urban water consumption is expected to double by 2025 (GWP, 2012). The increase in urban population globally is estimated to be 2 billion between 2000 and 2025 (Lundqvist *et al*., 2014) which may lead to the entire population growth in the coming decades being entirely urban population especially in Sub-Saharan Africa and Asia.

Provision of urban water services is a vital service that provides a basic good which is essential to life (Morgan, 2006). In many countries, urban water authorities and water planners are facing a great challenge to satisfy the growing demands for water and sanitation while achieving sustainability of urban water system (Mahgoub *et al*., 2010). Lack of water supply and sanitation has a great impact on health and well

being as well as huge financial cost and loss of economic activity (UN-Water, 2015). Access to water for productive purposes such as family businesses and agriculture is essential as it helps in generation of income that helps to improve livelihoods and promote economic growth (UN-Water, 2015).

According to the UN-Water report (2015), rapid population growth and incapacity or unwillingness of local and national governments to provide sufficient water and sanitation services are the major causes of increase in the number of people without access to clean water and sanitation in urban areas in developing world. The problem of water crisis in the world is associated with poor governance thus the solution can only be found in improving water governance (Birongo and Quyenle, 2005).

According to Cap-Net, GWA, (2006), inadequate water supply has a greater impact on women compared to men thus being more vulnerable to poverty and fewer opportunities to flee from it. In developing countries, it is estimated that women and children spend 40 billion hours every year in search for water which translates to about 8 hours a day (Cap-Net, GWA, 2006).

The most common indicators of assessing the quality of water services delivered to consumers include the quantity in litres per capita per day, quality which is assessed with one or more indicators assessing chemical and biological quality, distance to the water point, number of people sharing a water source and the reliability (Moriarty *et al*., 2011). The customers served by water utility would like sufficient and a reasonable quality of water service delivery to them whilst protecting the

environmental and public health protection at the lowest cost possible (AWWARF, 1998).

Most urban water utilities in Africa are faced with a major challenge of expanding appropriate services to the growing population (WOP, 2009). According to WOP report, the cause of poor access to water in Africa is as a result of the inefficiencies of African water utilities. Studies carried out in some African water utilities by WOP indicated that the biggest weakness in many African water utilities is high non-revenue water where the utilities get revenue for only half of their water production which makes it difficult for them to cover their operating costs.

Nairobi City Water and Sewerage Company which is the major water supply utility in Githurai 44 is faced with a major challenge of revenue collection and high non revenue water where in 2010/2011, 2011/ 2012 and 2012/2013 financial years, the targets for revenue collection and reduction of non revenue water were not met (NCWSC, 2014).

In order to improve on service delivery, municipalities need to develop performance indicators in all departments as well as proper interaction with all stakeholders so as to ensure good governance (Walt *et al*., 2000). A set of indicators that can be used to assess progress and determine trends and comparisons made between service providers and across countries are provided by water service monitoring frameworks (Kayser, *et al*.,2013), that help in the improvement and expansion of water service delivery thus promoting public health and human rights benefits. Service level is the

collection of different indicators that may be dependent or independent of each other in order to depict and distinguish between levels of service (Moriarty *et al*., 2011).

2.3 Availability and Reliability

The generally used indicator of availability of water is the total amount of blue water flow in the hydrological cycle (Falkenmark and Rockström, 2004) which is also expressed as m^3 of blue water available per person. According to World Bank Institute (2006), despite the fact that water appears to be plentiful on earth, 97% of the water is seawater, causing it to be unsafe for human consumption. Of the rest 3%, 87% is not accessible which is either in deep underground aquifers or is locked in polar icecaps. Consequently, out of all the water on the planet, only 0.4% of it is in a form that can be accessed and consumed by human beings (Cap-Net, 2005). The long term sustainability for water is becoming less certain for human and environmental needs due to issues like increase in deforestation, urbanization, manufacturing, water diversion projects and inefficient industrial farming (Barghouti, 2002).

Globally, the number of people who drink water from unimproved drinking water source is 884 million (WHO/UNICEF JMP, 2010). Billing *et al*. (1999) defines the indicator of water availability and reliability as the number of hours that water is available from a given system. This signifies that a reliable and appropriate water system should be able to provide water to its consumers 24 hours a day.

Previous studies carried out in Ngamiland Botswana show that there was unreliable water supply caused by just to mention a few, high cases of absenteeism related to

HIV/AIDS, breakdown of diesel powered pumps and untimely delivery of diesel fuel (Ngwenya and Kgathi, 2006). This resulted in increment in the use of poor quality water, high water collection opportunity cost and poor hygiene practices where the bathing of HIV/AIDS patients was cut from two times a day to once or even none. The study shows that various strategies that were adopted in order to cope with the water unreliability included storage, buying water, economizing on water and collecting from rivers/dug wells as well as other sources.

In Kenya, millions of people have inadequate access to water. According to a World Bank study (2009), countrywide piped water coverage is between 42% and 59%, which translates to majority of the people lacking access to water. In the country, a small number of about 2% of non-poor families in Nairobi get their water from water kiosks in comparison to more than a third of about 36% of poor families who depend on water kiosks for their water (Uwazi, 2010). This clearly indicates lack of equity in provision of the water services.

In some studies done in some parts of Kenya such as Kibera, water kiosks in the mid 1997 accounted for 64 per cent of the 1,014 water connections registered with the Nairobi City Council in Kibera, which were the principal outlets through which the Nairobi City Council made water available to consumers (WSP, 2005). The study by Water and Sanitation Program (2005) indicated that 30% of kiosks accounted for 70% of the total amount of water sold in Kibera. However, according to the report, Kiosk owners place pipes beside existing channels comprising of open sewers filled with solid waste as well as polluted water. This causes pollution of water as it is

transported to the kiosk from the utility system. In addition, pollution also occurs at the kiosk as a result of poor maintenance of storage tanks and unhygienic handling.

Previous studies carried out in Githurai indicate that there is an erratic water supply in the area which has a negative impact on social economic activities (Ngima, 2015). In this regard, there is a need to assess the water service delivery and its challenges as the information may help to cater for the needs of the growing population. The findings of this project will help to fill the gaps by providing information on the water service delivery in terms of the availability, affordability, reliability, physical accessibility and customer satisfaction. No research has been conducted in the study area previously regarding the challenges of water service delivery. The information will help the relevant government institutions and municipality to improve on water service delivery if the observed challenges are solved.

2.4 Water Quality

The guidelines for assessing water quality are based on risk assessment methods which not only considers the presence or absence of pathogens or chemical in water but also the risk for disease (WHO/UNICEF, 2006). Despite the fact that water for domestic use accounts only for 5% of water consumption, it is a percentage that must be protected in both quantity and quality as a basic human need (Bern *et al*., 1992). The quality of water that is delivered and consumed by households is a key feature of domestic water supplies and greatly influence hygiene and public health (WHO, 2003). Millions of the poorest people in the world die every year from avertable diseases caused by inadequate water supply and sanitation services while hundreds of

millions more suffer from regular waterborne diseases that destroy their lives such typhoid, and worm infections (Bern *et al*., 1992).

One of the main underlying determinants of global health inequalities is the differences in the availability of safe water where 60% of child deaths from diarrhoea are related to unsafe water, sanitation and hygiene (Boschi-Pinto *et al*., 2008). Women and children are the most affected by polluted water as they come into contact with the polluted water more during collection, bathing and drinking (Cap-Net, GWA, 2006). According to IDA (2009), 1.1 billion people in the world still lacked access to reliable source of water free from contamination in 2004. Increased collection time causes quality deterioration where contamination may occur during collection, transportation and storage (Kayser, *et al*.,2013).

Previous studies carried out in places like Ghana show that 3.5 million people lack adequate access to an improved water source and over 3,000 children less than five years old die annually from poor water and sanitation (The water project, 2015). According to these studies, these challenges are mostly found in peri-urban areas, characterized by poor infrastructure, low incomes and lack of recognition by the government. Studies carried out in Cameroon also indicate that diarrheal diseases are the most rampant among children water borne diseases among children under the age of five which is increasing in Yaounde (Yongsi, 2010). The studies show that in Yaounde, there has been an increase from 10.8% in 1998 to 13.1% in 2004.

According to previous studies done in Githurai, the average residents get treated for water borne diseases once in every three months (Kaluli *et al*., 2011). This indicates that most of the residents consume contaminated water. The studies points out that 30-40% of all patients visiting the hospitals suffer from diarrheal diseases. The gap on the challenges of improving the quality of water will therefore be filled by the information gathered in this research thus giving a way forward on how to improve the quality.

2.5 Coverage

The issue of access to water has been a global concern. Millennium development goals which came to an end in 2015 addressed the issue in Goal 7 whose aim was to Ensure Environmental sustainability whose target 10 was to half by 2015 the proportion of people without access to improved drinking water. According to the Millennium Development Goals Report (2015), 2.6 billion people gained access to improved drinking water source since 1990. However, the report indicates that Water scarcity affects 40% of people in the world and is projected to increase (UN, 2015).

In spite of an improvement in drinking water coverage from 56% in 1990 to 66% in 2010, the population depending on unimproved drinking water source rose from 279 million in 1990 to 344 million in 2010 (AMCOW, 2012). The research by AMCOW indicates that 65 million more people in Africa did not have access to improved drinking water source in 2010 which is worse than 1990. Joint Monitoring program defines an improved drinking water as a source that is more likely to provide safe drinking water as compared to unimproved drinking water source. This is through its

nature of construction whereby water source is protected from contamination especially by faecal matter (WHO/UNICEF, 2006) .Classification for improved and unimproved drinking water sources is given in Table 2.1. Bottled water is considered as 'improved' source of drinking water only where there is a secondary source that is 'improved'.

Table 2. 1: Classification for improved and unimproved drinking water sources (*Source: WHO/UNICEF, 2006; www.wss info.org)*

Improved sources of drinking water	**Unimproved sources of drinking water**
Piped water (into dwelling , yard or plot)	Unprotected dug well
Public tap/standpipe	Unprotected spring
Tub well/borehole	Vendor-provided water
Protected dug well	Tanker truck water
Protected spring	Surface water (river, stream, dam, lake, pond canal, irrigation channel)
Bottled water*	

In most cities in the developing world, the utility is mandated to supply all urban consumers, but the expansion of water supply to low-income consumers can be neglected, despite accounting for as much as 40% of a city's population (Noakes and Franceys, 2014). According to Noakes and Franceys (2014), most low income community consumers already pay high prices for their water, to an unregulated informal supplier; in many cases they pay more than the resident of a neighbouring high-income community with a piped utility supply. Non-poor households that are connected to water utility pay several times less the unit price paid by poor households to vendors (Whittington *et al*., 1991 in Phiri 2007).

The social equity is often not given a priority during the water allocation decision making processes despite the fact that IWRM should be guided by the 3 E's of economic efficiency, social equity and environmental sustainability (WGF, 2012). According to Wade (2011), the most important policy or tool in promoting equitable allocation of water resources is full commitment and public participation. This can also be done by use of some tools such as multi criteria analysis during decision making in order to ensure a balance between social, ecological and economic factors.

Some studies carried out in Durban South Africa show that most of the people still do not have access to clean water and sanitation. This is about 500,000 people who lack household connections thus relying on stand posts (WUP, 2003). In Kenya, there had been a reduction in access to improved water supply in urban areas where the coverage dropped from 91% in 1990 to 83% in 2008 (AMCOW, 2012). Previous studies show that there is a strong link between income, education, water supply choice and household water use where less poor households and those that are well educated mostly rely on private connections (Larson *et al*., 2006).

2.6 Physical Accessibility

According to UNDP (2006), physical accessibility implies that safe, acceptable and water of sufficient quantities must be accessible within or in the closest vicinity of each household, educational institution and work place. The water collection time should not be more than 30 minutes and the distance to water source should be within 1000 metres of home (WHO, 2003). This should include all population including the most vulnerable or marginalized groups. In low income countries,

women and children spend on average one hour per trip collecting water which reduces school attendance in children (Kayser *et al*., 2013) and also results to injury through musculoskeletal disorders and associated disabilities due to carrying water. According to Human Development Report (2006) by UNDP, women in Africa and Asia walk for an average distance of 6 kilometers to collect water. This results in them consuming less amount of water as water is heavy any they have to carry it for long distances.

