EFFECTS OF HOUSEHOLD CHARACTERISTICS ON URBAN WATER USE IN ITEN TOWN, ELGEYO MARAKWET COUNTY, KENYA

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DECLARATION

DECLARATION BY THE STUDENT

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DEDICATION

This work is dedicated to my dear children Angel-Cheryl, Adrian and Zenah. May this work inspire you to pursue higher education.

ABSTRACT

Urban areas of the world are already or almost facing unprecedented water scarcity due to increased demand from the ever-growing urban population without an equivalent growth in the development of water supplies. Unfortunately, contemporary urban water management practices have not been able to adequately respond to this need. Just like in other users, there is a growing need for urban water consumers to innovate in the way they utilize available water resources especially at the household level in order to ensure sustainable utilization. This makes it necessary for urban residents and planners to understand present water use patterns in order to influence their overall water consumption and policy on urban water management respectively. This makes it critical to study household water use patterns and the influence of different household characteristics on water use. This study, conducted in Iten Town of Elgeyo Marakwet County Kenya, is one such study. The specific objectives of the inquiry were to: determine household water use patterns in Iten Town, establish the relationship between household socio-economic characteristics and water use and establish household water conservation strategies practiced in the Town. The research adopted a mixed-method design where collection and analysis of qualitative and quantitative data was done. The data collected included information on socio-economic attributes of household heads, main sources and uses of water, the amount of water consumed within households, among others. Quantitative data was analyzed with the assistance of IBM Statistical Package for Social Scientists (SPSS) computer package. Pattern matching and thematic analysis of qualitative data was done to identify important themes and relationships in the use of water. The study revealed piped water as the main source of water in Iten Town and that large households consumed less water per person in a day than those with few members. For instance, households with 8 members used an average of 27 l/p/d while a single member household used 64 l/p/d. It was also found that households with gardens and livestock used comparatively large amounts of water. Findings further revealed reusing water, minimal water use, use of pit latrines instead of flush toilets, water storage and turning off taps while brushing teeth as the main water conservation options practiced in Iten Town. Besides controlling gardening and livestock keeping in urban areas, this study recommends exploration of alternative sources of water such as rain water harvesting particularly by households who must have gardens and livestock as a means of reducing pressure on municipal water supply.

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LIST OF ABBREVIATIONS AND ACRONYMS

CBD	Central Business District
CGEM	County Government of Elgeyo Marakwet
CIDP	County Integrated Development Plan
EMC	Elgeyo Marakwet County
GOK	Government of Kenya
GWP	Global Water Partnership
ITWASCO	Iten-Tambach Water and Sanitation Company
IWMI	International Water Management Institute
JMP	Joint Monitoring Programme
KACC	Kenya Anti-Corruption Commission
KIPPRA	Kenya Institute for Public Policy Research and Analysis
KNBS	Kenya National Bureau of Statistics
NCPD	National Council for Population and Development
NRW	Non-Revenue Water
PAI	Population Action International
PI	Population Institute
SPSS	Statistical Package for Social Sciences
TTC	Teachers Training College
UNDESA	United Nations Department of Economics and Social Affairs
UNDP	United Nations Development Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNICEF	United Nations International Children's Education Fund
WASREB	Water Services Regulatory Board
WHO	World Health Organization
WRMA	Water Resources Management Authority
WWAP	World Water Assessment Programme

DEFINITION OF OPERATIONAL TERMS

Household	A group of people (or just one person) who live together and take decisions jointly
Household characteristics	Changing family aspects such as household size, household age structure, level of household income and age of household members
Water use	Describes the total amount of water withdrawn from its source for use. These uses are agriculture, industry, energy production and households.
Water consumption	Is the quantity of water directly utilized by the consumers. It is the portion of water use that is not returned to the original water source after being withdrawn.
Water demand	Is the measure of the total amount of water needed by the customers within the water system
Water demand management	Is the development and implementation of strategies, measures and policies aimed at influencing demand, so as to achieve efficient and sustainable use of the scarce water resource
Water conservation	Refers to reducing water use or water loss by instituting behavioural changes
Water stress	Occurs when the demand for water exceeds the existing amount
Water stressed countries	Countries where their total renewable freshwater resources lie between 1,000 cubic meters and 1,700 cubic meters per person per year
Water scarcity	Refers to lack of adequate available water resources to meet water requirements
Water scarce countries	Countries where their per capita yearly fresh water resources are below 1000 m^3 per capita per year
Non-Revenue Water	Refers to the difference between the amount of water produced for distribution and the amount of water billed to customers

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A special word of thanks also goes to all the households whose fortitude, co-operation, and effort provided the essential information that enabled a better understanding of effects of household characteristics on water consumption in Iten Town.

I wish to thank my entire family, whose support enabled me to complete this thesis. Thank you all!

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Water is an important element of human development and poverty reduction and constitutes a crucial component of primary health care (WHO & UNICEF, 2000). Owing to this importance, water is considered a common need and a basic human right. However, water resources globally are experiencing immense challenges including climate change, rapid human population growth, increasing levels of urbanization, among others (Bogardi, *et al*., 2012; Patterson & Kayaga, 2015; Republic of Kenya, 2002; Jackson, *et al*., 2001). Besides aggravating overall water scarcity, these challenges have the potential of making water a non-renewable resource.

Already, one out of six people lack access to safe drinking water (UNICEF, 2004) and this situation is likely to get worse given the rapid global population increase. According to the UN estimates, the current world population stands at about 7.2 billion, and is projected to reach 9.6 billion people in 2050 (Gerland *et al*., 2014). Yet this growth in population is not matched by the rate of growth in water supply systems especially to urban areas (McDonald *et al*., 2011; K'akumu, 2004).

Regionally, the Middle East and North Africa (MENA) is considered the most water-scarce region of the world. It contains about 1.4 percent of the world's renewable fresh water and yet it is home to 6.3 percent of the world's population. On the other hand, about 40% of the populations in Africa lack access to clean water supply. The demand for water resources in these regions has been rising due to population pressures (Roudi-Fahimi *et al*., 2002; Hutton & Haller, 2004).

The rapid urbanization that has led to overwhelming demands on existing water systems in developing countries can hardly be overstated (Moe & Rheingans, 2006). While in 1975 availability of water stood at around 13,000 cubic meters per person per year, it has now dropped to 6,000 cubic meters. On the other hand, water quality has also deteriorated severely (Loucks & Van Beek, 2005). This makes the problem of water a big issue in the world today.

Kenya, a middle income country with a population of around 45.8 million people is also facing problems of water resource challenges. In addition to water resources degradation, precipitation in the country is not uniformly distributed both in time and space (Ayugi *et al.*, 2016; Republic of Kenya, 2006). The mean annual rainfall is 647 mm with Northern Kenya receiving less than 200 mm while the slopes of Mt. Kenya receives more than 1,800 mm. There is also a high level of aridity in the country with 80 percent of the land area being arid and semi-arid (Marshall, 2011). As such, Kenya is categorized as a water scarce country (NCPD, 2018; WRMA, 2015). Future projections show that the amount of water available is likely to drop from 647 to 359 cubic meters per year by the year 2020 due to population growth (Salami *et al.*, 2014; KACC, 2011).

Although the Joint Monitoring Programme (2012) puts access to safe water supplies in Kenya at 59%, about 41% of the population cannot access improved water supply (Wekesa, 2013). The situation is even worse in urban and urbanizing areas. While access to safe water here is estimated at 55%, the overall access has been declining in terms of quality, quantity, and reliability (WASREB, 2016).

This therefore means that besides expansion of water supplies which is at the moment constrained by limited resources, there is an urgent need to conserve water available to urban areas as a first line intervention. However, this cannot be done in the absence of an accurate understanding of factors that influence water use especially at the household level in such urban areas (Corbella & Pujol, 2009).

For this reason, an understanding of the behaviour of household users with regard to the use of water is important for policy makers and water utility managers (Romano *et al*., 2016; Republic of Kenya, 2006).

1.2 Statement of the Problem

Securing safe and adequate water supplies especially in urban areas is a major and a perennial challenge for policy makers (Fielding *et al.*, 2012). Water as a resource is experiencing rapid degradation (Patterson & Kayaga, 2015; Bogardi, *et al*., 2012; Republic of Kenya, 2006; Republic of Kenya, 2002; Jackson, *et al*., 2001) that has led to reduced water supply in terms of quantity and quality (CGEM, 2013; Grey, *et al*., 2013; Bogardi, *et al*., 2012).

As intimated in SDG Number 6, states are required to "ensure availability and sustainable management of water and sanitation for all by 2030". Water resource planners, as part of the major players in the realization of this goal, must therefore change their approach on water resources management. In the backdrop of the already mentioned water resource challenges, planners must focus at improving water use efficiency to promote sustainability. This is in line with Target 6.4 of SDG 6. Efficiency here means enhancing the productivity of a unit of water (Fielding *et al*., 2012).

Households being a major water user of municipal water supplies, this study sought to investigate the role of household characteristics on the overall water use with Iten Town of Elgeyo Marakwet County as a case.

Although it not only receives adequate rainfall but with also a new water supply that currently supplies adequate water of about 55 litres per person per day, Iten town was chosen as a study site due to its unique challenges. From Personal Communication in 2017 with the Technical Manager, Iten-Tambach Water and Sewerage Company (ITWASCO), the Town experiences erratic water supply. This is brought about by inconsistent flows in the main rivers feeding into its reservoirs. Secondly, the catchment population served by the supplies which currently stands at 74,000 is increasing meaning that water demand in the future shall be increasing. As such, without water efficiency measures being put into consideration, the future of water availability in Iten Town remains uncertain. This therefore made Iten Town an appropriate case for study.

1.3 Main Objective

In line with the research questions, the broad objective of this study was to assess the influence of household characteristics on urban water use in Iten Town.

1.3.1 Specific Objectives

The specific objectives of the study were:

1) To determine household water use patterns in Iten Town
2) To establish the relationship between household socio-economic characteristics and water use
3) To establish household water conservation strategies practiced in Iten Town

1.3.2 Research Questions

The study sought to answer the following questions:

1) How is household water use behaviour in Iten Town?
2) Is there any significant relationship between household socio-economic characteristics and overall water used?
3) Which water conservation strategies exist in Iten Town?
4) What can be done to ensure sustainable utilization of water in Iten Town?

1.4 Justification and Significance

Access to safe drinking water together with adequate sanitation are essential components for healthy living as they contribute to reduced disease and increased health (Sobsey & Bartram, 2003). Yet access is currently constrained by, among others, inadequate supply (Wekesa, 2013; Hutton & Haller, 2014). Since expanding infrastructure and development of new water sources is becoming difficult due to limited financial resources, efficiency in the use of existing supplies must be pursued. As such, there must be a paradigm shift to water demand management as this is the only feasible way to manage the ever-increasing water demand (Butler & Memon, 2006).

In this regard, a study such as this which aims at investigating the role of household characteristics on the overall water demand in Iten town, could not have come at the right time. This is because no effective management of water demand can be achieved without understanding the household factors that drive urban need and use of water. Such an understanding is critical in informing policy on management of water demand and use thereby contributing towards addressing the current national and global water supply challenges.