In Nairobi, a usual household takes 54 minutes to walk to the kiosk in usual times, and more than two times of that (126 minutes) during water scarcity and worse in other places (Uwazi, 2010). Studies done in Kibera which is one of the slums in Kenya show that in some villages, the collection time for water is about 10 to 30 minutes while in other villages there is frequent water shortage where it takes about 40 minutes for villagers to access water (Hakijamii Trust, 2007)**.** Other studies carried out in Southern Kenya show that water is very scarce in the area where the pastoralists have to travel for many kilometers in search of water for their cattle as boreholes which are the main sources of water are available 25 kilometers apart and some do not function (Langendijk and Brakel, n.d.).

2.7 Willingness to Pay (WTP)

According to Africa Development Bank (AfDB) (2000), Willingness to pay is defined as the maximum amount consumers are prepared to pay for a good or service. However, when improvements are made in a situation, willingness to pay is shown by the payment increment that leaves the consumer indifferent like the state

before and after change while the willingness to pay in order to avoid worsening of a situation signifies the payment compensation which will be vital to leave the consumer indifferent (CWS, 2002). Willingness to pay for water services can be affected by various factors such as the degree of consumers' awareness on water management issues, their perception towards the Water Company, age, socio-economic status, education level, water quality and affordability (Kiwa Water Research, 2008).

Previous studies carried out in Bangladesh show that willingness to pay is higher in richer households for both monthly fee and connection cost for water (Gunatilake and Tachiiri, 2012). In the same studies, despite the fact that the willingness to pay was higher in richer households in comparison to poor households; the poor households shared a higher household expenditure. The households that had an alternative source of water like a private well expressed lower willingness to pay while those that were using public tube wells which were far from their homes expressed higher willingness to pay (Gunatilake and Tachiiri, 2012). Other studies carried out in Canberra Australia demonstrated that water service interruptions determined the willingness to pay where more interruptions in a year demonstrated less willingness to pay (Hensher *et al*., 2005). This is because the more interruptions the consumers' faced, the more they became accustomed thus looking for alternatives to cope with them.

CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Area

Githurai is a mixture of slums and suburbs located on the North Eastern side of Nairobi city about 15 km from the city centre along the Nairobi Thika Highway. Kaluli *et al*. (2011) indicates that its characteristics are those of an informal settlement though it is not classified as one. It is divided into various wards which include Githurai 45, Githurai 44 and Githurai Kimbo with a total population of more than 100,000 persons (Nganga *et al*., 2012). However, this study focused on Githurai 44 (Figure 3.1) which has a population of 70,000 people.

The rainfall is bimodal with the long rains occurring between March and June while the short rains between October and December with an average annual rainfall that ranges between 900 mm and 1,250 mm per annum (Ngima, 2015). The wastewater is usually discharged without any form of treatment where industries discharge effluents that do not comply with Kenya's standards for discharge into the environment thus allowing it to either percolate into the ground where it flows into the natural drainage system causing surface water pollution or contaminates (Kaluli *et al*., 2011). The major socio economic activities in the area are small and large scale businesses such as hotels, welding, shops, and supermarkets as well as casual and permanent employment. However, majority of the people in the area depend on casual employment to meet their basic needs.

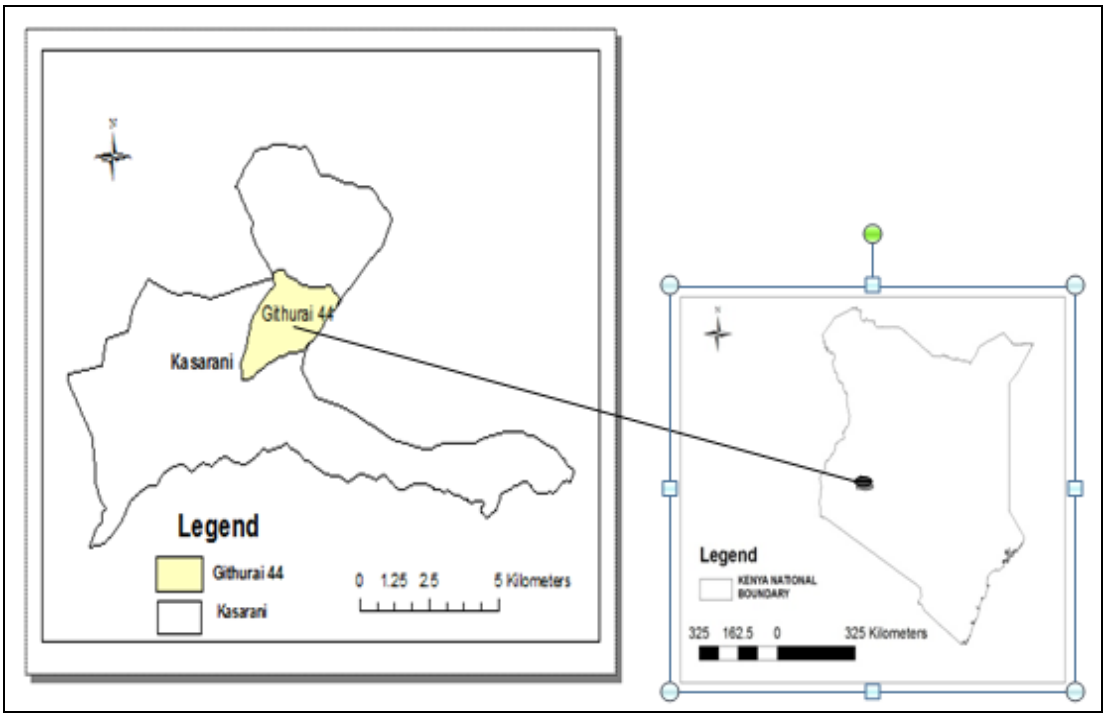

Figure 3. 1: Map of Githurai 44

3.1.1 Water supply in Githurai 44

Water supply is done by Nairobi City Water and Sewerage Company which was incorporated in 2003 under the Act cap 486 whose role is to supply clean water and sewerage services to the inhabitants of Nairobi County, in a financially sustainable manner and within the Government regulations (NCWSC, 2016). The company consists of Company Chairman, Company Secretary, Board of Directors whose main function is to made decisions in regard to provision of water, Technical department that deals with technical issues such as designing and laying of pipes and handling leakages, Commercial department that deals with marketing the company, Human resource department that handles training and hiring of employees as well as promotions and retrenchment and financial department that deals with financial

planning of the company such as revenue collection and budgeting (Birongo and Quyenle, 2005).

The water supplied is obtained from Ndakaini dam which supplies water to the whole of Nairobi and its environs and has a storage capacity of 70,000,000 m^3 (NCWSC, 2016). Currently, of the three million people in Nairobi, only 40 per cent have direct access to piped water (Herrero *et al*., 2010). The rest get water from kiosks, vendors and illegal connections. Of the existing customers, about 40 per cent obtain water on the 24-hour basis.

3.2 Study Design

Githurai ward is divided into various locations but Githurai 44 was chosen for the research. This is because it is the most highly populated and has a mixture of low and middle income earners. However, majority of the people are low income earners. Due to constraints of time and resources, it was not possible to carry out the research in the whole Githurai ward. Both qualitative and quantitative researches were employed. Qualitative research involved a detailed description of the situation using interviews which were guided by use of questionnaires; observations were also done as well as literature review.

Quantitative research dealt with quantities in terms of numbers which were analyzed using graphs and a detailed planning prior to data collection was made (Neuman, 2000). The importance of quantitative research method is that it is capable of stating

the research problems in a clear and precise manner (Frankfort-Nachmias and Nachmias, 1992).

3.3 Data Collection Methods

The data was obtained through primary sources, secondary sources as well as observation. Primary data source was obtained through administering questionnaires which were conducted through interviews to household water users. This was selected randomly in the area putting to consideration a proper representation of the whole area. Focus group discussions were done to a group of vendors, community leaders and water users. Observation was also used and photography was done so as to provide more information on the current situation. Interview method was selected to avoid respondents failing to return the questionnaires and for proper understanding of the questions by the respondents. Interviews were also conducted to the water utility officials.

3.3.1 Demographic data

Demographic data such as sex, age of the respondent, the level of education, the number of people per household, the marital status of the respondents and duration of time that one has been in the study area were collected.

3.3.2 Survey questionnaires

3.3.2.1 Surveying service delivery

Structured questionnaires were used whose indicators were service hours, water quality, the coverage of water services and the customers' satisfaction. Service hours

included the duration that the customers get water in a day and the alternative to water available while the coverage of water services was shown by the percentage of people with an individual household connection as well as alternative to household connection. In addition, customers' satisfaction was assessed by their perception in regard to water quality which included odour and colour, and occurrence of water borne diseases. Customer's satisfaction on water service delivery was also assessed which involved the number of days water is available per week and their satisfaction with the hours available.

The efficiency of redressal of complaints was also assessed which was done by the number of respondents who had made complaints in regard to water resources and the number of complaints that were handled. The income per household was taken and the charges paid for water. This was done to compare the water kiosks/vendors charges to that of Nairobi City Water and Sewerage Company.

3.3.2.2 Surveying physical accessibility and availability

Water accessibility was assessed by households connected to water supply and distance to the water point and queuing time. On the other hand, water availability was determined by the water demand per household and the ability to meet the demand. Direct observation and photography was used to determine the various water points for different users as well as the time spent in collecting water.

3.3.2.3 Surveying willingness to pay

The assessment of the amount the people of Githurai community willing to pay for the water was also assessed using questionnaires. Water users were told to indicate their willingness to pay for improved water services. Those who were not willing to pay for improved service delivery pointed out their reasons for not willing. Unstructured questions were also asked in order to gather more information in regard to improvement of water service delivery. The respondents also gave their opinion on what needs to be done in order to improve the service delivery.

3.3.3 Water quality testing

Water quality testing was done through laboratory measurement where samples were tested for PH, Total dissolved solids, turbidity, residual chlorine and *E.coli*. These parameters were chosen because they are vital to drinking water quality (WHO, 2011). The tests were done in Water Resources Management Authority (WRMA) Nairobi-Kenya. 7 samples were taken from different points of water kiosks, vendors, unaccounted for water and yard taps. This is because these are the main water sources in the area. The results were compared to the Kenya's drinking water standards as stated in The Environmental Management and Coordination (Water Quality) Regulations, 2006 and WHO guidelines.

3.3.4 Focus Group Discussions

Focus group discussions were done in order to assess the performance of water service providers and the challenges they face in water service delivery. This included various water service providers such as owners of water kiosks/vendors, a

group of water users and community leaders. It was done with the help of questionnaires which were accompanied by unstructured interviews to gather data from various water users, community leaders and water service providers. The information obtained from the focus group discussions included the information regarding the water services they get. The owners of water kiosks, vendors, boreholes and municipal council provided information on their charges for water resources and challenges they may be facing in their delivery. In addition, they gave information on their perception regarding the quality of water they deliver to the users.

3.3.5 Desk Study

Secondary data was obtained from the water utility in the area to provide information the number of customers they serve, the source of water, the production, the volume of water supplied in the study area as well as the challenges faced in the improvement of water service delivery.

3.4 Sample size and sampling procedure

Given the target population of 70,000 people, a total of where 290 household questionnaires were administered through interviews where 275 questionnaires were used for reporting as the rest were incomplete. 95% level of confidence and an error of 5% was used (Fisher *et al*., 2008). 5 respondents from Nairobi City Water and Sewerage Company were also interviewed using a different questionnaire from that of the households. 5 focus group discussions were also conducted of which 2 of them had 3 kiosk owners and 4 vendors, one of them had 7 vendors while the other 2

comprised of 9 vendors and 1 kiosk owner. In addition, 5 community leaders were also interviewed and 11 people interviewed through unstructured interviews.

Statistical method was used to determine the sample size where formula [3.1] was used

$$n = \frac{N}{(1 + N \times e^2)} \qquad [3.1]$$

Where;

n: Sample size

N: the population per block

e: error

For the questionnaires, the samples were taken from various areas as shown in Table 3.1.

Table 3.1: Areas where samples were taken

Area	Sample size
Kiangiciri	97
Kwa chief	60
Sonic	86
Rurii	47
Total	**290**

3.5 Pilot Study Site

The researcher conducted a pilot study in the neighbouring area of Zimmerman where 20 questionnaires were administered in randomly selected houses.6 water kiosks owners and 8 vendors were also interviewed giving a total of 34 respondents. The area was chosen since it has almost the same characteristics as the study area in order to identify the relationship in the water supply. It would also help to correct

any errors that would have been available in the questionnaires as well as to get acquainted with the administering of the questionnaires. During the pilot study, of the 20 questionnaires administered, only 11 of them were completely filled thus leading to the researcher to opt for administering the questionnaires through interviews. This helped to minimize the number of incompletely filled questionnaires.

3.6 Assessment of Water Utility Performance

In order to aid in water governance processes such as planning and analysis, service levels are used as a means of aggregating and benchmarking vital indicators of water service where they are assessed using qualitative methods of data gathering (Moriarty *et al.*, 2011) . In this research, service level indices were used to evaluate the accessibility index and infrastructure quality index (Walt *et al*., 2000). According to World Bank's classification, Infrastructure quality is categorized in four classes where 1= **Minimal** determined by communal standpipe located in a distance greater than 250 m, 2= **Basic** which is communal standpipe less than 250 m, 3 =**Intermediate** which is yard standpipe and 4 =**Full** which is metered in-house supply (Walt *et al*., 2000). The fomular for calculating the average service level is

$$I_i = N \times \frac{C}{N_{total}} \qquad [3.2]$$

Where I_i is the index, N is the number of users in the category, C is the Category level which is 1-4 above and N_{total} is the total number of users.

Accessibility index was also calculated using the average service level formula [3.2]. It is classified into 4 categories where percentage of households connected to water service and those households with access to safe potable water within 250 metres of the dwelling are classified into >95% is **full access** given value 1, 95%-90% is **part access** given value 2, 89%-85% is limited given value 3 and <85% is **No access** given value 4 in each category (Walt *et al*., 2000). Therefore the average service level index in each category from 1-4 was calculated using formula 3.2 and the total for all categories obtained to give the index. Calculations were also done in reference to Tynan and Kingdom (2002), Mehta *et al*., (n.d.) and Castro and Mugabi (2009), where various formulas were used for each indicator in order to assess whether the indicators met the standards or not.

3.7 Data Analysis

The main software that was used for data analysis was Statistical Package for Social Sciences (SPSS). Data was entered and coded where it was analyzed using descriptive statistics where various charts were produced using frequencies and percentages. Microsoft Excel office was also used to analyze some of the secondary data from the Water Company.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Demographic Data

Demographic data such as age of respondent, level of education, respondent gender and marital status results are described below.

4.1.1 Age of Respondent

The respondents' had to be above the age of 18 because this is considered as the age of maturity in the country and therefore mature enough to know about the water uses in the family. As shown, 52.4% of the respondents were aged between 27-35 years, 32.4% between the age of 18-26, 12.4% the age of 36-44, 2.5% the age of 45-53 and 1% above the age of 54. The high percentage of people between the age of 27- 35 clearly showed that majority of the people in the area are young and came from the rural areas in search of employment. The data is shown in Table 4.1.

Table 4. 1: Age of respondents

Age group (years)	Frequency	Percent	Cumulative Percent
18-26	89	32.4	32.4
27-35	144	52.4	84.7
36-44	34	12.4	97.1
45-53	7	2.5	99.6
>54	1	.4	**100.0**
Total	**275**	**100.0**	

4.1.2 Respondent's Gender

Most of the people that were interviewed were females which were 91.6% while that of males was 8.4%. This is because the interviews were conducted during the day

while the men had gone to work and most of the women were stay at home mums. In cases where both a male and female were present, the male would pass on the responses to the female claiming that they know more about issues of water. This clearly showed the role that women play in provision, management and safeguarding of water resources as stated in one of the principles of IWRM (GWP, 2012). The respondents' gender is shown in Figure 4.1.

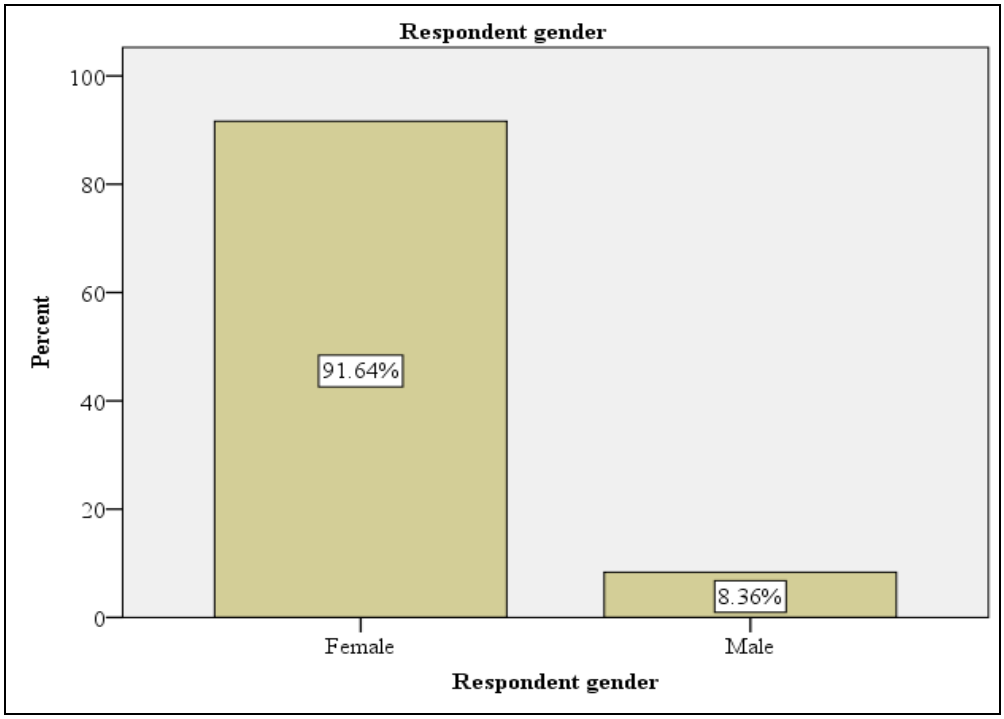

Figure 4. 1: Respondents' Gender

4.1.3 Level of Education

The categories for the level education were primary, secondary, tertiary, university and others of which 59.3% of the respondents acquired up to secondary level of education, 20.7% had primary level of education,16.7% tertiary level, and only 2.5% had achieved university level of education which is shown by Table 4.2. This could

be one of the reasons of majority of the people earning a low income in the area. The few respondents who had attained tertiary and university education lived in the middle income areas and had individual house connections. However, all the respondents could communicate in Swahili which is the national language and all had attained primary level of education.

Table 4. 2: Level of Education

Level	Frequency	Percent	Cumulative Percent
Primary	57	20.7	20.7
Secondary	163	59.3	80.0
Tertiary	46	16.7	96.7
University	7	2.5	99.3
Others	2	.7	**100.0**
Total	**275**	**100.0**	

4.1.4 Marital status

The categories given for marital status were, single, married, separated, divorced and widowed. All the respondents were either single or married. 182 respondents were married and 93 of them single while none from the other 3 categories as shown in Table 4.3. The marital status had a part to play in the water consumption by the households as most married people had children thus an increase in water consumption.

Table 4. 3: Marital Status

Status	Frequency	Percent
Single	93	33.8
Married	182	66.2
Total	**275**	**100.0**

4.2.1 Current water service delivery situation in Githurai 44

4.2.1 Water quality

This was carried out in order to assess the quality of water provided to the customers as one of the indicators of the performance of water service providers. The samples were taken from 7 areas which included water kiosks, vendors, leaking pipes and plot yard taps. These were chosen because majority of the people in the area depend on them as their source of water. The parameters that were tested included, Turbidity, Residual chlorine, PH, *E.coli* and Total dissolved solids. All the tests were done in Water Resources Management Authority (WRMA) Nairobi laboratory. The summary of water quality tests is given in Table 4.4.

Table 4. 4: Water Quality

Site	Samples	Temp	Residual chlorine	Turbidity	PH	*E. coli* (per 100ml)	TDS mg/l
Kiosk (Rurii)	1	25.3	0.6mg/l	1.0NTU	6.45	0	47.74
Vendor (Kiangiciri)	2	25.1	0.6mg/l	1.3NTU	6.94	0	47.49
Plot yard tap (Kiangiciri)	3	25.2	0.6mg/l	1.2NTU	6.98	0	47.37
Illegal connection (Sonic)	4	25.8	0.6mg/l	1.4NTU	6.94	0	47.68
Illegal Connection (Kiangiciri)	5	25.3	0.6mg/l	1.1NTU	6.86	0	47.18
Plot yard tap (Chief's)	6	25.1	0.6mg/l	1.0NTU	7.17	0	46.50
Plot yard tap(Sonic)	7	24.6	0.5mg/l	1.1NTU	6.82	0	45.63

From the laboratory tests above, the amount of residual chlorine in 6 samples exceeded the one in the WHO guidelines of 0.2-0.5 mg/l. One of the samples from the plot yard tap was within the recommended range. However, it is recommended to dose water which has a turbidity of less than 10 NTU with free chlorine at about 2 mg/l (WHO, 2011). The recommended Kenyan standards for total dissolved solid is less than 1200 mg/l while that of WHO is less than 600 mg/l while more than 1000 mg/l is considered unpalatable. All the samples were therefore within the recommended total dissolved solids.

Turbidity in water results from suspended particles or colloidal matter that hinders light transmission through the water (WHO, 2011). This may be as a result of inorganic or organic matter or both. WHO recommends a turbidity of between 1- 5 NTU. This therefore indicates that all the samples were within the recommended range. *E.coli* is another parameter that was tested in water quality. Presence of E.coli in drinking water indicates the presence of faecal contamination and can result to diseases such as urinary tract infections, diarrhoea and meningitis (WHO, 2011). The Kenyan standards as well as WHO guidelines recommend that drinking water should not have any presence of *E.coli* in every 100 ml (EMCA, 2006) From the results obtained, no sample had any traces of E.coli and therefore within the recommended. For the PH, the Kenyan standards are 6.5-8.5 (EMCA, 2006) and the WHO recommended one is 7.0-8.5 and the maximum allowable level is 6.5-9.2 (WHO, 2011). The entire samples therefore met the recommended standards.

4.2.2 Coverage

The results indicated that 82.9% of the respondents did not have an individual household water connection and only 17.1% had an individual house connection (Figure 4.2). Most of them paid for water through intermediaries such as landlords, water kiosks and vendors thus having no direct link with the municipality. As stated by WUP (2003), having an individual house connection did not guarantee a secure and reliable water supply as the water utility is faced with intermittent and irregular water supply. As a result, those with a household connection also required an alternative to water resources. Those with a household connection also paid for water through the landlords thus paying more.

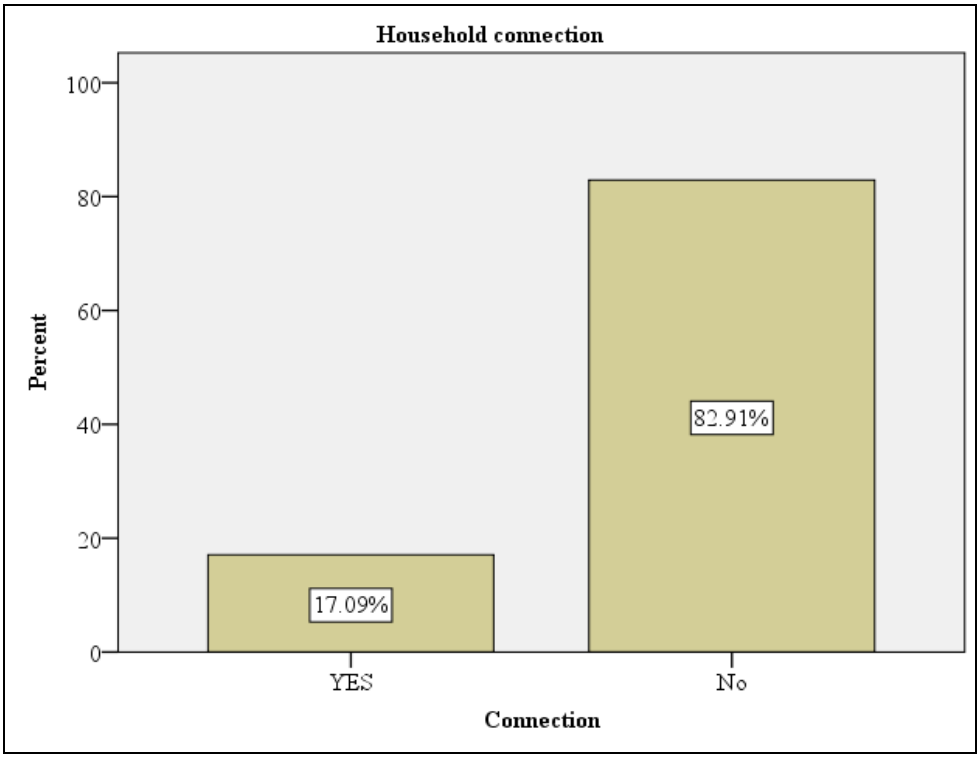

Figure 4. 2: Household Connection

Lack of individual household connection which was experienced by most of the respondents forces them to have an alternative source of water such as vendors, kiosks, plot yard taps, and leaking pipes in order to meet their demands (Figure 4.3). This is because water is vital to sustain daily life and people cannot live without it.