1.5 Organizational Structure of the Thesis Report

The thesis is organized into six chapters. Chapter one gives an introduction to the study and lays out the research problem, objectives, research questions and justification. Chapter Two covers the empirical literature review including the theoretical and conceptual frameworks; Chapter Three presents methods of data collection, analysis and presentation; Chapter Four presents the findings of the study in line with the objectives; Chapter Five presents discussion of research findings of the study while chapter six draws conclusions and makes recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews empirical, theoretical, and conceptual literature pertinent to the study. In order to put the study in proper perspective, the review is divided into sub-sections including importance of water to human life, water resource challenges including scarcity and the problems it portends, underlying causes of water scarcity, urban water scarcity, drivers of urban water scarcity, strategies for addressing urban household water scarcity and theoretical and conceptual frameworks.

2.2 Water and its Importance to Human Life

The importance of water to the well-being of human beings is beyond question (Loucks & Van Beek, 2005). In their natural state, water is beautiful and because of that people like to live and holiday near water sources such as lakes, rivers, coasts and even dams. Further, all life on earth depends on water. Besides, the entire foodstuff we cultivate, process and consume requires water (Corbella & Pujol, 2009). This means provision of clean water results in better-quality of life. In addition to the fact that most of our economic activities consume water, wastes generated by man are transported and integrated by water (Loucks & Van Beek, 2005).

Culturally, water has symbolic significance in many cultures and religions too. In many religious activities, water is viewed as a symbol of purity and is used to clean the body as well as the soul (Feitelson, 2012). As such, water has found use in a variety of religious and cultural ceremonies and traditions such as for ritual washing, remission of sins, as well as for cleaning the dead (Schelwald-Van der Kley & Reijerkerk, 2009).

In some instances, specific water bodies are regarded as holy, for instance River Jordan in the Middle East where it is believed Jesus was baptized. The Ganges in Asia and various springs there are thought to be holy (Feitelson, 2012).

Biologically, water is an important nutrient in the body of a human being and is essential to human life (Schelwald-Van der Kley & Reijerkerk, 2009; Moe & Rheingans, 2006). It is important in the assimilation of food, absorption, transportation of nutrients and the removal of wastes from the body. Therefore, the loss of water by the body needs to be restored through intake in order to keep the water balance in a person and to avoid dehydration (Howard & Bartram, 2003).

Apart from using water for basic needs, it is also used for leisure. Gardening is one such activity which is linked with extra water use (Ramulongo *et al.*, 2017). This is more pronounced if the garden is formed by exotic and water demanding species. Swimming pools are outdoor activities that are known to raise domestic water consumption in households that have them (Corbella & Pujol, 2009). Indeed, the new concept of waterfront development in urban planning hinges on water availability. Waterfronts provide a unique opportunity to reconnect what is special and remarkable about water by transforming water front areas into attractive, safe, more sustainable and enjoyable places (Ferreira & Visser, 2007).

Some of the uses of water are thought to be more vital than others. For instance, it is important to have a few litres of water for drinking every day than having water for personal cleanliness or laundry. Nevertheless, individuals will still need water to take bath in order to prevent diseases and to meet other physical needs (WHO, 2013).

Thompson *et al.* (2000) observes that urban households use water for consumption, hygiene and amenities. He further argues that small quantities of water are required for drinking and food preparation whereas more water is required for showering, cleaning, clothes washing, gardening and to a large extend beer brewing.

WHO (2013) adds to this discourse by stating that some water uses have health benefits, although the benefits decrease in urgency, i.e., water for drinking and food preparation is needed for short-term survival. Water for bathing or showering, washing clothes, cleaning the house, growing crops, cleanliness and waste disposal is necessary for medium-term sustenance. Finally, he notes that water for business activities such as crops and livestock and that for gardens and recreation is important for economic growth. This is demonstrated by Figure 2.1 on Hierarchy of Water Needs which was adopted from Maslow's Hierarchy of Needs.

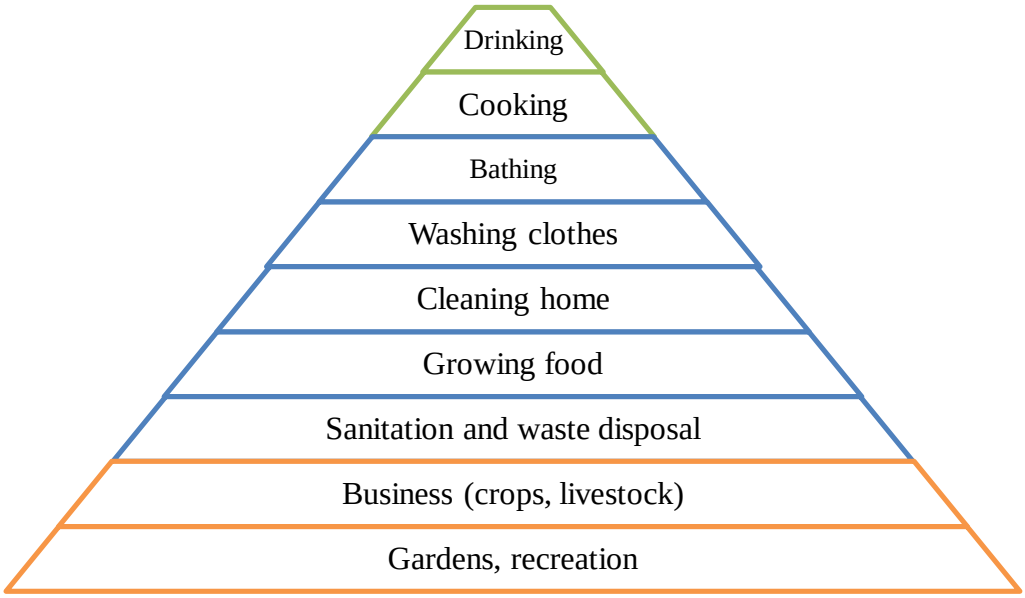

Figure 0.1: Hierarchy of Water Needs

(Source: WHO, 2013)

Water uses activities at the top of the pyramid require less water but of a higher quality than those activities at the bottom of the pyramid which require a lot of water but of low quality. The quantity of water needed for each activity increases as you move down the pyramid while the quality decreases. Clearly thus, water is no doubt a powerful natural resource throughout the world and our reliance on it will last eternally (Loucks & Van Beek, 2005). As such, its demand in the globe is made worse by the growing population which is increasing its scarcity and as such, it has the potential of enhancing conflicts and catastrophes (WRMA, 2015).

2.3 Water Resource Challenges – Emergence of Water Scarcity

There is evidence of many physical indications that show man made activities have led to unsustainable exploitation of water in many parts of the world. For instance, the over pumping of ground water that has surpassed recharge levels in Middle East, Mexico and Northern Africa (WWAP, 2006; Postel, 2000).

Another indication of excessive water use is the inability of many major rivers to reach the sea thus, are dry during most of the dry season. They include the Ganges in South Asia, the Colorado in North America and the Nile in Africa (Postel, 2000). This situation has been made worse by poor water management practices that has led to water scarcity that is being witnessed (Goonetilleke & Vithanage, 2017; Republic of Kenya, 2006).

Despite the usefulness and importance of water as presented in Section 2.2, global fresh water is scarce and very vulnerable (Loucks & Van Beek, 2005).

According to Rijsberman (2006), water scarcity is what is experienced when individuals are not accessing clean affordable water to satisfy their requirements for drinking, laundry or their livelihoods. An area becomes water scarce when many individuals in that place are water insecure for a long time.

UNDP (2006), on the other hand argues that water scarcity is not entirely about absolute shortage of physical supply but is as a result of difficulties in mobilizing available freshwater resources. The difficulties may include costs involved, challenges related with infrastructure, the number of people competing for water and inadequate knowledge and necessary expertise especially in developing countries. It is further argued that lack of political willpower as well as flawed water management policies prevents efficient mobilization and use of the available water (UNDP, 2006).

Globally, one out of six people cannot access safe drinking water which is approximately 1.1 billion people (UNICEF, 2004). About 1.7 billion people, representing a third of the developing world's population live in countries that face water stress resulting from an imbalance between water use and water resources. It is believed that if the current trends continue, this figure could rise to 5.0 billion people by 2025 (UNDP, 2003).

Currently, there are about 25 countries classified as water scarce and Kenya is one among them. They are: Pakistan, Egypt, Algeria, Kuwait, United Arab Emirates, Saudi Arabia, Libya, Singapore, Jordan, Yemen, Israel, Oman, Tunisia, Burundi, Rwanda, Burkina Faso, Morocco, Kenya, Lebanon, Somalia, Australia, Syria, Eritrea, Ethiopia and Uzbekistan. Most of these nations are in the Middle East and Northern Africa with a few found in Asia, Europe and the Caribbean (Qadir, 2007; Bremere *et al*., 2001).

According to Falkenmark *et al*. (1989) water scarcity is measured using "Falkenmark indicator" or "water stress index". The indicator proposes a threshold of 1,700m^3 of water per person in a year, based on estimates of water requirements for the numerous uses.

These are households uses, agricultural uses, industrial uses and energy sector uses and ecological requirements. Countries are said to be water stressed when water supplies are between 1700m^3 and 1000m^3. When supply is below 1,000m^3 the country is termed as water scarce and a country experiences absolute water scarcity when supplies are below 500m^3.

Countries can experience physical water scarcity referred to as real scarcity, economic water scarcity denoted as apparent scarcity or absolute water scarcity (Brown & Matlock, 2011). Physical water scarcity happens when more than three quarters of river flows are withdrawn for agricultural, industrial and domestic uses. Pointers of physical water scarcity are falling groundwater, environmental degradation and shrinking of lakes. Countries that have plenty of water that is used inefficiently and wastefully with many losses is said to be experiencing economic water scarcity (Brown & Matlock, 2011).

These countries have sufficient renewable resources and having less than 25% of their available water withdrawn for human needs, but needs to make substantial changes in available water infrastructure to make the resource available for use (Brown & Matlock, 2011). Absolute Water Scarcity on the other hand is experienced by countries that do not have sufficient annual water resources to meet equitable per capita water needs for their fast-increasing populations (World Water Assessment Programme ,2006).

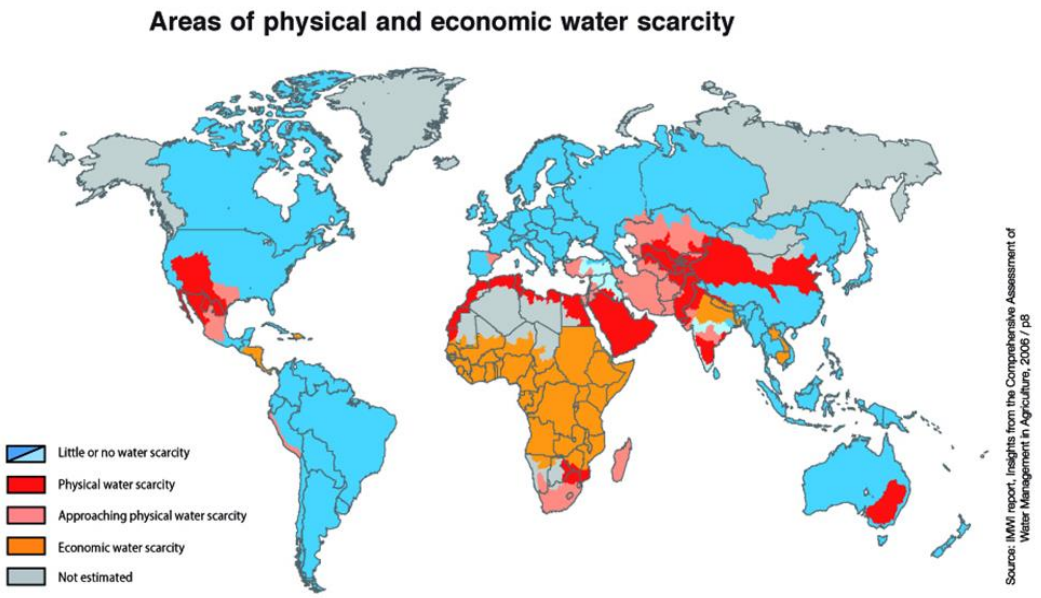

Figure 0.2: Global Map Showing Areas of Physical and Economic Water Scarcity

(Source: International Water Management Institute (IWMI) Annual Report; 2006-2007)

As illustrated in Figure 2.2, Kenya is among countries facing economic water scarcity. This means that most of its available water resources are used inefficiently and wastefully. This seems to suggest that the manner in which water in Kenya is utilized needs to be re-examined if water security is to be attained.

Figure 2.2 also shows that most countries in Africa are experiencing economic water scarcity. Those countries situated within North Africa such as Morocco, Algeria, Tunisia and Libya are facing physical water scarcity. All countries in the Middle East for instance Yemen, Bahrain, Oman and Jordan are facing physical water scarcity. A good number of countries in Asia are also facing physical water scarcity, some of the examples are: Pakistan, China, and Afghanistan. Southeastern cities of Australia such as Melbourne, Canberra and Sydney are also experiencing physical water scarcity.

A few cities in North America such as Los Angeles in California, Salt Lake City and Miami are experiencing physical water scarcity. A few countries such as Spain and Macedonia in Europe and Ecuador in Latin America are approaching physical water scarcity.

2.4 Water Situation in Kenya

Kenya as a country covers a total area of 582,646Km^2. Land surface covers 581,679Km^2 while water covers 11,230Km^2 which represents 1.9%. It is only 16% of the land surface which is suitable for arable agriculture, the remaining 83%, is the arid and semi-arid lands (ASALs) which is suitable for pastoralism, agricultural irrigation and wildlife (Shisanya *et al.*, 2011; Nyanchaga, 2011). About 40,136Km^2 (6.9%) of the land is covered by forests, against a benchmark of 10%. The forest cover has decreased from about 12% in 1960s to the current level of 6.9% (Kenya Forestry Research Institute, 2017).

Degradation of water catchment areas has reduced the amount and quality of water reaching water bodies. This is because catchment degradation causes increased runoff which reduce infiltration, soil erosion and siltation (KIPPRA, 2013). Poor farming methods, increasing population growth together with deforestation are the main causes of catchment degradation (Republic of Kenya, 2006).

The availability of water in Kenya has been decreasing over time due to persistent droughts and unsustainable land-use patterns (Republic of Kenya, 2006). Further to this, the climate situations indicate that rainfall variability and increased evaporation due to high temperatures will lead to further reductions in the available water (Urama & Ozor, 2010).

The country experiences very limited amount of fresh water resources as well as high hydrological variability both in space and time. Yearly rainfall is highly unpredictable with prevalent droughts and recurrent floods (Nyanchaga, 2011).

For instance, an assessment of the March-April-May long rainsfor 2017 showed that the rainfall performance in most parts of the country was generally poor. The long rain season was characterized by late onset as well as poor distribution temporally and spatially (KNBS, 2018).

Water resources in the country is skewed and unevenly distributed, with 86% of the total water resources found in three drainage basins namely Lake Victoria North, Tana River and Lake Victoria South (KIPPRA, 2013). Over a half of Kenya's water resources (aquifers, rivers and lakes) is shared with her immediate neighbours; Ethiopia, Somalia, Tanzania and Uganda. They include four lakes: Jipe, Chala, Turkana and Victoria; ten rivers in the following basins: River Umba and Lake Jipe and Chala adjoining Kenya and Tanzania, Mara River Basin bordering Tanzania and Kenya, Lake Turkana and River Omo Basin between Ethiopia and Kenya, Rivers Malaba, Sio and Malakisi Basin between Kenya and Uganda and the Merti and Kilimanjaro aquifers between Kenya and Somalia and between Kenya and Tanzania respectively (KIPPRA, 2013; Nyanchaga, 2011). As a result of the shared water resources, Kenya cannot fully utilize these resources.

Another challenge experienced in the water sector is the Non-Revenue Water (NRW) which is water that is lost through losses and unbilled authorized use. The loss is estimated at 60%, hence does not generate any revenue (Republic of Kenya, 2007).

Illegal water connections and other ways of obtaining water without payment or where metering devices are inaccurate also causes water losses. In addition, leaking distribution lines, as well as overflowing water at the storage facilities also add to water losses (KIPPRA, 2013).

Water coverage in rural areas is still inadequate and is estimated at 40% with majority of rural water supply sources being non-piped systems. The few piped systems face challenges of water quality, sustainability and reliability (Republic of Kenya, 2007). Many households in rural areas spend many hours in a day fetching water from unsafe sources where water quality is doubtful. Some of the domestic water sources are wells, boreholes, small-scale piped systems and traditional sources such as shallow wells, springs, streams and dams (Republic of Kenya, 2007).

Water coverage in urban areas stands at 55% with a slow growth in coverage, starting from 48% in 2010 to 55% currently. During this period, the average annual growth is about one percentage point (WASREB, 2016). In order to reach the 2030 target of universal water access, the sector must need to grow at five-fold every year (GOK, 2007). As such, with regard to access to water, there is a widening gap between rural and urban areas with urban areas scoring more access levels than rural areas (KIPPRA, 2013).

2.5 Underlying Causes of Water Scarcity

A number of factors are put forward to explain reasons behind water scarcity in the globe. These include global water distribution, demand from the growing world population and uncertain effects of climate change.

2.5.1 Global Water Distribution

One of the major factors inducing water scarcity is the manner in which water is distributed in the globe. The distribution of water on the planet's surface is exceedingly uneven. Only 2.5% of water on the planet is fresh; the remaining 97.5% exist in the ocean and is salty hence not suitable for human use (Figure 2.3).

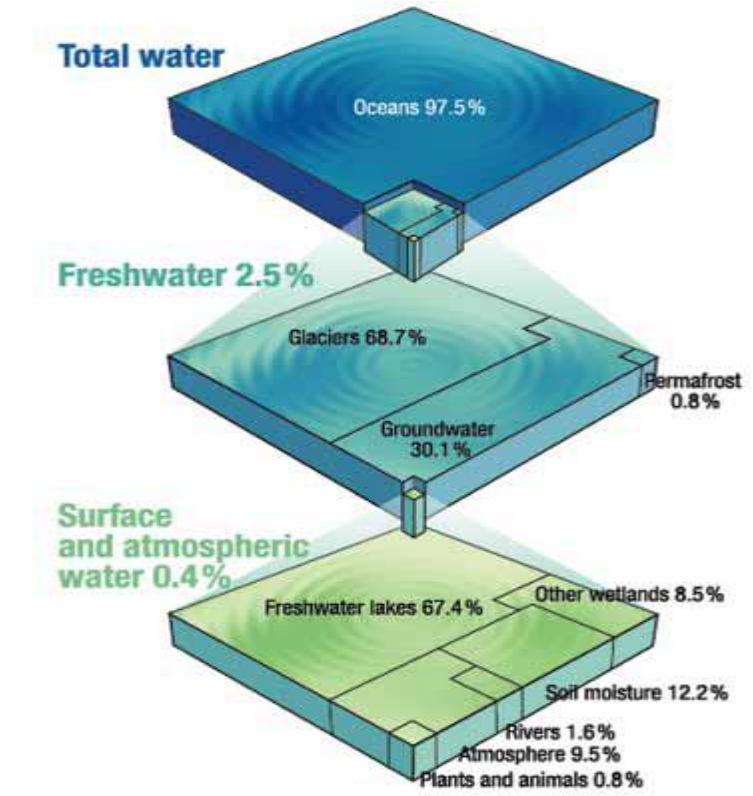

Figure 0.3: Distribution of the World's Available Water Resources

(Source: Adopted from Shiklomanov and Rodda, 2003, cited in WWAP, 2006)

Slightly over two thirds (68.7%) of the available freshwater is ice-covered in glaciers and polar ice caps, 30.1% in ground water and 0.8% in permafrost. This means that only 0.4% is available for world human use. To worsen the situation, only 1.6% of the 0.4% fresh water is what is found in springs and rivers (Sipes, 2010, Cassardo & Jones, 2011).

According to Loucks & Van Beek (2005), this water is not evenly distributed in the globe. More often there is too much water or too little, or what is present is too polluted or too expensive. Kayaga (2007) concurs by noting that the world's available water is enough to meet the demand for water globally in the next few years, but the challenge is the poor distribution of fresh water spatially and temporally.

According to Fry & Martin (2005), less than 10 countries own 60% of the earth's available fresh water stock namely: Democratic Republic of Congo, India, Columbia, China, Indonesia, Brazil, Russia, Canada and U.S. He notes that local disparities within countries are also highly evident. Figure 2.4 gives an illustration.

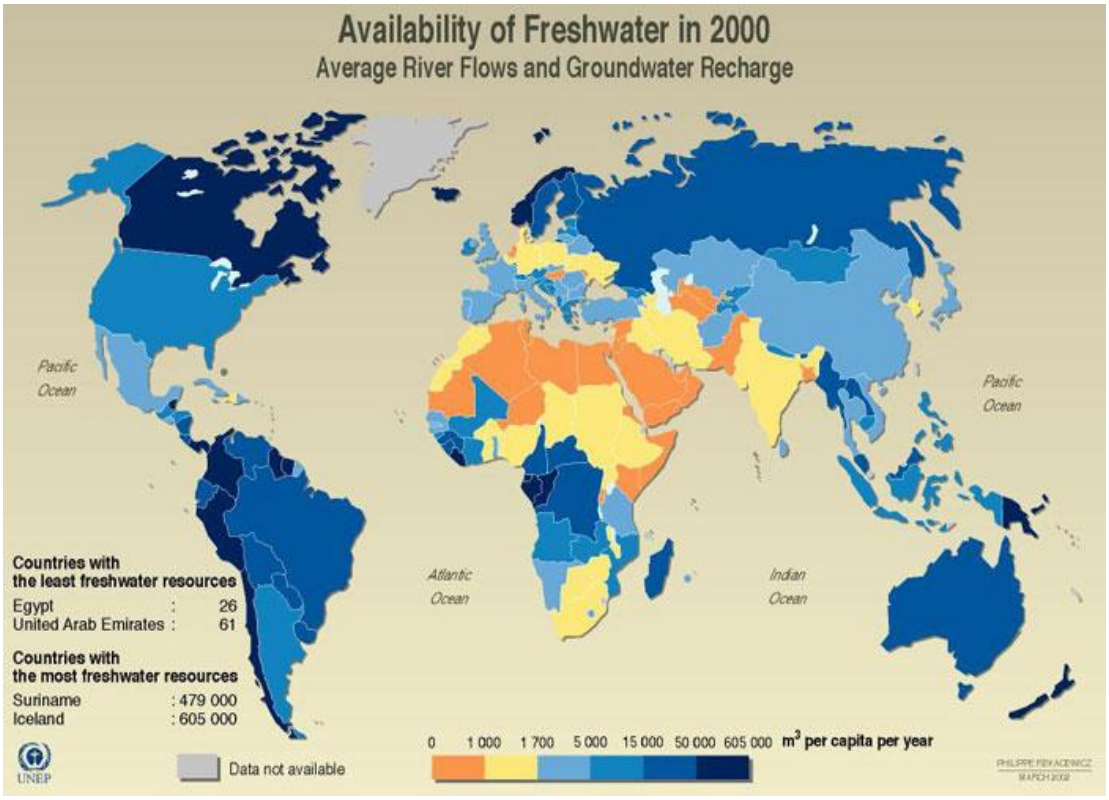

Figure 0.4: Amount of Water Available in the World

(Source: Meis *et al.*, 2005)

Despite abundant water resources found in Africa such as large rivers for instance; Nile, Zambezi and Lake Victoria which is the second largest lake on the planet, most Africans suffer from water shortages. Africa is the driest continent after Australia (WWF, 2002). Further, the Congo Basin contains 10% of the continent's population but accounts for about 30% of it's annual run-off (Urama & Ozor, 2010).