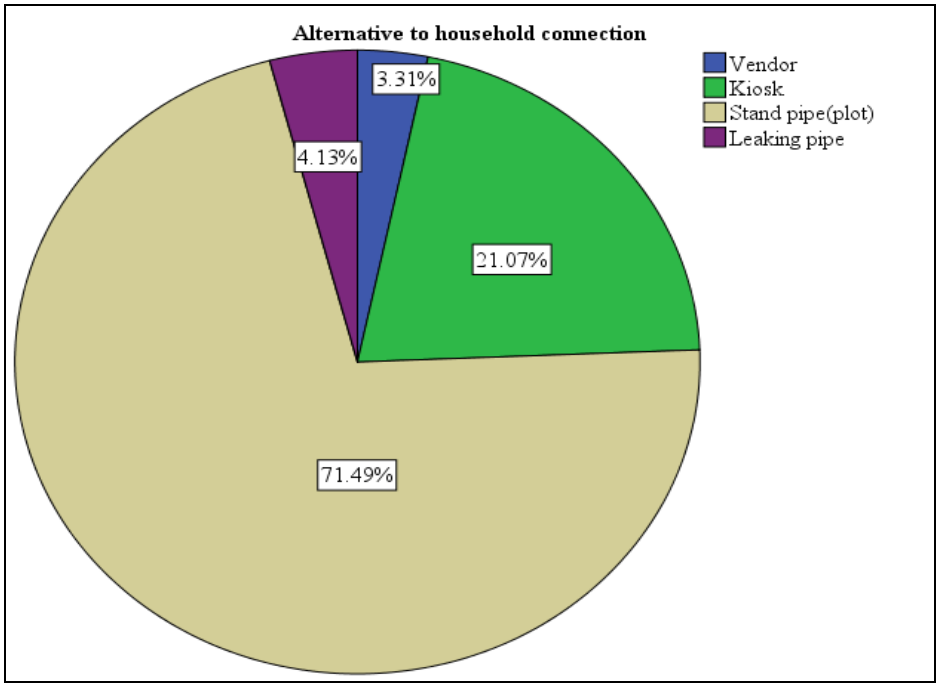

Figure 4. 3: Other sources of water

As shown in Figure 4.3 majority of the people in the area who did not have a household connection depend on water from plot yard pipe. This was 71.49% of the respondents, while 21.07% buy water from kiosks, 3.31% from vendors and 4.13% got water for free from unaccounted for water (leaking pipes). The plot yard taps water's fee is inclusive in the rent and therefore not paid directly to the municipality by the water users. The respondents who get water from the leaking pipes claimed that the water is also not very reliable and are forced to buy from the kiosks when

there is no water. However, they claimed that the water has saved them a lot of money as it is free of charge and are not to blame for the causes of leaking pipes in the area as they are due to lack of proper repair and maintenance by NCWSC (Figure 4.4).

Figure 4. 4: Illegal water connection and a vendor respectively (*photo by Karimi)*

4.2.3 Service hours

This was assessed by the number of hours the water is available to the consumers. From Figure 4.5, 45.61% of the people receive water for 11-15 hours a day which gives an average of 13 hours which does not come every day. The respondents claimed that sometimes water was available at night thus forcing them to wake up at night to fetch water for use during the day. However, this is a disadvantage to those who work during the day as they could not fetch water at night since they wake up

early in the morning for work. In addition, one is required to have enough storage facilities to store water which some did not have.

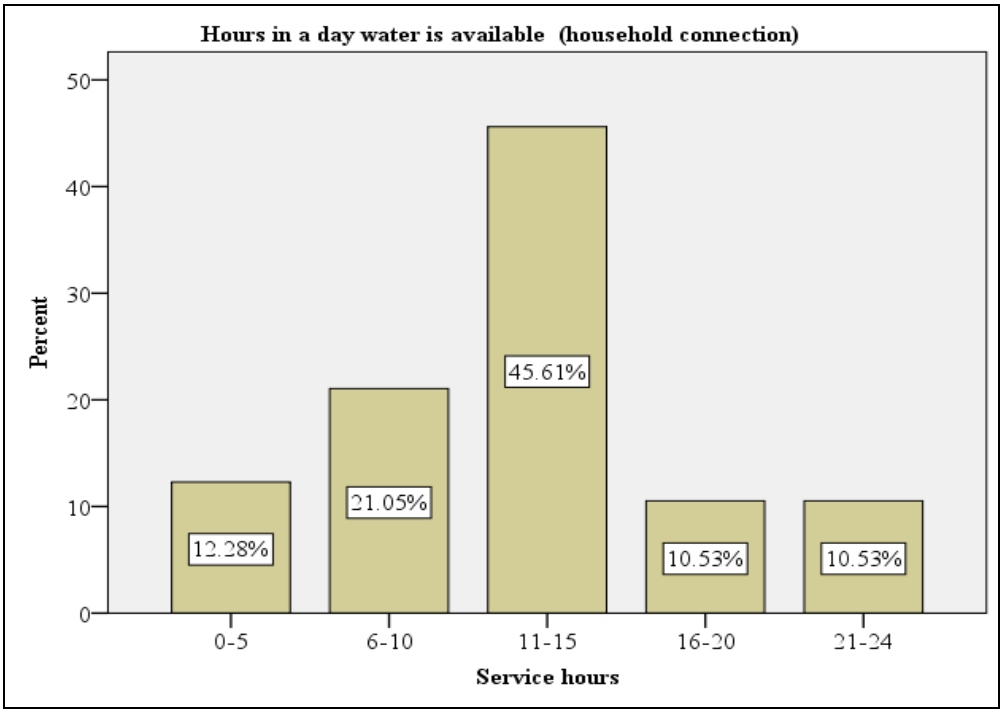

Figure 4. 5: Service hours

4.2.4 Customers' Satisfaction

The level of customers' satisfaction was assessed by their perception on water delivery services and water quality, response to complaints and the satisfaction with the number of hours that the water is available as well as charges. The percentage of people who get water every day is 40.73% with the rest not getting water every day. Majority of the people get water 4 days a week while few of them go for weeks without the resource. These are forced to have alternatives in order to survive with 45.76% relying on storage, 11.30% and 35.03% buy from vendors and kiosks respectively, and 5.08% of those with a household connection had yard taps as an

alternative. Figure 4.6, Table 4.5 and Figure 4.7 indicate the water availability, number of days per week the water is available and the alternative that people have. 2.82% claimed that they could not afford to buy water from other sources thus end up economizing on water thus compromising on hygiene issues. Those who did not have water storage facilities claimed that the houses were too small to accommodate water facilities as most of them were single rooms for the whole family.

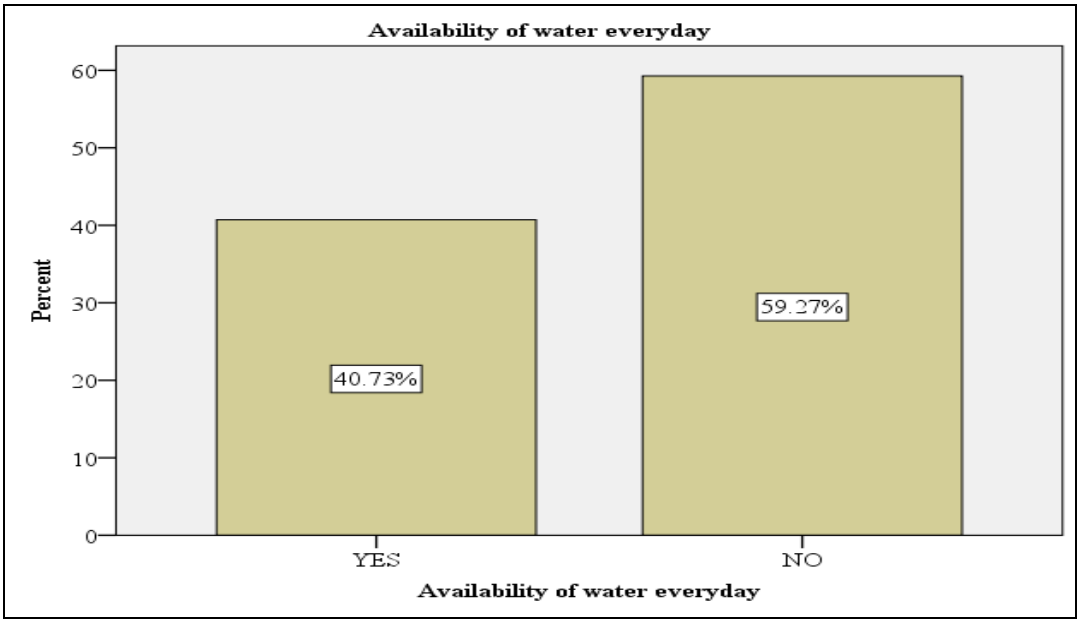

Figure 4. 6: Availability of water every day

Table 4. 5: Water availability per week

Days	Frequency	Percent
2	26	9.5
3	55	20
4	101	36.7
5	56	20.4
6	27	9.8
Weeks	10	3.6
Total	**275**	**100.0**

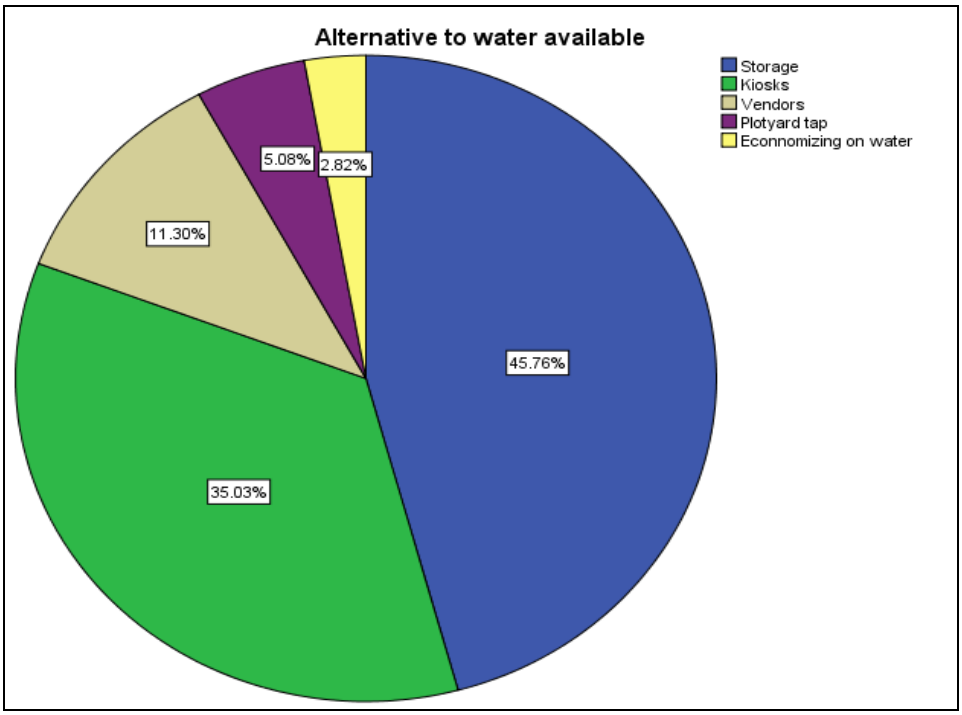

Figure 4. 7: Alternative sources of water

Majority of the respondents were not satisfied with the number of hours the water is available in the area and therefore wished for 24 hours availability every day (Table 4.6). However, 186 respondents rated the quality of water service delivery to be good as shown in Figure 4.8. This might be because despite the fact that water is not available everyday for 24 hours, they have an alternative to water source.186 respondents rated it as good, 61 fair, 23 of them poor while 5 rated it as excellent.

Table 4. 6: Satisfaction with the number of hours available

Value	Frequency	Percent
YES	38	13.8
NO	237	86.2
Total	**275**	**100.0**

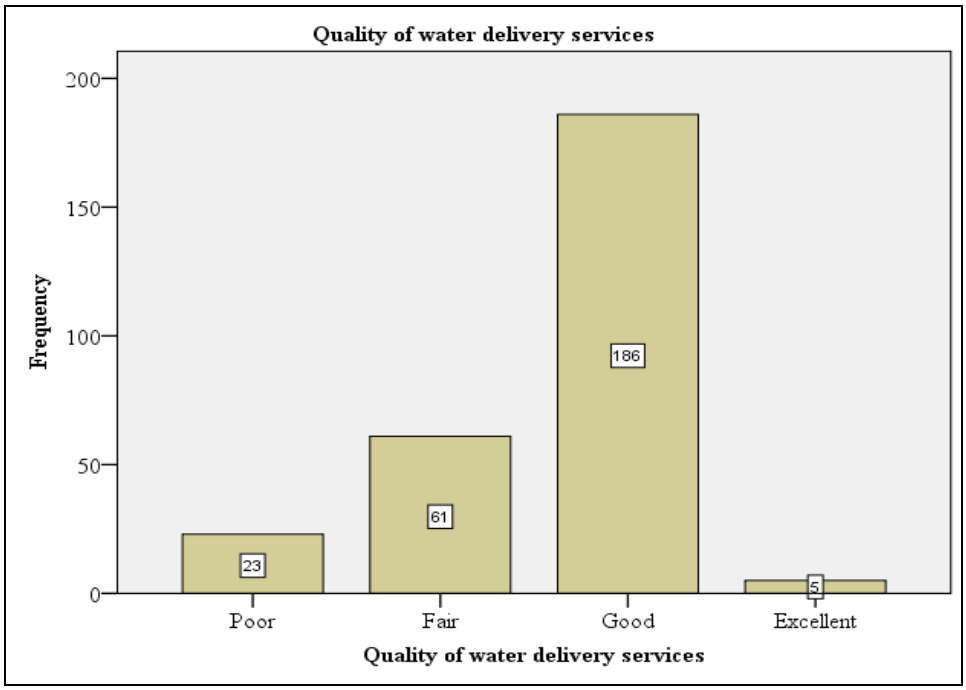

Figure 4. 8: Quality of water delivery services

In regard to their perception on water quality, the respondents stated that when the water is rationed for some time, it comes back with a foul smell and this was especially from the respondents who get water from the leaking pipes. From the observation and photography made (Figure 4.9), some of the pipes were leaking next to a bursted sewerage system which might be the cause of the contamination thus the foul smell. This is because the feacal materials find their way into the water pipes during times of no supply and therefore contamination occurs when the water is supplied. From Table 4.7, 41 respondents claimed to have suffered from water borne disease mostly typhoid after consuming it. Those who rely on plot stand pipes explained that they would let the water flow for sometime without using it to clear it up. The kiosks owners also complained of the foul smell in water at times. Majority of the respondents however boil their water before drinking.

Table 4. 7: Cases of waterborne diseases

Response	Frequency	Percent
YES	41	14.9
NO	234	85.1
Total	**275**	**100.0**

Figure 4. 9: A leaking pipe next to bursted sewerage line (*photo by Karimi*)

Out of the total number of respondents interviewed, 48 respondents had made complaints in regard to water resources to water authority where 30 complaints were handled and 18 of them were not. Out of the 30 respondents whose complaints were handled, 23 of them were satisfied with the way the complaints were addressed while 7 of them were not satisfied. Most of the complaints were done through personal visits and some through Maji Voice platform which is a service that enables Kenyans to easily and conveniently reach the water company through a mobile phone or the internet (NCWSC, 2016). The complaints comprised of issues to do with high water

charges, low pressure in water, disconnection of water and the number of days and hours that the water was available. When the Nairobi Water company officials were interviewed in regard to handling of complaints, they claimed that some of the complaints such as less service hours were beyond their control as this was an issue to do with water availability from the dam.

4.2.5 Water consumption Per Day

Many households in the area consumed 20-60 litres of water everyday followed by those who consumed 61-100 litres of water per day (Table 4.8). Only 5 household of the total households interviewed consumed more than 200 litres of water per day. From the research, the respondents with an individual house connection and those relying on yard taps spent more water as compared to those who got it from kiosks and vendors. However, some asserted that the consumption of water differed from day to day depending on the daily chores whereby they used more during the days they washed the clothes.

Table 4. 8: Household daily water consumption

Household consumption (l/d)	Frequency	Percent
20-60	92	33.5
61-100	87	31.6
101-150	74	26.9
151-200	17	6.2
>200	5	1.8
Total	**275**	**100.0**

4.2.6 Water charges from kiosks/vendors

The amount that the customers pay for water when buying from vendors/kiosks was also assessed and is shown by Table 4.9. The charges for the vendors were higher than those of water kiosks as they buy water from the kiosks and deliver it to the consumers at the doorsteps. The charges vary depending on the distance they deliver the water.

Table 4. 9: Water charges from other kiosks/vendors

Amount charged for 20 litres in Kshs	Frequency	Percent
10-20	1	5.6
10-30	5	27.8
10	2	11.1
20-30	4	22.2
5-10	2	11.1
5	4	22.2
Total	**18**	**100.0**

As shown in the Table 4.9, most of the water vendors charge Kshs 10-30 for water depending on the distance they are delivering water to their consumers. This gives an average of Kshs 20 (0.2 USD) per 20 litres. The consumption of 20-60 litres of water per household per day where the majority of people are gives an average of 40 litres per day. This indicates that those who buy water from vendors would spend Kshs 40 (0.4 USD) per day which when multiplied by 30 days gives a total of Kshs 1,200 (12 USD) per month (using the conversion rates in Table 4.11). This would be a lot of money spent on water especially for the people who earn less than 98 USD per month as this money caters all the other needs.

4.2.7 Current water tariff for Nairobi water

The current water tariff from Nairobi City Water and Sewerage Company is a flat rate of Kshs 204 (2 USD) per month, Kshs 53/m^3 (0.52 USD) for consumption of 7-60 m^3/month and Kshs 64/m^3 (0.63 USD) for consumption of >60 m^3/month. This is mostly for people with an individual household connection and pay directly to Nairobi City Water and Sewerage Company (Table 4.10).

Table 4. 10: Current water tariff for Nairobi Water Company

Consumption per month	Charges per month
0-6m^3	Flat rate of Kshs 204 (2 USD)
7-60m^3	Kshs 53/m^3 (0.52USD)
>60m^3	Kshs 64/m^3 (0.63USD)

From the consumption above, many people in the area would be in the 1st category of 0-6m^3 per month which is charged a flat rate of Kshs 204 (2 USD) per month. This means that those buying water from vendors pay Kshs 996 (10 USD) more per month. From the Table 4.11, 53.5% of the respondents have a monthly income of 10,000-30,000 (98-294 USD) and 34.2% earning <10,000 (98 USD). Only a small percentage earns more than Kshs 30,000 (294 USD) per month. Based on their income, the consumers spend a lot of money on water per month especially when buying water from kiosks/ vendors in comparison to NCWSC charges. This is because the income is supposed to cover other expenses such as house rent, food, school fees and transport among others.

Table 4. 11: Income per household

Income (Kshs)	Frequency	Percent
<10,000	94	34.2
10,000-30,000	147	53.5
31,000-50,000	29	10.5
51,000-70,000	4	1.5
>71,000	1	.4
Total	**275**	**100.0**

Current rate of conversion is Kshs 102=1 US dollar

4.2.8 Physical accessibility

From Figure 4.10, 44.4% of the people take 5-15 minutes to walk to the water point, 34.6% take 16-25 minutes, 9.9% take 26-35%, 1.2% takes 36-45 minutes while only 6.2% take less than 5 minutes. The distance was estimated in terms of time taken since most of the respondents were not conversant with the number of metres. From the observation made by the researcher, the distance where the respondents took less than 5 minutes was less than 250 metres while the rest walked more than 250 metres. Some of the women were forced to carry their children to and from the water source as they had no one to leave them with when fetching water. The water (20 litres jerican) would be carried on their backs and the children on the front.

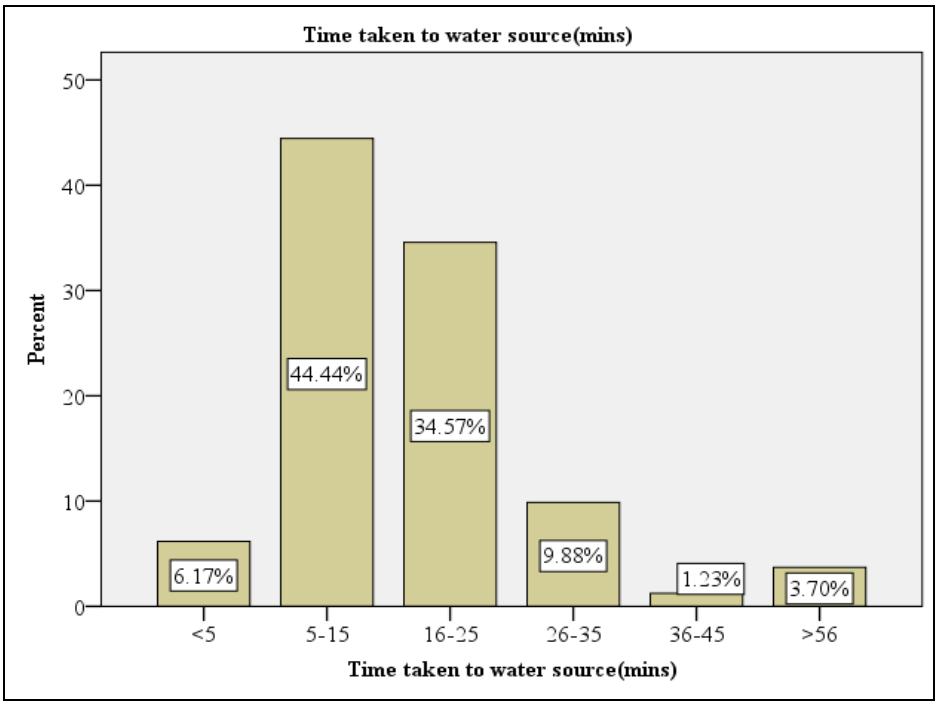

Figure 4. 10: Physical accessibility

4.2.9 Queuing Time

The distance to water source is not the only factor considered when it comes to accessibility of water but also the queuing time as shown in Figure 4.11. Majority of the respondents who get water from water kiosks queue for 21-30 minutes with some taking more than an hour. They end up wasting a lot of time which could be used for other purposes. Those doing small businesses such as shops claimed to waste a lot of time that would be used to serve their customers thus losing some of them to other shops. The respondents explained that the queues were longer during the morning hours and over the weekends when majority of the women were at home and doing the cleaning and washing.

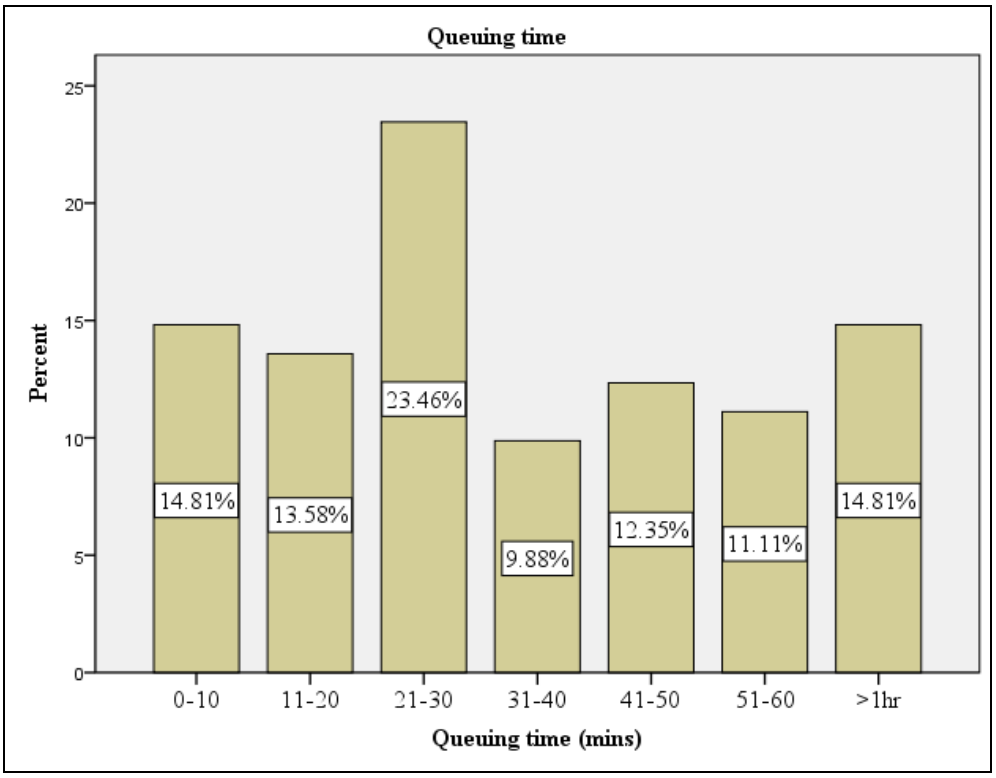

Figure 4. 11: Queuing time

4.2.10 Willingness to Pay (WTP)

The number of people who were willing to pay for improved water service delivery was 61.45% and who were willing to pay less than Kshs 5000 (49 USD) while those who were not willing were 38.55% (Figure 4.12 and Figure 4.13). The main reason why the rest were not willing to pay was due to financial constrains whereby they claimed to have difficulties even to pay for the current water services. Some claimed they were satisfied with the current situation as they are able to store water and use it when there is no water. A percentage of 2.86% felt that it is the responsibility of the municipality to provide water as it is a free commodity by nature thus making it their right as shown in Figure 4.14. This demonstrated lack of understanding of water as an economic good. As described by Savenije 2002, “Water is an economic good, but

it is not a normal economic good". This is because of some of its unique characteristics of being essential, scarce, fugitive and non substitutable (Savenije, 2002).