The distribution problems associated with time, space and affordability has widened the gap between demand and supply of water in many regions of the world. Further, the overall water situation is likely to deteriorate more due to global change drivers such as urbanization, population growth and rural-urban migration, all of which poses unprecedented challenges (Falkenmark, 2007; Loucks & Van Beek, 2005).

2.5.2 Population Growth

Population Action International (PAI, 2011) points out that as population grows, the need for water rises and pressure on few water resources escalates. The world water usage doubles every twenty years, which is two-fold the pace of population development. The population of the world is expanding by 80 million individuals yearly; this raises the demand for freshwater by around 64 billion cubic meters (PAI, 2011; Loucks & Van Beek, 2005).

As a result of the rapid population growth, water withdrawals have significantly increased during the last 50 years. Consequently, the worldwide accessibility of water decreased from 12,900 m^3 per an individual in a year in 1970 to 9,000 m^3 in 1990 to about 7,000 m^3 in 2000 (Population Institute, 2010). Water scarcity is made worse by rapid population growth (Okello *et al.*, 2015).

The most water scarce areas are ordinarily those with few water resources, are densely populated and have high population development rates. Population growth restrains the amount of water accessible per individual by driving individuals into fringe areas where water stress is already being experienced (PAI, 2011).

In many urban areas and especially in the more densely populated areas of Asia and Africa, water demand is rising quickly (Rogers, 2008). In concurrence, United Nations Children's Fund (2004) observes that in developing nations, water withdrawals are rising more quickly (by four to eight percent a year) on account of fast population growth and increasing demand per capita.

It is projected that the water availability will be surpassed by water demand by 56%, if the growth of population and consumption trends persists. As such, it is projected that close to 1.8 billion people will be living in regions of water scarcity by the year 2025 (Population Institute, 2010).

In Kenya, rapid population growth which was estimated to be 2.46% per annum in 2011 coupled with accelerating urbanization which was estimated at 4.2% per annum between 2010 and 2015 has fueled the challenges being experienced by the water sector (WASREB, 2012).

2.5.3 Uncertain Impacts of Climate Change

Climate has been cited by academics as one of the factors influencing water scarcity (Brown *et al*., 2007). It is thought that water utilization fluctuates depending on the amount of precipitation and temperature. These weather variables impact on the type of activities that consume water for instance taking a bath, garden irrigation and car cleaning (Romano *et al.*, 2016).

Global climate change is anticipated to fuel the present and future pressures on water resources coupled with population growth and unsustainable land uses thus increasing the incidence and severity of famines and floods (WWAP, 2012).

It is foreseen that climate change will affect the availability of water resources through changes in precipitation, soil moisture, glacier melt and river as well as groundwater flows (Fry & Martin, 2005; WWAP, 2012).

According to Ringler (2012) climate change has been impacting on the availability of water through increase in temperatures and unpredictable rainfall distribution leading to an increase in demand for irrigation water. Changes as a result of climate change are now being witnessed everywhere around the world. It is now unmistakable that the earth's climate is changing progressively. As a consequence of global warming, the polar ice caps and many of the mountain glaciers around the world are now melting. This has reduced water availability during warm and dry seasons in areas supplied by melt water (Urama & Ozor, 2010).

The most prominent glaciers affected by global warming are the Himalayan glaciers which have led to gradual drying up of river systems originating from it. As a consequence, the water supply for many people in the region is gradually diminishing (Schelwald-van der Kley & Reijerkerk, 2009).

Australia has also felt the impacts of global warming, where severe drought has been experienced in the Murray-Darling catchment area. Therefore, there is inadequate water for the farmers, for domestic use and to preserve the precious river ecosystems (Schelwald-van der Kley & Reijerkerk, 2009).

As a result of climate change, existing water-related problems in Africa are likely to worsen. Noticeable and potential impacts of climate change on water resources in Africa include: flooding, extended dry season, change in the recurrence and distribution of precipitation and reduction of size of water bodies due to increased evaporation. This will eventually reduce the quality and quantity of water (Urama & Ozor, 2010). For instance, access to water in the countries along the Nile Basin will reduce as a result of reduction in runoff from the Ethiopian highland which is its major source (Brown *et al*., 2007).

In East Africa, the level of water in Lake Victoria which is shared by the three East African states of Tanzania, Uganda and Kenya will reduce since, like any water body, it is sensitive to variations in rainfall (Brown *et al*., 2007). The lake is likewise inclined to climate change since it has an enormous surface area contrasted with its volume. The greatest depth is 84 meters and the mean depth is just 40 meters thus increasing the rate of evaporation as a result of high temperatures (Urama & Ozor, 2010).

As indicated by UNEP (2009), just 11 of the 18 ice sheets that secured Mount Kenya's summit a century ago remain. This leaves less than one third of the previous snow cover. The intense reduction in the snow and glaciers together with thinning of the ice are ascribed to global warming. It is believed that if the trend continues, the glaciers could vanish in the next 15 years.

2.5.4 Increased Rates of Urbanization

Over the years, many people have moved from an agricultural life to urban areas in search of greener pastures for economic prosperity.

They left behind their old and often sustainable existence which is in tune with nature and adjusted to city life (Schelwald-van der Kley & Reijerkerk, 2009). At present, a large portion of the total populace live in urban centres, with around a billion urban occupants inhabiting the informal settlements (WWAP, 2006). The most rapid period of urban growth will be witnessed in the next few decades, where approximately 2.6 billion additional urban dwellers are expected to live in urban communities by 2050 (UNDESA, 2012).

During this time, global water shortage because of urbanization is anticipated to increase by 55%, mainly because of growing demand from electricity generation, manufacturing and residential use, all of which is as a result of growing urbanization particularly in developing nations (WWAP, 2015). This implies that more than 1 billion individuals will live in urban areas without adequate water inside their homes (McDonald *et al*., 2011). As urban communities grow, urban water administrators are being faced with increasingly unpredictable and multi-faceted difficulties as societal needs develop and natural resources which includes water, reach the limits of sustainable use (Brown *et al*., 2009).

Urbanization has lead to increased pressure on limited supplies of water as people become more concentrated in one territory (McDonald *et al*., 2014). This makes it hard to meet the goals for the provision of a safe and reasonably priced water supply (Fischlin *et al.*, 2007). This happens due to the costs associated with the connection of water supply facilities as well as the limited capacity of governments to manage them,hence cannot keep up with the rapid urbanization pace (Schelwald-van der Kley & Reijerkerk, 2009).

2.6 Urban Water Scarcity

Fresh water plays a significant part in the advancement and prosperity of urban areas. As urban communities keep on advancing, dealing with the freshwater demands of urban residents is becoming progressively complex (Brandes & Maas, 2004). Freshwater provision to urban inhabitants has three parts: water availability which whether or not enough water is available, water quality which identifies how much treatment is required before it is clean and safe to use and delivery systems put in place to carry water to consumers (McDonald *et al*., 2011).

With regard to availability of water, many urban areas in the world continue to have problems with regard to providing sustainable water to its inhabitants (Olmstead & Stavins, 2009). The rising demand stems from the growing population and economic advancement (Patterson & Kayaga, 2015; Olmstead & Stavins, 2009). Amidst this predicament, available water quantities keep on decreasing because of excessive use, water contamination and by the significant effects of climate change. The issue of water shortage is more pronounced in urban areas of developing nations as 66% of the world's urban inhabitants live in these areas (Patterson & Kayaga, 2015). This is even worse in sub-Saharan Africa because urbanization is occurring more quickly. In these areas the number of individuals with piped water in their premises dropped from 42% to 34% between 1990 and 2012 (WHO/UNICEF, 2014).

In respect to water quality, interrupted service in various urban areas whereby water is given to the residents for a limited number of hours in a day or rationing of water because of shortage encourages stagnancy of water and development of micro-organisms in the distribution system.

Further, according to Lee & Schwab (2005), normal ageing and wearing of infrastructure encourages the growth of bacteria. They further argued that these weaknesses in the distribution system often work together hence compromising water quality and quantity reaching the user.

There is a growing challenge in delivering water to households and other users especially in developing countries. This is because many existing water delivery systems are operating erratically and below their capacity (Lee & Schwab, 2005). Further, they argue that there are many more problems with distribution systems such as aging infrastructure, broken and faulty ones taking long to be repaired or replaced and damages also occur more frequently.

Access to improved water supply in urban areas in Kenya has dropped over the years against a backdrop of rapid growth of urban areas (Salami *et al*., 2014). Compounding the problem of urbanization is the uneven distribution of water resources in the country (KIPPRA, 2013). The normal yearly precipitation in Kenya is 630 millimeters with Northern Kenya receiving less than 200 mm while the slopes of Mt. Kenya receives more than 1,800 mm. There is also a high level of aridity in the country with 80 percent of the land area being arid and semi-arid (Marshall, 2011). In this manner, the problem of water accessibility is probably going to continue. Figure 2.5: shows number of urban centers in Kenya with piped water

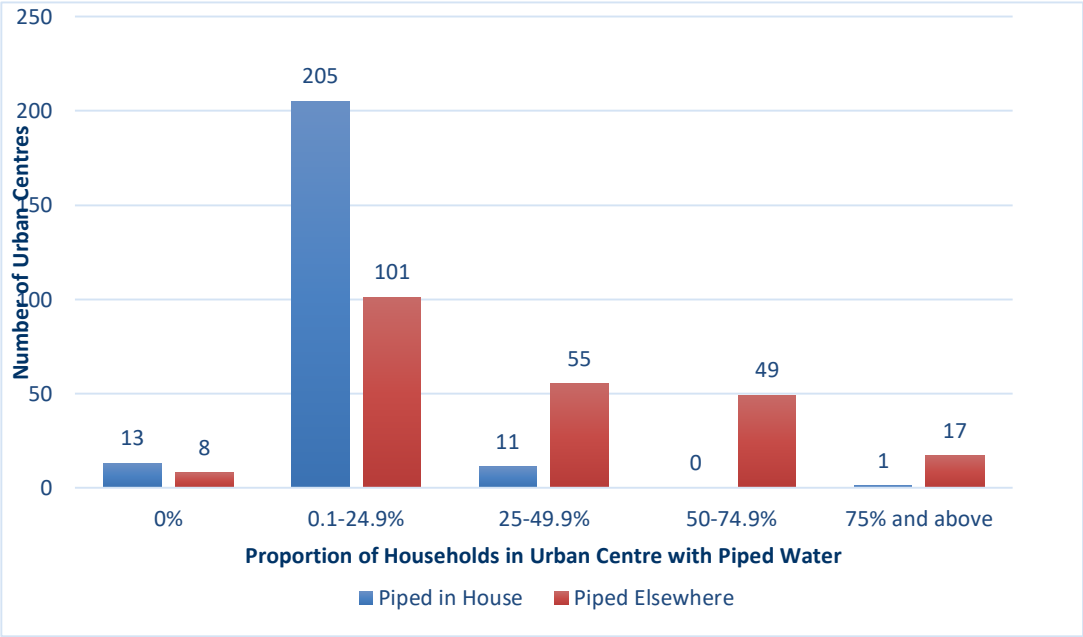

Figure 0.5: Proportion of Urban Dwellers in Kenya with Piped Water

(Source: Adopted from Owuor, 2012 Conference Report)

According to Owuor (2012), the number of gazetted urban centres in Kenya in 2009 was 230 and it is certainly now more since the advent of devolution in 2013. In these towns, a small percentage of between 0.1-24.9 percent of households had piped water connections. Further, 75% of households had piped water connections but in a few urban centres.

2.7 Drivers of Urban Water Scarcity

Water demand in many urban areas globally has been rising over the years and projections of continuing growth over the coming years is inevitable (Butler & Memon, 2006).

A combination of factors affects the sustainability of urban water structures such as increasing levels of water use by different users, failing infrastructure and the associated costs, urbanization and economic growth (Brandes & Maas, 2004).

Ecological pressures which are aggravated by climate change affect the quality and quantity of water. Social issues emerging from changes in population as well as user's preferences and expectations are also affecting water demand and water consumption patterns (Howe *et al.*, 2006).

2.7.1 Increasing Water Demand

When water is abundant, there is relatively little attention paid to water uses and users. But with increasing scarcity and competition for this vital resource in many places especially in urban areas, there has been growing attention to it (Meinzen-Deck & Bakker, 2001). Mitchell (2006) concurs that an important component of any town area is provision of water supply, among other services, to its inhabitants. The article further explains that population increases due to urban growth has outstripped advances in water use efficiency, thus creating a need for additional water supply.

The complexity of water users and uses makes it hard to manage water resources in a sustainable way. This is as aresult of manifold users such as municipal water users, industrial users, local small-scale farmers and water forleisure. This is compounded by the complexity caused by different uses of water, including domestic use, small scale farmers, industrial production and recreation (Berger *et al.*, 2007).Small scale farmers include those who have home gardens and keep livestock while domestic uses include; drinking, cooking, bathing, washing and even recreation (Meinzen-Deck & Bakker, 2001).

To satisfy increasing demand for urban water, sources from outside an urban area may be used, although it is faced by increasing environmental constraints due to the terrain and the distance involved (Mitchell, 2006).

2.7.2 Failing Water Infrastructure

Current trends in the world indicate that urban water demand is possibly likely to place increasing pressure on available water supplies in the coming days (Fitzhugh & Richter, 2004). As urban areas develop without sufficient supply framework, they may face frequent water deficiencies, consequently curtailing further development. As a result of the water shortages, cities may also be compelled to rely on unsustainable extraction of groundwater. As such, many people living in urban areas exert more pressure on water resources resulting in more fluctuations in the water table, hence greater vulnerability (Srinivasan *et al*., 2012).

Problems with water supply in the distribution network are specifically serious in developing nations where there are inadequate resources to maintain the water distribution infrastructure (Moe & Rheingans, 2006).

Mitchel (2006) agrees that budgetary limitations in the development of infrastructure as well as high financial expense of rehabilitation and replacement of aging water infrastructure influence availability of sufficient water in urban areas.

Richer urban areas with more resources can develop more strong urban water infrastructure, enabling it to escape water shortage since it does not require frequent repairs and replacements (McDonald *et al*., 2014).

On the other hand, in majority of the developing nation's towns, urban water infrastructure experiences challenges in meeting the test of an expanding population (Lundin & Morrison, 2002). This is because water infrastructure in certain towns of less developed nations is underdeveloped and resources are few. This compels families to rely on local resource base for example utilization of wells and boreholes (Srinivasan *et al*., 2012).

2.7.3 Economic Growth

Water demand rises with growth in population as well as rise in income levels which is associated with growth in the economy: richer people spend more water, particularly in urban zones (Rogers, 2008). Bigger landscaped private plots that require more water are frequently associated with well-to-do families. Also, higher salary family units might be less sensitive to the cost of water, as it represents a smaller part of their family income (Ringler, 2012).

Growth in income as well as rising living standard of a growing middle class have prompted sharp increments in water use which in the long run is unsustainable. This is progressively pronounced where supplies are limited and where its utilization, distribution, price, use and management are inadequately managed (WWAP, 2015).

In addition, consumer lifestyle changes for example increase in meat consumption, building bigger homes and more use of motor vehicles leads to a rise in water consumption (WWAP, 2015).

2.7.4 Consumer Awareness

It has been shown that households with more positive behaviour towards water conservation use less water than those without (Fielding *et al*., 2012).

Willis *et al*. (2011) points out that households who are environmentally anxious and who are aware of water conservation practices use considerably lesser amount of water as compared to those who were not aware and are less concerned. Gilg & Barr (2006) further states that commitment to conservationism influences water conservation activities and the more dedicated the conservationist, the more they are willing to take part in water conservation. Clearly, user's behaviour and knowledge has a positive influence on overall water use (Kortenkamp & Moore, 2006).

2.8 Determinants of Household Water Demand

A critical look at the supply side water management measures presents solutions that do not offer lasting solutions to water shortages; the main practicable approach therefore is to understand the drivers of household water demand in order to reduce demand. Household water demand is influenced by various factors such as: household size, age of household members, education level, water sources, property types (own, rented), presence of water storage facilities, presence of gardens, household income and conservation strategies adopted in the household (Waskom *et al*., 2011; Arbués *et al*., 2000; Corbella & Pujol, 2009).

2.8.1 Household Size

Households with many residents use more water compared with those with few members (Jeffrey & Gearey, 2006). According to Corbella & Pujol (2009), the higher the number of persons living in a household, the larger the cumulative demand for water. However, according to Stratzu & Strazzera (2009) due to economies of scale realized in some uses of water for instance cooking, cleaning the house, washing clothes and dishes leads to an increase less than proportionate to the increase in the number of individuals in a household.

Arbués *et al*. (2000) concurs that economies of scale with regard to the optimization of water use cannot be achieved in small households. This therefore means that optimal use of water can be best achieved in large families.

2.8.2 Age of Household Members

Older household members consume less water than young members (Arbués *et al*., 2003). This could be as a result of reduction in water use activities in older people which is thought to induce a reduction in water consumption (Stratzu & Strazzera, 2009). Outdoor use of water by teenagers and more so children is thought to be higher, this is because young people are known to use water less carefully, do laundry more frequently and also have more showers in a day (Arbués *et al*., 2003).

2.8.3 Education Level

Education is related to environmental mindfulness and awareness (Syme *et al*.,2000). Educated household members purchase water conserving appliances and also choose drought-tolerant plant species for their gardens (Corbella & Pujol, 2009). On the contrary however, Gregory & Di Leo, (2003) argues that households with lower education engage in more water conservation behaviours and use less water as compared with households with higher education.

2.8.4 Property Types (own, rented)

Homeowners are more probable to adopt water saving behavior compared to households that rent. Owners have a tendency to conserve water and install water-saving devices more willingly than those who rent since they anticipate reaping the long term returns of the investment. Again, owners generally pay their water bills as opposed to renters whose rent payment at times is inclusive of water bills (Millock & Nauges, 2010).

2.8.5 Household Income

Domestic water use is positively related with income (Arbués *et al*., 2003). Family units with higher incomes utilize more water than those with lower pay (Jeffrey & Gearey, 2006). Corbella & Pujol (2009), states that higher income levels may result in an increase in living standards, which in turn enables households to purchase more water-consuming appliances. This will consequently lead to more water consumption.

2.8.6 Presence of Gardens

Gardens are known to help in stress management, recreation and personal identity (Domene & Sauri, 2006). They are aesthetically pleasing, a source of food, a source of regeneration and a safe place for children to be raised and experience contact with the environment (Randolph & Troy, 2008). However, vegetable and lawn gardens are high-water demanding outdoor uses that contribute to increased levels of water usage in households (Corbella & Pujol 2009).

2.9 Strategies for Managing Urban Household Stresses

Solving water scarcity problems calls for innovative approaches. These approaches include adaptation of traditional ways to solve the present-day difficulties, the adaptation of the externally existing technologies to the prevailing social and physical conditions, and the adoption of new innovations (Pereira *et al*., 2002). These approaches are classified into supply side and demand side water management measures.

2.9.1 Supply-side Water Management Measures

By tradition, the reactions to shortage of water were resolved by expanding supply including establishment of new sources and increasing withdrawals from the present ones (WWAP, 2006).

Supply-side measures include a wide scope of water supply sources, for example, construction of dams, transfer of distant surface water, groundwater abstraction, rain water harvesting as well as conventional storage, treatment and transfer options (Kayaga, 2011).

To understand supply side water management measures, dam construction, rain water harvesting and water storage measure will be briefly stated.

Dam Construction

Water control structures for example dams, weirs and reservoirs are important to the environment. They influence not just the personal satisfaction in human communities, but also the wellbeing of the environment. They are important to individuals' everyday lives: they give drinking water, generate electricity which is used in homes and industrial facilities, fishing and provide opportunities for sailing and swimming. They also irrigate farms and control floods (Sharma, 2015; Lehner *et al*., 2011).

However, dams cause environmental damages that overshadow their current benefits to society. Examples of environmental consequences associated with dams are: alteration of water balance due to increased evaporation losses which is bound to diminish river discharge downstream and ecological problems. By construction of dams, vast areas are altered. Consequently, stream, wetland and floodplain ecosystems are irreversibly lost (Kiplagat, 2016).

As such, a good number of them have been removed in the United States for example Edwards Dam and the Elwha and Glines Canyon dams in Washington State (Postel, 2000).

Rainwater Harvesting

Rainwater denotes downpour that is gathered or collected from surfaces for example, rooftop or ground catchment and put away in a holder, tank or containers until when it is utilized (WHO & UNICEF, 2006). Rainwater harvesting is currently viewed as a method for increasing supply. Capturing and gathering water where it falls is an activity that was practiced in the ancient world (Pereira *et al*., 2002). It was utilized over 4,000 years ago in Greece as well as Palestine (WWAP, 2006).

A notable example of successful rain water harvesting was undertaken in India, where it has been applied to recharge groundwater at proportions that exceeded natural recharge condition (UNESCO, 2000). Rainwater harvesting can assist in addressing water shortage at the family level and it is simple and financially feasible to actualize. However, many buildings especially in urban areas were built without putting roof-water harvesting into considerations hence most of the rain water is wasted.

Water Storage

Many households especially in urban areas store water in order to cope with the intermittent water supply. The stored water is used in times of water shortages and the storage containers refilled during the resumption of water supply (Gulyani *et al*., 2005). The presence of water storage materials make water to be readily available in the household hence increasing the total amount of water used in that household (Corbella & Pujol 2009).