A greater number of those willing to pay were the ones who had no yard tap and walked for long distances for water. In addition, those with individual household connections had a higher number of willingness to pay as their level of income was higher thus higher ability to afford. This could have been contributed by the number of hours that water was available as they wished for 24 hours availability thus willing to pay. The lowest number of willingness to pay was those getting water from yard taps as they had developed strategies to cope with water shortages such as storage. Storage of water poses a major risk of microbial contamination due to high temperatures, long time of storage and dust storms thus increasing the risk of diseases (WHO, 2015). According to Tynan and Kingdom (2002), it is recommended that the level of willingness to pay be 100% thus this was below the recommended. This is a challenge towards improvement of service delivery as the municipality requires revenue for activities such as repair and replacement of old pipes and treatment of water. However, this is only possible if revenue is collected efficiently and used for improvement of water service delivery.

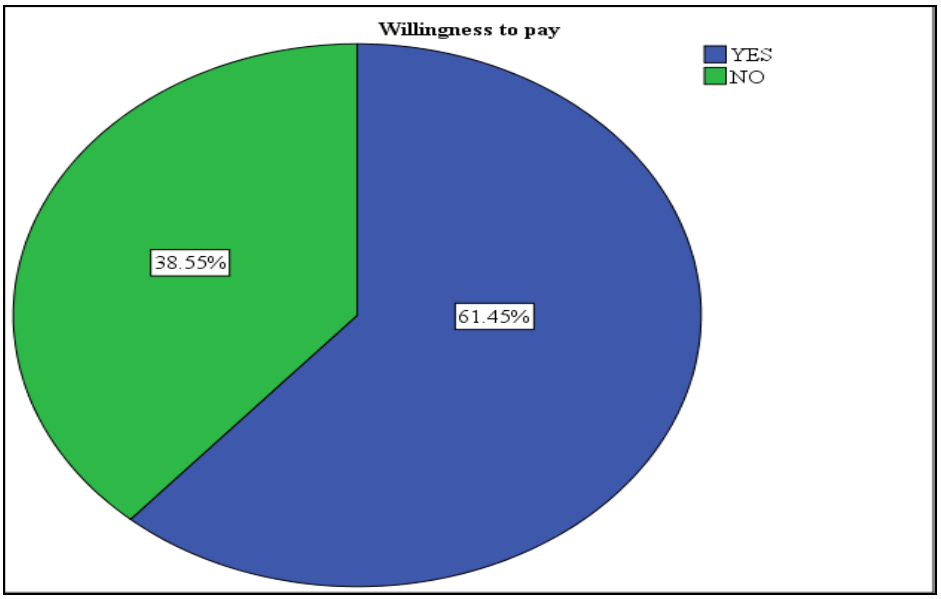

Figure 4. 12: Willingness to pay for improved services

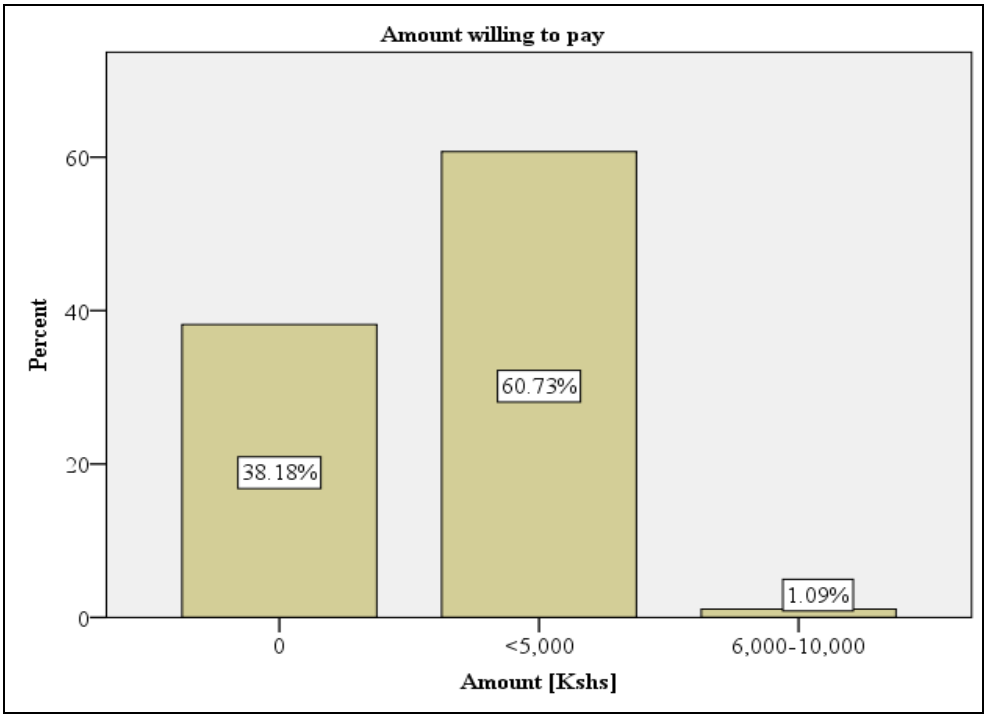

Figure 4. 13: Amount willing to pay

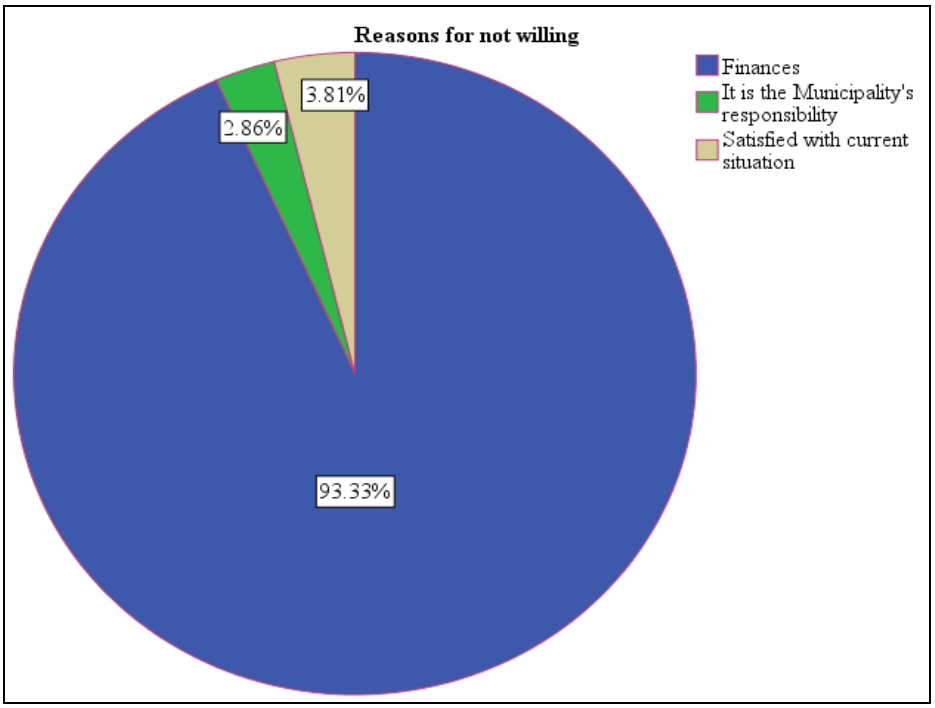

Figure 4. 14: Reasons for not willing to pay

4.3 Assessment of water utilities performance

In order to assess whether the indicators met the standards or not, comparisons were done in reference to Tynan and Kingdom (2002), Mehta *et al*., (n.d.) and Castro and Mugabi (2009), where various formulas were used for calculations for each indicator. Service level indices were used to evaluate the accessibility index and infrastructure quality index (Walt *et al*., 2000).

4.3.1 Service level benchmarking

The discussed indicators were assessed in reference to various service levels benchmarking in order to determine whether they meet the standards or not. Table 4.12 shows the assessment that was done.

Table 4. 12: Service level benchmarking

Performance indicator	Description	Standard	Indicator Range for Githurai 44	Reference
Availability	Hours water is available per day	24 hours	13 hours	Tynan and Kingdom (2002), Castro and Mugabi (2009)
Water quality	The percentage of water samples that meet or exceed the specified potable water standards	100%	100%-4 parameters 14.3%-1 parameter	Mehta *et al*., (n.d.)
Coverage	Percentage of effective means of supplying water either through household connections or shared yard taps	100%	80%	Tynan and Kingdom (2002)
Consumers' perception to water quality	Percentage of consumers satisfaction with quality	100%	93.8%	Tynan and Kingdom (2002), Castro and Mugabi, (2009)
Amount paid for water	Percentage of consumers' ability to afford	>75%	84.7%	Tynan and Kingdom (2002), Castro and Mugabi, 2009
Willingness to pay	Number of customers willing to pay for improved services	100%	61.5%	Tynan and Kingdom (2002)
Per capita quantum of water supplied	Total water supplied to consumers expressed by population served per day	135 l/ca/day	All months below 135l/c/d	Mehta *et al*., (n.d.)
Efficiency of redressal of complaints	Percentage of complaints responded to	100%	62.5%	Tynan and Kingdom (2002)

According to Tynan and Kingdom (2002), the number of service hours per day should be 24 hours. The availability was calculated as the average number of hours water is available for 7 consecutive days. The results obtained were 13 hours per day which indicated that the required standards were not met. This signifies why most of the respondents were not satisfied with the number of hours that water was available and wished for 24 hours availability. The percentage of water quality was calculated by the total number of samples that met the standards, divided by the total number of sample taken, multiplied by 100. In all the 5 parameters that were analyzed, the total number of samples taken was 7. 6 of the 7 chlorine tests done did not meet the standards while 1 was within the recommended standard of 0.2-0.5 mg/l thus giving a percentage of 14% which was way below the recommended standard of 100%. However, all the other 4 parameters namely; turbidity, PH, *E.coli*, and Total dissolved solids met the standards thus attaining the recommended 100% mark.

From the answers given by the respondents, the percentage of consumer satisfaction with regard to water quality was 93.8% which was below the standard which is 100%. Some of the respondents had complained of foul smell in water sometimes as well as occurrence of water borne diseases such as typhoid. The number of people with an individual household connection or a shared yard tap was 80% which was below the standard 100%. The rest relied on vendors/ water kiosks and illegal water connection. Due to the fact that most of the respondents relied on water from yard taps which they did not pay for directly, they had no difficulties paying for the water since it is inclusive in house rent. The level of affordability was therefore realized to be 84.7% which is within the standard >75%. In regard to the efficiency of redressal

of complaints, the total number of complaints lodged was 48 and the ones handled were 30 which gave a percentage of 62.5% that was below the recommended 100%.

4.3.1.1 Per capita quantum of water supplied

In order for the water supply to meet the demand for water resources, per capita water demand standard should be 135 l/c/d **(**Mehta *et al*., n.d.). Mehta *et al*. (n.d.) explains that it is obtained by dividing the water supplied to the distribution system in litres by the number of days in a specific month divided by the number of people in the area. Table 4.13 gives a summary of the demand versus supply for 14 months from January 2015 to February 2016 which was calculated from the data obtained in Nairobi City Water and Sewerage Company.