Storage capacity and investment varies by level of household earnings and type of storage method, with the poor relying on portable cheap and low volume storage options such as jerricans, while the well to do use expensive options such as overhead tanks (Gulyani *et al*., 2005).

Supply-side management therefore, takes fresh water as an essentially limitless resource resulting in a wasteful scenario. The supply-side measure hardly considers full account of environmental or financial effects of municipal water services (Brandes & Maas, 2004). The continued uses of traditional water management concepts in present-day times will not deliver the essential results because such strategies are not efficient and cost-effective (Patterson & Kayaga, 2015). (Kayaga & Smout, 2011) concurs that over-dependence on the development of new water sources to react to expanding demand causes environmental degradation. As such, a general change in perspective to water demand ought to be considered as well.

The only feasible way to manage the ever-increasing water demand therefore, is possibly to reduce demand since supply cannot be expanded as quickly as the rate of demand increase (Butler & Memon, 2006). Brandes & Maas (2004) agrees that continued development of new infrastructure and construction of a new water sources is more expensive and eventually will be unsustainable economically and ecologically.

2.9.2 Demand-Side Water Management Measures

Unlike the conventional supply-side water management measures which intends to increase capacity of water available to consumers (Brandes & Maas, 2004), water demand management utilize different strategies to conserve water and improve the efficient utilization of water by consumers (Marandu *et al.*, 2010).

Promoting behavior changes in consumers is also an essential component in water conservation measures. Proponents of water demand management argue that such a strategy would have substantial monetary, environmental and social benefits (Marandu *et al*., 2010).

The said interventions include population control, maintenance of water supply infrastructure, reduction of losses in the system as well as leakage detection and repair, programs designed to facilitate treatment and reuse of wastewater by customers. Use of sanitary facilities that conserve water and household water demand behaviour changes are also some of the measures (Smith *et al*, 2010; Stuart, 2001). These water demand management measures are worth examining.

Population Control

Preventing births could increase per capita Gross National Product (GNP) by redirecting money spent on social amenities such as health, education and water to more productive investments, while at the same time reducing the number who would share in the proceeds (Connelly, 2006). Supporting this argument are Rosenzweig & Zhang (2009) argue that reducing family size will free up resources for investments in human development. The other advantages for limiting population growth include economic development, geopolitics and conservation of natural resource including water (Connelly, 2006).

If population growth could be controlled, water demand could be managed by the available water supply, but it is evident that controlling population and to an extent, urbanization is almost impossible (PAI, 2011).

Growth in population is not easy to curtail and does not slow down on its own. As such, there should be sound policies including measures such as improving access to family planning that will promote the move to a stable population size (PAI, 2011). However, such measures take a long period of time to achieve the desired results hence the most workable way to address water scarcity is to reduce water demand.

Maintenance of Water Supply Infrastructure

Water consumption and demand has been increasing for various uses such as for domestic and other urban uses, for agriculture, for industrial use and energy generation and for recreation and leisure activities (Statzu & Strazzera, 2009). However, these increases cannot match with the existing water supply. UN-HABITAT (2006) concurs by noting that efficiency in the system and delivery of water service are affected by poorly maintained infrastructure that has outlived its usefulness, as reflected by the leaky and non-functional infrastructure.

In order to attain water conservation, repairing of leaking water distribution systems is a major area that needs to be implemented (Moe & Rheingans, 2006). This refers to the identification and repair of leaks in the water supply system that are visible and those that are underground and reducing water losses to an acceptable level. To achieve this, leakage management should be done continuously (UN-HABITAT, 2006). Water service providers can also reduce water loses by introducing efficient plumbing facilities. This will reduce to a large extend the amount of water lost during storage and distribution (Moe & Rheingans, 2006).

Choice of Sanitary Facilities

Several studies have shown health benefits of accessing adequate sanitation facilities and shielding drinking water from contamination (Ordinioha & Owhondah, 2008; Gleick, 2003; Narain, 2002). They contend that there is an immediate connection between provision of clean water, sufficient sanitation and improved wellbeing. This implies effective disposal of human waste controls the spread of infective agents and interferes the transmission of water-related illnesses.

The most common way of human waste disposal in urban areas is the use of flush toilets. Flushing of toilets consumes large amounts of water in a normal urban family unit. Enormous measure of clean water is utilized to transport even small amount of human excreta (Narain, 2002). In numerous nations, flushes are made to be water-inefficient, to such an extent that with each flush, more than 12 liters of clean water is wasted (Millock & Nauges, 2010; Narain, 2002).

Narain (2002) laments that huge dams which are constructed to bring water to urban areas are capital intensive. He notes that significant amount of the water is flushed down the toilet which goes into similarly expensive sewage system. Flushed water may also find its way into septic tanks. Septic tanks are excreta collection devices which consist of a water-tight settling container situated underground and away from the house or toilet (WHO & UNICEF, 2006).

The flushed water from toilets end up polluting more water when raw sewage is drained into water bodies. According to Gleick (2003), waste disposal does not require any water, although he acknowledges that using little water for this reason might be culturally desired for instance reasonable amounts for hygiene and washing.

Gleick (2003), points out that substantial improvement in technology has led to a 75% reduction in water utilized by toilets in North America and even further reduction in amount of water used in toilets in western countries. According to him, these toilets are dual flush and uses between three and six litres for every flush.

To conserve water that is used to flush the toilet, there is need for change in the way human waste is disposed. As such, there is need to look for a less expensive and non-sewerage model of human waste disposal. For instance, a simple pit latrine which is one of the most basic forms of domestic sanitation offers a low-cost option to costly and environmentally intensive sewage systems (Montgomery & Elimelech, 2007). WHO & UNICEF (2006) identifies the following types of pit latrines that can be used to dispose human waste without the use of water:

i. A pit latrine without slap utilizes a hole in the ground which is used for excreta collection and does not have a crouching seat. It is a simple opening in the ground where excreta is collected.
ii. A pit latrine with a slab uses a hole in the ground to gather the excreta and has a squatting slab. It is easy to clean and it is raised above the ground to avoid water from entering the pit.
iii. A composting toilet is a dry toilet that utilizes no water and depend on a blend of human waste and other compostable organic matter, for example, vegetable wastes, grass or saw dust.
iv. A ventilated improved pit toilet (VIP) is a dry pit restroom which is ventilated by a pipe that reaches out over the lavatory rooftop. A gauze mesh is used to secure the open end of the vent pipe.

Practicing the "7 R's" lifestyle

This is the mechanism for achieving resource optimization and waste prevention through the main environmental strategies (the "R's"): Reuse, Reduce, Recycle, Repair, Re-think, Refuse and Respect (Kalmykova *et al.*, 2017; Kahrİman-Öztürk, *et al.*, 2012). The "R' s" are words that start with letter 'r" that guides people to reduce the utilization of natural resources including water (El-Halwagi *et al.*, 2003).

The "R's" were originally identified by the Brundtland Commission in Our Common Future (1987), and have now been supported by many authors advocating for sustainable use of resources (Kahrİman-Öztürk, *et al.*, 2012; Engdahl & Rabušicová, 2011; Ceclan *et al.*, 2011).

Resource optimization can be done through the extension of its use-life. Broadening item life improves the total lifespan of products and minimizes depletion of natural resources among them water. This thus leads towards a manageable society in which development is made consistent with the world's limited resources (Stahel, 2013).

The "7 R's" are viewed from various dimensions;

i. **Reduce**

   Reduce means using less so we have less to throw away. By reducing household water use, there is substantial reductions in production of waste water, which would in turn cause minimum pollution of water resources.

ii. **Reuse**

   Reuse refers to using water again before throwing them away, e.g., Water used to wash clothes can be reused to clean the house.

In many large urban centres especially in developed world where there are inadequate or less freely available freshwater supplies, wastewater has been used in riverbeds or filtration ponds to artificially recharge groundwater aquifers.

iii. Recycle

To recycle is to re-use the item and create something else with, for example water that could have been used to grow trees, is saved by recycling paper.

Recycling is one way of making the world a better place by reducing waste. For instance, by recycling 1 tonne of paper we save 17 trees and an equivalent of 7,000 gallons of water.

iv. Repair

To repair products encourages fixing things instead of discarding them and buying new ones for replacement. Repairing of water supply infrastructure will save on money that could have been used to buy new ones. The money saved can be used to extend water coverage.

v. Re-think

It involves re-designing our way of living by asking ourselves what we can do to lessen the amount of waste we produce including waste water.

vi. Refuse

Water is a finite natural resource hence, refusing to waste it through indiscriminate use will help in conserving this precious natural resource. Since water price is the main instrument to manage water demand, it can be used to deter households from indiscriminate use of water. This is so because higher water prices lead to lower consumption.

vii. Respect

This means respecting nature and its competences, as such water should be treated with consideration as it is finite and man cannot do without it (Swafford, 2015; Abella, 2013; WWAP, 2006; Arbués *et al*., 2003).

The 7R's measures such as water reuse and recycling can greatly add to the benefits gained from limited supplies of freshwater (Anderson, 2003). The 7R's presented in Figure 2.6

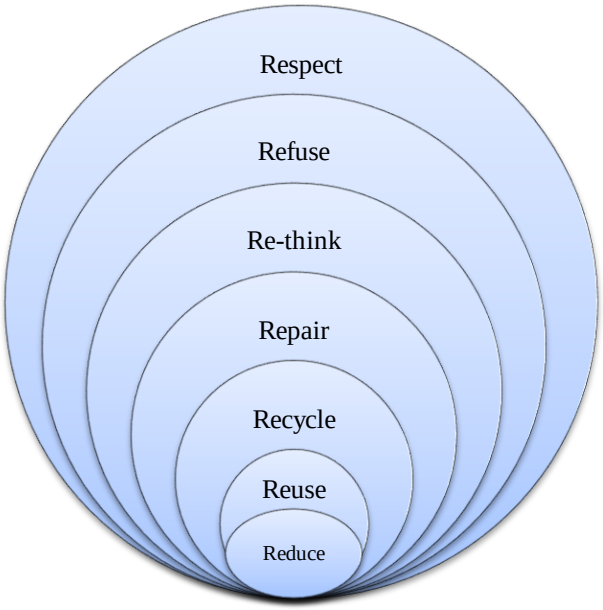

Figure 0.6: 7R's Water Management Measures

(Source: Author, 2017: Concept adopted from sustainable waste management hierarchy for zero pollution Ceclan *et al*., 2011).

2.9.3 Positive Household Water Use Behaviour

Many water using practices are activities that are performed regularly and along these lines may end up becoming habitual, for example, individuals can nurture helpful water use behaviours for instance turning off taps while brushing teeth. On the other hand, they may be inclined to undesirable behaviours, for example, taking longer showers, which when continued with time, has an effect on the overall water utilized in the family unit. In that capacity, families which practices water conservation use less water in the long run as opposed to those without water conservation identity customs (Fielding *et al*., 2012).

Water conservation is progressively plausible when people accept that water is rare and when they see that other consumers are similarly conserving water. Individuals are also ready to save water when they believe that water authorities and governments are additionally doing their part to guarantee improved supplies (Jorgensen *et al*., 2009). Though it seems impossible to envision that one individual can contribute in conserving water supplies on the planet, every individual can truly help. The following practices can help conserve water:

i. Turning off taps while brushing teeth saves approximately 25 gallons per month,
ii. Turning off the tap when shaving saves up to 300 gallons per month,
iii. Installing low-flow regulators on all household taps. The regulators can restrict flow to less than 1.0 gallons in a month,
iv. Checking and repairing leaks in the house aid in saving up to 140 gallons of water each week,
v. Keeping showers brief by making it lasts for five minutes saves a significant amount of water,
vi. Turning off the water tap while lathering up with soap and shampoo,
vii. Turning off the water tap when washing vegetables, fruits and utensils,
viii. Checking and repairing leaks from all shower, tub and kitchen valves,
ix. Using waterless toilets where permissible,
x. Irrigating in the evenings and early mornings,
xi. Only doing full loads of washing.

(Source: Fielding *et al*., 2012; Waskom *et al.*, 2011; Marandu *et al.*, 2010).

Water demand management measures may help to ease water shortages thereby reducing the rising pressure on the environment. Therefore, the requirement to develop costly infrastructure might not be necessary after all hence, reducing the need for new investments and reducing expenditures.

2.10 Water Related Policies in Kenya

The following policies govern water resources in Kenya:

Sessional Paper No. 1 of 1999

The Sessional Paper No. 1 of 1999 was the first water policy in Kenya (Huggins, 2002). The main aim was "to ensure availability of portable water at reasonable distances to all households by the year 2000" (Republic of Kenya, 1999). To achieve this objective, the plan was to develop water supply systems by directly providing water services to consumers.

The policy gave directions on how to address water challenges. The directions were; to preserve, conserve and protect available water resources, to ensure water supplied for the various needs should meet acceptable standards and should been adequate and ensuring that allocation of water should be economical, rational and sustainable (Republic of Kenya, 2006)

The National Water Resources Services Strategy (NWSS)

The National Water Services Strategy (NWSS) was derived from the water sector policy contained in Sessional Paper No. 1 of 1999. The NWSS defines strategic goals and actions designed to deliver efficient and more effective answers to water challenges.

One of the goals is “to reach at least 50% of the underserved urban population with safe and affordable water by 2015 (MDG) and thereafter, move to access to all by 2030”.

National Water Master Plan (NWMP) 2030

The NWMP is the country’s blue print on development and management of water resources. It provides estimates of the water resources in the country as well as making a plan for the period 2010-2030. The water demand for the year 2010 were estimated and projections for the years 2030 and 2050 made. The targets of the NWMP 2030 among others are “to ensure water and sanitation are available and accessible to all by 2030 and allocation of water for the reserve, international obligations and inter-basin water transfer is kept to meet basic water needs and to protect the water environment” (Kibiiy, 2018).

Water Act of 2016

The Water Act, 2016 is mainly concerned with decentralization of water services. It provides for the separation of the management of water resources from the provision of water services, the separation of policy making from day to day administration and regulation. In addition, the Policy “defined the government's role as regulatory and delegated water service provision to the private sector, municipalities and communities”.

2.11 Theoretical Framework

The study adopted three mutually reinforcing theories namely: Malthusian Theory of Population, Boserupian Population Theory and Sustainable Development Theory.

2.11.1 Malthusian Theory of Population

In Essay on “the Principle of Population”, Malthus notes that human population grows exponentially (i.e., multiplying with each cycle1, 2, 4, 8 …) while food (or rather resources) grow arithimetically, i.e., by the repeated adding of a uniform number 1, 2, 3 (Urdal, 2005; Demont *et al*., 2007)) .

In ecological terms, Malthus was arguing that human population and economic development was in danger of exceeding the world's carrying capacity. He argues that population grows at a rate that available resources cannot support the resulting population (Ashraf & Galor, 2011). This implies that due to the natural difference between the rate of increase of population and that of the earthly resources such as water, it is expected that a section or entire population must experience scarcity at some point. As such, as population grows, resources such as supply of clean water will not be able to support the increasing number of people. The theory helps in understanding how unchecked population growth rate may cause communities to experience water scarcity.

With regard to water, this theory seem to suggest that as population continues to grow, degradation and water shortages is inevitable (Urdal, 2005). As such, the current water scarcity is a manifestation of the inability of the earth to match the rate of human population growth.

2.11.2 Boserupian Population Theory

Ester Boserup questioned Malthus' decision that the size of the human population is restricted by the amount of food it can produce. She proposed that food production can increase to match the requirements of the populace.

Boserup reasoned that the risk of hunger and the difficult of providing for more mouths inspire individuals to improve their cultivation techniques and design new advancement in technology so as to deliver more food.

According to Boserup, food production does not dictate how much population can grow; instead, population growth determines food production. It can therefore be argued that natural resources do not determine the extent of population growth but population growth determines how resources are exploited.

The same concept can be applied to address challenges of water shortages experienced in urban areas through advancement in technology. For instance, wastewater from households can be purified and be reused for other domestic uses or for irrigation. It may also mean humans changing their water consumption behaviours in response to scarcity.

2.11.3 Sustainable Development Theory

Sustainable development is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987).

This concept relates to the water resource challenges. The water scarcity being experienced in the globe denotes unsustainable development as the resource has been overexploted thereby denying the present and the future generations access to water. Consequently, there is need to re-examine present water use patterns with the aim of making them sustainable. It is no wonder therefore that Sustainable Development Goal Number 6 aims at ensuring water and sanitation is efficiently managed.

The SDG No. 6 focuses on increasing water use efficiency through all sectors in order to achieve sustainable exploitation ansd use of water thereby meeting the needs of present and future generations.

2.11.4 Conceptual Framework

The conceptual framework developed for this study is guided by the three theories discussed in Section 2.11. The framework brings in the relationship between the key variables and concepts in the study. It shows the relationship between the dependent variables, independent variables and intervening variables of the study. In this study, the independent variables include, among others, household size, income levels, occupation, age of household members and presence of gardens.

Dependent variable is house hold water use patterns while the intervening variables include; supply side water management measures, demand side management measures and household water consumption behaviour.

To curb water scarcity, intervening variables intervene between dependent variables and independent variables in order to reduce water demand and eventually water use. The relationship between the three types of variables therefore leads to sustainable management of water. This relationship is represented in Figure 2.7

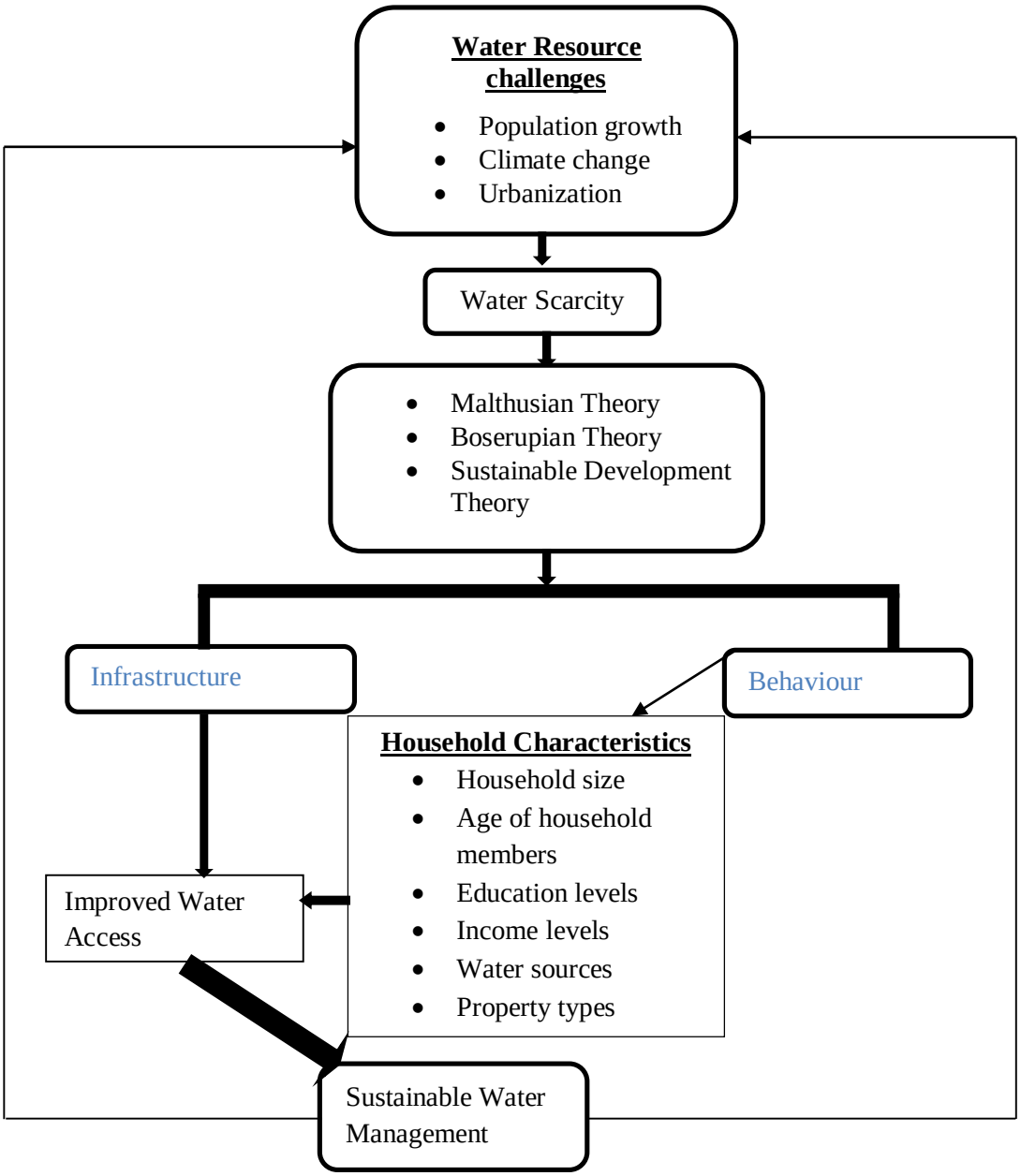

Figure 0.7: Conceptual Framework on Water Consumption Patterns

(Source: Author, 2017)

CHAPTER THREE

METHODOLOGY

3.1 Overview

This chapter discusses the procedures followed in pursuing the realization of the objectives of this research study. It presents the research design, sample and sampling techniques and methodology used to collect and analyze data.

3.2 Study Area

The study area is Iten Town which is located in Elgeyo Marakwet County, Kenya within coordinates 00°40’23’’N and 35°30’30’’E and at an elevation of 2,400m above sea level. It is located approximately 32 km North East of Eldoret Town. It is one of the largest towns in Elgeyo Marakwet County and doubles up as its headquarters. Iten Town is situated along Kabarnet-Eldoret Highway. The town is strategically located and proximate to key towns in neighbouring counties such as Eldoret to the West, Kitale to the North-West, Kapenguria to the North; and Kabarnet to the East. Figure 3.1 is a map showing Iten Town.