Table 4. 13: Per capita quantum of water supplied

Month	Volume of water supplied (m^3)	Standard l/c/d	Per capita quantum of water supplied (litres)
Jan	97,041	135	44.72
Feb	99,089	135	50.56
Mar	100,520	135	46.32
Apr	96,129	135	45.78
May	89,132	135	41.07
Jun	107,311	135	51.10
Jul	950,95	135	43.82
Aug	139,894	135	64.47
Sep	92,425	135	44.01
Oct	110,262	135	50.81
Nov	101,863	135	46.94
Dec	88,489	135	40.78
Jan	92,243	135	42.51
Feb	86,139	135	42.43

From the results of Table 4.13, in all the months the per capita quantum of water supplied was below the standard of 135 l/c/d and therefore could not meet the demand. This is shown by Figure 4.15.

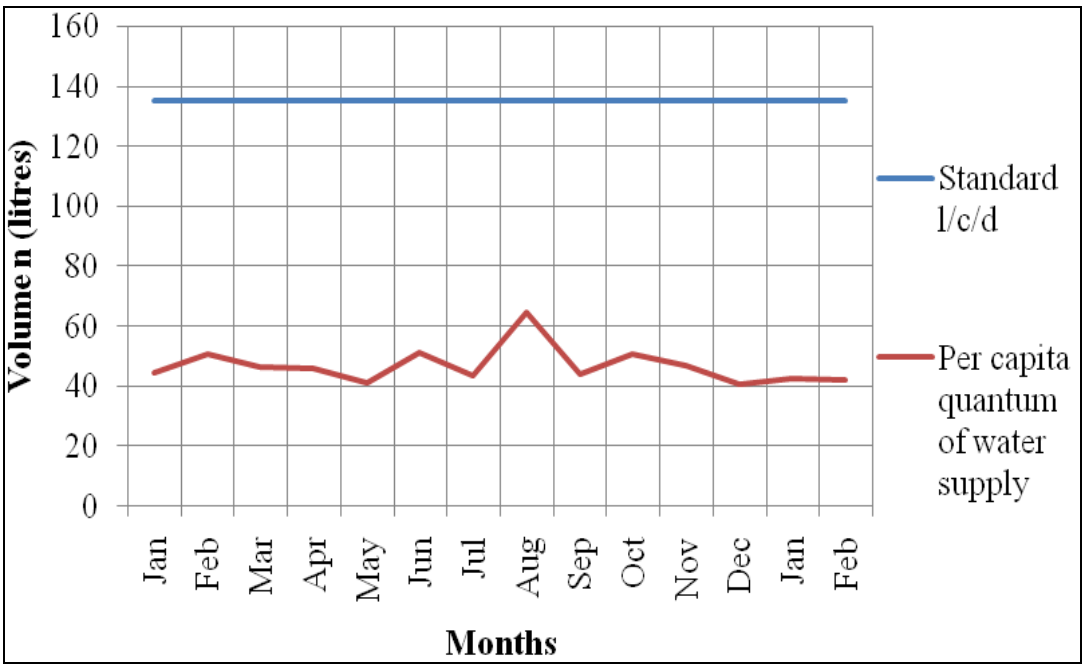

Figure 4. 15: Per capita quantum of water supplied

4.3.2 Service Level Indices

Service level indices were also used to determine the standards of the indicators. The ones that were examined were accessibility index and infrastructure quality index. From the data that was collected, the number of users in category 1 were 50, category 2 were 5, category 3 were 173 and category 4 were 47 where formula [3.2] was used thus the index was obtained by I_i+…I_n which was 2.78 which was in the 2nd category of **basic**. This shows that the infrastructure quality index requires to be improved in order to be in the full category.

Accessibility index was also calculated where from the data collected, the total number of users with a household connection were 47 and those with access to safe potable water within 250 metres of dwelling were 225 thus the total index for the 2 categories was 3.95 hence in the 3rd category of **limited access** to water resources. This was calculated using the average service level index formula [3.2].

4.4 The challenges of improving water service delivery

Having discussed the current situation of water service delivery in Githurai 44, it is vital to look at the challenges of improving service delivery. From the interviews conducted with the Nairobi City Water and Sewerage Company officials, the major challenges for improving water service delivery include; low water production from Ndakaini dam thus making it impossible for the supply to meet the current demands, high number of illegal connections due to high volumes of non revenue water, poor revenue collection efficiency which makes the maintenance and repair of the existing system difficult, development works interfering with the existing systems, old distribution network, high water demand due to increase in population growth, material delivery delays and transport system problems. Some of the development works mentioned was the construction of Thika super highway where some of the distribution pipes are laid.

The challenges faced by the kiosks owners is unreliable water from Nairobi City Water and Sewerage Company, low pressure sometimes and foul smell while those of vendors are long queues when buying water thus spending a lot of time and customers' complaining of high charges and lack of water reliability from the kiosks.

From the focus group discussions that were conducted with 5 community leaders organized by the area chief, the major challenge in the area is high population growth without an increase in the water supply systems. The challenges are discussed in details below.

4.4.1 Challenges to improve water availability and reliability

The water supply in Githurai 44 is done by Nairobi City Water and Sewerage Company. From the interviews conducted with the water utility officials, the company was established in 2003 and it has 7 connections serving around 10,000 people in Githurai ward. The water supplied is obtained from Ndakaini dam which supplies water to the whole of Nairobi and its environs. The dam produces 430,000 m^3/day of water. The amount of water produced by the dam depends on the rainfall thus climate change poses a great challenge of improving water availability in future. This will also affect the reliability of water resources leading to a reduction in the service hours. The volume of water supplied to the people of Githurai 44 from the month of January 2015 to February 2016 is as shown in Figure 4.16.

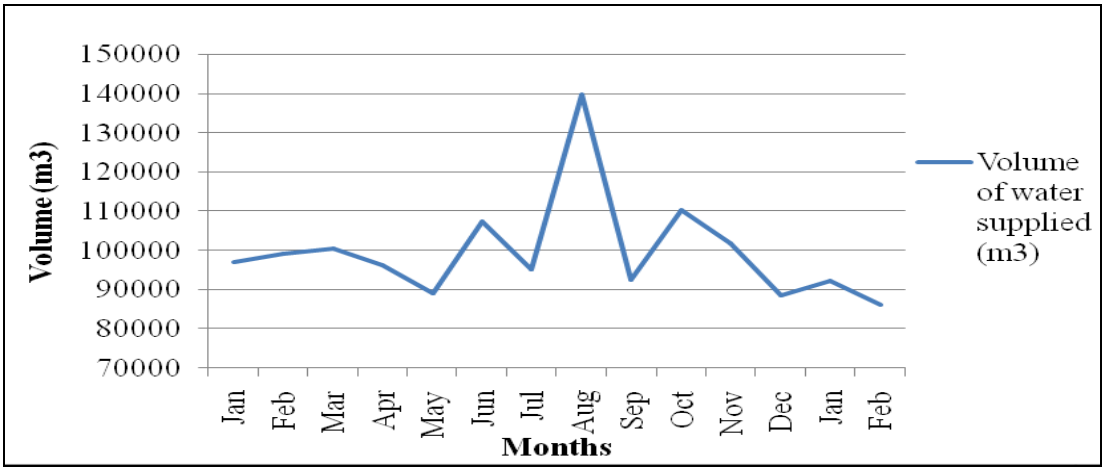

Figure 4. 16: Volume of water supplied to people of Githurai 44 in 2015/2016

The volume is highest in the month of August with a volume of 139,894 m^3 followed by October. The officials stated that the volume of water is not enough to supply to the whole Githurai area every day thus rationing is applied. In addition, the municipality experiences water shortages that result from low water production from Ndakaini dam and bursts as well as leakages when upgrading the lines. The challenges were also assessed from the focus group discussions were conducted with kiosks owners and vendors which comprised of 5 groups of which 2 of them had 3 kiosk owners and 4 vendors, one of them had 7 vendors while the other 2 comprised of 9 vendors and 1 kiosk owner. The results that were analyzed were from 18 of them as the rest did not respond to the questions fully. The results showed that the source of water for the kiosks is Nairobi City Water and Sewerage Company while the vendors buy water from the water kiosks. As shown in the Table 4.14, 100% of the respondents said that the source of water is not reliable.

Table 4. 14: Water reliability as per the respondents

Answer		Frequency	Percent
	No	18	100.0

The number of litres supplied per day by kiosks/vendors is shown in Table 4.15 where the highest amount of water supplied was 17,500 l. This was a kiosk whose owner has tanks that stored water to supply when there is no water from the water company (Figure 4.17). During the days that there is no water availability from Nairobi City Water and Sewerage Company, the kiosks would have no water to supply and the vendors as well since they buy water from the kiosks. This is also a

major challenge in the future as the water kiosks/vendors also rely on water from NCWSC. Most of the respondents who rely on these water sources may be forced to get water from unprotected sources such as rivers in the future.

Table 4. 15: Number of litres supplied per day by kiosks/vendors

Volume (litres)	Frequency	Percent
1000-1400	1	5.6
1000-1500	1	5.6
1000-1550	1	5.6
1000	4	22.2
1200	2	11.1
1500	3	16.7
17500	1	5.6
200	1	5.6
2000	1	5.6
600	1	5.6
7000	1	5.6
800	1	5.6
Total	**18**	**100.0**

Figure 4. 17: Kiosk supplying the highest amount of water in the area (*photo by Karimi*)

4.4.1.1 Water consumption versus supply

There is a high population growth in the study area as well as high level of leaking pipes and wastage of water resources thus posing a threat in improving water reliability. Based on the questionnaires that were administered, the total amount of water consumed by the sampled households was 30,020 l/d and the total number of people in the households was 1011 (Table 4.16) thus giving an average consumption of 29.69 litres per capita per day. This gives a total of 2,078,300 litres per day in the study area that has a population of 70,000 people. The daily per capita water consumption is below the recommended 135 l/c/d (Mehta *et al*., n.d.)

Table 4. 16: Number of people in sampled households

Number of people	Frequency	Total
1	9	9
2	30	60
3	86	258
4	94	376
5	40	200
6	8	48
7	5	35
8	2	16
9	1	9
Grand Total	**275**	**1011**

From the secondary data obtained from Nairobi City water and Sewerage Company which is the major source of water in the area, the total amount of water supplied for the year 2015 was 1,217,250 m^3 while the total water consumption in that year was 758, 580 m^3 thus the water supplied is more than the consumption. However, the consumption is even below the recommended 50 l/c/d (Gleick, 1999) and the respondents claimed that the water was not enough to meet their demand. The low

consumption might be contributed by the less days and hours of water availability thus compromising on their hygienic purposes. In addition, the long distance travelled to get water and queuing time as well as high charges for water from the kiosks and vendors led to the low water consumption. The reason why the water consumed was lower than the water supplied is due to wastage of water resources through bursted pipes and some faulty yard taps as observed in some areas as shown in Figure 4.4 and Figure 4.18.

Figure 4. 18: Faulty yard tap (*photo by Karimi*)

A consumption of the recommended 50 l/c/d would give a total of 1, 277,500 m^3 which is more than 1,217,250 m^3 supplied by Nairobi City Water and Sewerage Company in 2015 and therefore not enough to meet the future water demand. The situation may get worse due to high population growth in the area resulting to an increase in demand for water resources. The urban population in Kenya continues to

grow with Nairobi which is the capital city and where the study area is having the highest population growth (UNEP/GRID-Arendal, 2011). According to UNEP/ GRID-Arendal (2011), the population of Nairobi increased from 5.2 per cent to 32.4 per cent between 1948 and 2009. The trend of population growth is shown in Figure 4.19.

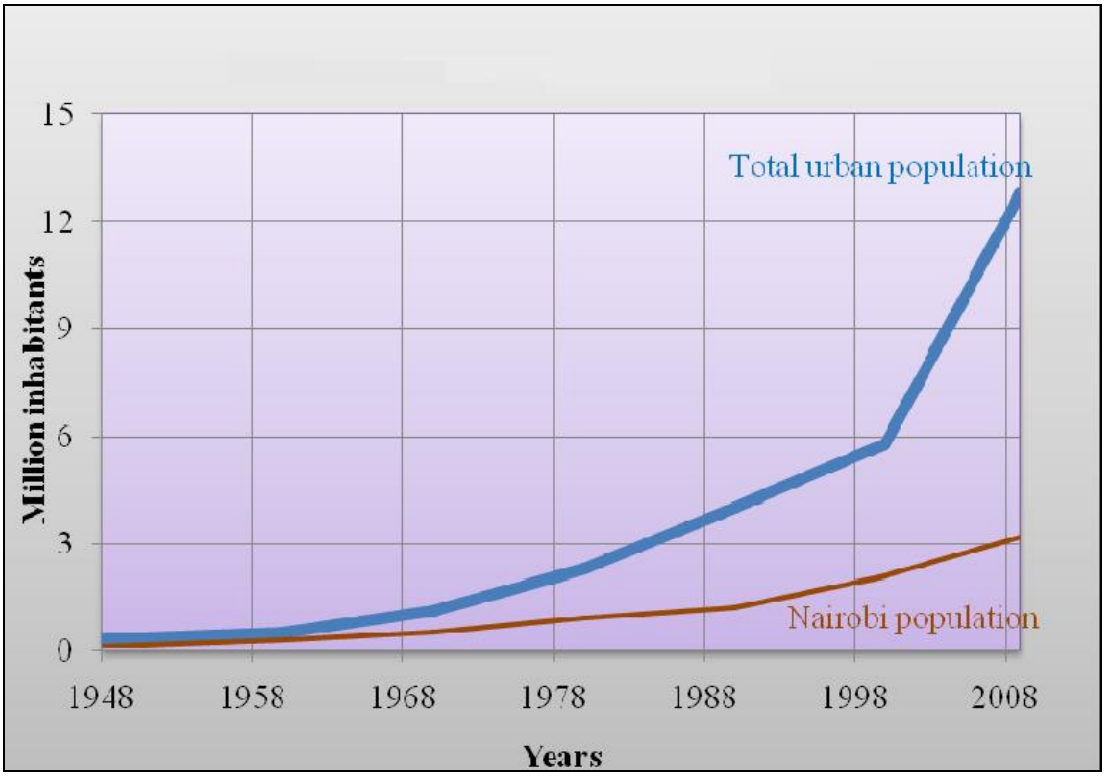

Figure 4. 19: Urban population trends, Kenya and Nairobi

With the trend in increase in population in the area, there will be more pressure on the existing water resources as the demand will increase. The service hours therefore may be fewer in future as compared to the current situation. This will lead to more people lacking access to safe drinking water and therefore more demand for alternative sources of water which may be unsafe leading to waterborne diseases and more deaths especially to children under the age of five. As a result, the distance to

water points and queuing time will also increase. This will have more impact on the socio economic activities as well since more time will be wasted looking for water hence increase in poverty. The impact will be felt more by women and girls as they are the ones responsible for the provision of water resources thus denying them equal opportunities to men. This may also result in conflicts as witnessed in some communities in the past as they fought for water resources in Tana River Delta district of Kenya's Coast province in 2012 where 38 people were killed including women and children (Onyango, 2012).

4.5 Respondents' suggestions on improvement of water service delivery

In order to improve the water service delivery in terms of water availability, reliability, physical accessibility and quality, the respondents gave various opinions on what needs to be done. The suggestions that were made included installation of durable pipes to avoid bursting; this would help to reduce the level of leaking pipes thus improving water reliability and avoid wastage of water resources. Necessary legal actions should be taken to those doing illegal connections in order to minimize it. Establishment of more water service providers apart from Nairobi City Water and Sewerage Company was another suggestion that was made that would help to improve the water supply services and avoid monopoly of services. In order to improve the future water availability, protection of water catchment areas would be necessary as this would increase the amount of water available.

In addition, the respondents suggested the need for all the house owners to fix proper taps to avoid wastage of water resources. This is because there were so many faulty

taps in the area where a lot of water was being wasted. Since majority of the respondents were not satisfied with the number of hours that water is available, they felt there is a need to have more water supply lines in order to improve the reliability of water. This is because the current water supply lines were not enough for the current population and some of the plots had no yard taps thus relying solely on water kiosks/ vendors. The increase in supply lines would help them by being connected to yard taps. Some of the respondents who were not satisfied with water quality proposed proper sewerage pipes and water pipes separation to avoid contamination of water during leakages from the bursted pipes. In order to improve the revenue collection efficiency, it was suggested that proper billing systems should be installed and individual water metres to avoid paying for water through intermediaries.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The quality of water service delivery in the area was below average as assessed using the service level benchmarking, infrastructure index which was basic and the accessibility index being limited access to water resources. The major cause of this is low water production from the source thus making it inadequate to meet the demands of the growing population. In addition, high levels of illegal connections as a result of leaking pipes, wastage of water resources and development works that interfere with the current system. This has led to many people lacking access to clean water thus relying on other sources such as illegal water connection which exposes them to the mentioned cases of water borne diseases and wasting a lot of time looking for water.

Due to low water resources reliability, majority of the people have developed adaptation strategies to cope with the shortage such as storage thus reducing the percentage of people willing to pay for improved service delivery. Majority of those willing to pay for improved service delivery obtained water from water kiosks/ vendors thus walking for long distances and paying more. In addition, most of the people in the area are low income earners thus not able and willing to pay for improved services.

5.2 Recommendations

Based on the outcome of the studies, it is recommended that;

- Proper maintenance and repair of the current system be done in order to reduce the high levels of bursts that lead to illegal water connection and come up with legal measures that deal with illegal water connections.
- Water distribution pipes and sewerage lines should be far from each other in order to avoid contamination of water resources as seen in photography taken.
- More water distribution systems should be established in order to cater for the increasing demand thus reducing the number of people without access to safe drinking water and ensure yard taps are provided to those who have no access to safe drinking water.
- The water users should be educated on the importance of conservation of water resources and water demand management to avoid wastage of the resources as observed in some of the yard taps.

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APPENDICES

Appendix A: Household Questionnaire

General information

Date of interview…….

Time interview started**……** Time interview ended……

Location……..

Please tick where appropriate and write in available spaces where applicable

Section 1: Demographic data

1. Sex Male [ ] Female [ ]
2. Age of respondent A. 18-26 [ ] B. 27-35 [ ] C. 36-44 [ ]
   D. 45-53[ ]
   E. 54 and above [ ]
3. Marital status A. Single [ ] B. Married [ ] C. Separated [ ]
   D. Divorced [ ] E. Widowed [ ]
4. Level of education of the respondent A. Primary [ ] B. Secondary [ ]
   C. Tertiary [ ]
   D. University [ ] E. Others, specify [ ]
5. How long in years have you been in this area? A. Less than 1 year [ ] B. 1- 5 [ ] C. 6-10 [ ] D. 11-15 [ ] E. 16-20 [ ] F. Over 21 [ ]
6. How many people live in this household? A. 1-5 [ ] B. 6-10 [ ]
   C. 11 and above [ ]

Section 2: Water availability, reliability and physical accessibility

7. Do you have a household connection? A. Yes [ ] B. No[ ]

8. If No, Where do you get water from? A. Vendor [ ] B. Kiosk [ ] C. Borehole [ ] D. Shallow well [ ] E. Other, Specify [ ]
9. Do you get water every day? A. Yes [ ] B. No[ ]
10. If No, how many days per week? ----------
11. How many litres of water do you use per day?

    A. 20-60 [ ] B. 61-100 [ ] C. 101-150 [ ] D. 151-200 [ ]

    E. More than 200 [ ]

    Specify if possible
12. Is the water enough for domestic use? A. Yes [ ] B. No[ ]
13. If No what alternative do you have? ----------
14. If no household connection, how long does it take to travel to the water source minutes?

    A. Less than 5 minutes [ ] B. 5-15 [ ] C. 16-25 [ ] D. 26-35 [ ] E. 36-45 [ ]

    F. 46-55 [ ] G. 56 and above [ ]
15. How much time in minutes do you spend queuing for water? A. 0-10 [ ]

    B. 11-20 [ ]

    C. 21-30[ ] D. 31-40 [ ] E. 41-50 [ ] F. 51-60[ ]

    G. More than 1 hour [ ]
16. How many times do you go for water every day?

    A. 0-3 [ ] B. 4-6 [ ] C. 7-9 [ ] D. 10 and above [ ]

Section 3: Performance of water service provider

17. If you have a household connection, how many hours per day is the water available?

    A. 0-5 [ ] B. 6-10 [ ] C. 11-15 [ ] D. 16-20 [ ] E. 21-24 [ ]

18. Are you satisfied with the number of hours that the water is available? A. Yes [ ] B. No [ ]

19. If no, how many hours would you want the water to be available? ----------

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20. Have you ever made any complaint about water services to water authority?

    A. Yes [ ] B. No [ ]

21. If yes, was the complaint handled? A. Yes [ ] B. No [ ]

22. Were you satisfied with the way the complaint was handled? Yes [ ] No [ ]

23. How do you rate the quality of water you use?

    A. Poor [ ] B. Fair [ ] C. Good [ ] D. Excellent [ ]

24. During the time that you have been here, have you or any member of you family suffered from water borne/ vector borne diseases? A. Yes [ ] B. No [ ]

25. If yes, name them ----------

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26. In your opinion, how do you rate the quality of water delivery services that you receive?

    A. Poor [ ] B. Fair [ ] C. Good [ ] D. Excellent [ ]

B. In your opinion, what do you think should be done to improve the water services?

Section 4: Willingness to pay for water services

27. What is the total income in the family in Kenya shillings? A. Less than 10,000[ ] B. 10,000-30,000[ ] C. 31,000 -50,000[ ] D. 51,000-70,000[ ] E. 71,000 and above [ ]

28. If using a household connection, how much do you pay for the water per month in Kenya shillings?

    A. Less than 5,000 [ ] B. 6,000-10,000 [ ] C. 11,000-15,000 [ ] D. 16,000 and above[ ]

29. If buying water from other sources, how much do you spend per daily in Kenya Shillings?

    A. Less than 100 [ ] B. 100-200 [ ] C. More than 200 [ ]

30. Do you have difficulties paying for the water? Yes [ ] No [ ]

31. Are you willing to pay for improved water services? Yes [ ] No [ ]

32. If yes, how much are you willing to pay for water every month in Kenya shillings?

    A. Less than 5,000 [ ] B. 6,000-10,000 [ ] C. 11,000-15,000[ ] D. 16,000 and above [ ]

33. If not willing, kindly give reasons ----------

Appendix B: Focus Group Discussion

Interview questions for Water service providers and community leaders.

Date of interview ----------

Time interview started ---------- Time interview ended----------

General information

Tick where appropriate

Community leader [ ] Water service provider [ ]

For water service providers only.

1. What kind of water service provider are you?

A. Municipal council official [ ] B. Private Borehole owner [ ] C. Vendor / Water Kiosk owner [ ]

Section for municipal council

2. When was the municipality established?

3. How many customers do you serve?

4. How many people was the water supply system designed to serve?

5. How many people does it serve currently?

6. How many have a private connection?

7. How many stand pipes do you have?

8. What is the source of the water?

9. Do you experience any water shortage?

10. What do you think are the causes of water shortage if any? ----------

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11. What is the quality of the water that you provide to the community?

12. Do the customers report any complaints regarding the services you provide?

13. If yes, how do you handle the complaints? ----------

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14. What is the average water consumption per capita per day?

15. What is the revenue collection efficiency?

16. What are the challenges that the municipality is facing to improve water service delivery? ----------

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17. How do you rate your performance as a municipality?

Section for Private Borehole owners

18. How many litres do you supply per day?

19. Is your borehole protected or unprotected?

20. Have you had any complaints from the people you serve? If yes, what kind of complaints?----------

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21. How did you handle the complaint? ----------

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22. What challenges are you facing to improve the delivery of water services? ---

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For water kiosks/ Vendors

23. How many litres do you supply per day?

24. Where do you get your water from?

25. Is the source reliable?

26. How do you store the water?

27. How often do you test the water quality?

28. How much do you charge for the water?

29. Is there any discount for customers who buy large amounts of water and if yes, how much? ----------

30. Have you had any complaints from the people you serve? If yes, what kind of complaints? ----------

31. How did you respond to the complaints? ----------

32. What challenges are you facing to improve your performance on water service delivery?----------

Community leaders

33. How long have you been a leader in this community?

34. What percentages of people are served with water from the municipality?

35. Approximately, how many water kiosks/vendors are there in this community? ----------

36. Approximately, how many private boreholes are there?

37. Do you receive any complaints about water services from the community?

38. What challenges if any in regard to water provision is the area facing?---------

39. What do you think is the solution to these challenges if any? ----------

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40. Who is responsible for handling the water provision challenges?

41. What improvements if any have been there regarding water service provision in this area? ----------

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42. In your opinion, does the population in the area decrease or increase? ---------

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43. Among the water service providers that are there in the area, who serve the highest number of people?

Thank you very much for your response