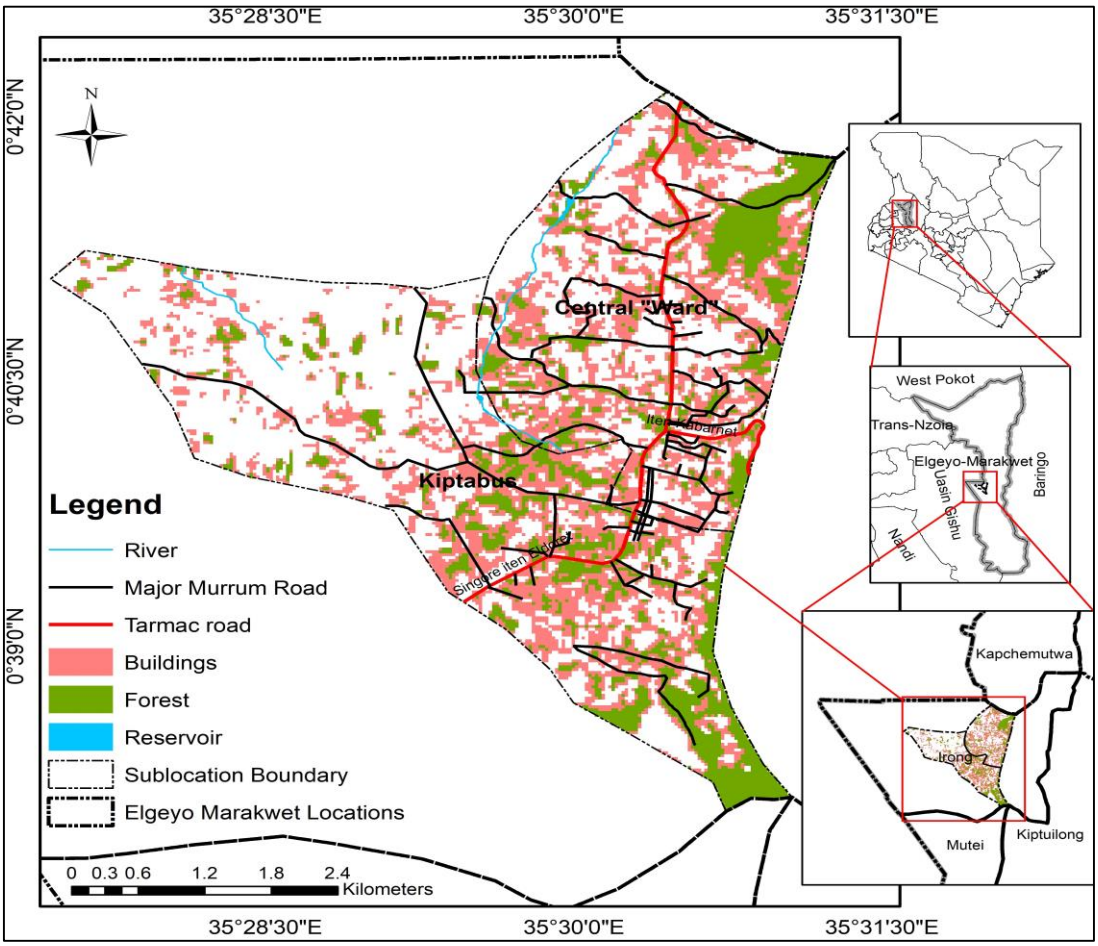

Figure 0.1: A Map Showing Iten Town

(Source: Author, 2018)

3.2.1 Population Size

Iten Town is one of the fast-growing towns in Kenya. The population of the town was 8655 people in 2017 and is projected to reach 13611 by 2035 (CGEM, 2013). The major drivers of population growth in the town are largely natural growth and immigration especially by government employees, tourists and athletes (CGEM, 2016). Majority of the population living within the town are of the Kalenjin ethnic community accounting for 92.6% of the total population, with a small percentage of the population consisting of individuals from other ethnic communities and a few foreigners (CGEM, 2016).

3.2.2 Climate

Iten town experiences two rainy periods in a year. The long rainy season is between the months of March and July, whereas the second season is between August and November (CGEM, 2013). Temperatures range between 15° C during rainy season and 23° C during the dry season. Iten is normally very cold during the rainy season. The town receives between 1200mm and 1500mm of rainfall per annum (CGEM, 2016).

3.2.3 Topography and Drainage

The geographical position of Iten town is such that due to its elevation (2,400 meters above sea level) it is one of the highest points in the region. Consequently, most rivers neighbouring the town flows away from it with no major river flowing towards it (Ngetich *et al.*, 2018).

3.2.4 Water Infrastructure and Facilities

The water supply in the town is under the management of Iten-Tambach Water and Sewerage Company (ITWASCO). It is operating as an agent of the Rift Valley Water Services Board through Service Provision Agreement (SPA) entered between the Company and the Board. This arrangement is provided for by the Water Act (2016) pointing out that Water Service Providers will deliver services as agents of the Board.

The total population served by the Company is 74,000 comprising of downstream zones including Kapkoi, Tembelio, Kapteren, Kipsoen, Kamariny, Katalel, Iten Town, Sing'ore, Bugar, Kessup and Tambach. Presently, the company supplies the recommended water per capita, albeit inconsistently. This is due to erratic river flows in the main rivers (R. Sabor) that feeds into the Company reservoir.

3.3 Research Design

A research design is a strategy and structure of enquiry that guides the research process with the aim of obtaining answers to research question or problems. It shows the logical arrangements by integrating the different parts of the study for instance empirical data collection, study's initial questions and ultimately lead to its conclusions (Yin, 2009; Kothari, 2004; Mugenda & Mugenda, 2003). It is also methods or set of methods applied in doing research, including the materials used (Munyao, 2016).

This study adopted mixed method research design as it allows the use of both quantitative and qualitative techniques of inquiry (Fraenkel *et al*., 2012; Kothari, 2004). Descriptive survey was thought suitable since the study was concerned with describing conditions around which households in Iten consume fresh water accessible to them while at the same time using statistical techniques to test the relationship between household characteristics and water use.

3.4 Nature and Types of Data

The main types of data sought by this study included: household characteristics such as household size, education levels, household water sources, property types whether home owner or rented, water storage, presence of gardens, household income, quantities of water consumed by households, the average amount of water consumed by households and conservation strategies adopted in the town.

3.5 Sources of Data

The study made use of both primary and secondary sources of data;

3.5.1 Primary Data Sources

Primary data are raw data collected for the first time by the researcher (Hox & Boeije, 2005).

The primary data collected include; household size, education levels, property types, presence of water storage, presence of gardens, household income, the average amount of water consumed by households and conservation strategies adopted in the town. Primary data was collected through observation checklists, interviews schedules and questionnaires.

3.5.2 Secondary Sources of Data

Secondary data provide background information which is used as a platform for research. It can also provide specific details in order to corroborate and augment information from primary data sources (Yin, 2009). Literature on the subject of water was reviewed. Secondary data was obtained through review of published information. These included books, journals, National and County government documents, research reports, development plans, published and unpublished research papers, reports, academic theses, conference literature and internet sources.

In addition, data on water sources and progress in water provision were obtained from documented information of ITWASCO.

3.6 Target Population and the Sampling Procedure

The target population for this study was households living in Iten Town that numbered 1996 (KNBS, 2010). The sample was drawn from this population using the formula advanced by Mugenda & Mugenda (2003).

According to the authors, a sample size of 10% of the researcher's population size is adequate if the target population is less than 10,000. Therefore 10% of the researcher's population size is 200 households, i.e., 10% *1996= 199.6 where it was rounded up to the next whole number, that is 200.

Given that the household was spread in distinct settlements locally known as "estates", stratified simple random sampling technique was employed where population was classified into nine strata comprising of the town's estates. Since population data according to neighbourhoods could not be obtained, the total sample was distributed proportionately across all the estates as shown in Table 3.1.

Table 0.1: Sampled Households in Iten Town

Estate	Sample Size (n) Number	Percentage (%)
Lilies	23	11.5
Kariobangi	23	11.5
Milimani	22	11
Koisungur	22	11
Kapsio	22	11
Kamariny	22	11
Chebokokwa	22	11
Kapchepkoima	22	11
Mindililwo	22	11
Total	200	100

To select the respondent for interview, two transects in each estate (strata) were identified (access roads in the estates). The sampling involved picking the first household randomly at the entrance of the estate and thereafter picking the 10^{th} household along the transect until the allocated sample was reached.

On the other hand, the key informant who is the manager of ITWASCO was selected purposively because of his experience and knowledge on issues of water demand and supply in the town since ITWASCO is the sole water service provider in Iten Town.

3.7 Data Collection Techniques and Tools

The main techniques employed for data collection by this study was household survey, key informant interviews and direct observation. Consequently, questionnaires, interview schedules and observation checklists were used as the main instruments for data collection.

3.7.1 Questionnaires

Questionnaires are research tools used by researchers to ask individuals to give answers to a set of questions which are in a certain order. Questionnaires allow the researcher to have direct contact with respondents (Creswell, 2003). A total of 200 questionnaires were administered by the researcher and a research assistant using the face to face interview method. Face-to-face method enabled the researcher to provide clarification of the questions and thus led to a high response rate.

The contents of the questionnaire included respondents' personal information such as sex, education level and occupation and their effects on water consumption; migration trends of the respondent for instance place of birth of the respondent and how respondent's access water they use in their homes for example their source of water and how they conserve it. A sample of the questionnaire is given in Appendix I.

3.7.2 Key Informant Interviews

Interview of key informant, the technical manager of ITWASCO, was conducted with the help of an interview schedule.

Interviews are rich and provide clarity on the material it unearths. Well conducted interviews help in bringing out information on people's attitudes and their views (Gray, 2004). The information unearthed by the interview schedule included the coverage of water supply network in Iten Town and water sources for the company as shown in Appendix II. The use of interview was chosen since it provides insightful information on water supply and use in the study area.

3.7.3 Direct Field Observation

Observations involve collection of formal and informal activities. Observation of key issues such as water sources, evidence of water conservation strategies and water supply infrastructure were guided by a checklist.

Evidence of observation provide supplementary information and aid in gaining rich understanding of the topic being studied. Photography was used to record observed information to provide a broad impression of issues concerning challenges faced by residents in accessing water. Observation schedule used is as shown in Appendix III.

3.8 Data Analysis and Presentation

Data analysis in research involves the drawing of inferences from raw data (Wahyuni, 2012). Questionnaires were used to generate quantitative data. The univariate analyses were carried out on the collected data. It provided descriptive statistics such as mean and averages for the various data items. Bivariate analysis, on the other hand was used to examine relationships between pairs of data items (Al-Maskati, 2011). Statistical analyses were done with the help of IBM Statistical Package for Social Sciences (SPSS) software (Version 21) and Microsoft Office Excel 2013.

Correlational analysis was carried out in this study to explain relationships between variables. According to Frankel *et al*. (2012) correlation analysis is carried out to explain important human behaviours and relationships.

Karl Pearson's coefficient of correlation was used to determine relationships between variables. The value of '*r*' lies between ± 1. Positive values of *r* indicate positive correlation between two variables i.e., high scores on one variable tend to be associated with high scores on the other variable.

Negative values of '*r*' indicate negative correlation (changes in the two variables taking place in the opposite directions) meaning high scores on one variable are associated with low scores on the other variable, and low scores on one are associated with high scores on the other (Frankel *et al*., 2012; Kothari, 2004).

The qualitative data on the other hand was analyzed in three main phases. The qualitative data analyzed were data gathered through observation and semi-structured interview with key informant. The first stage is the description phase which relied on matters of significant importance that were observed and respondent's exact quotes, then the analysis phase where relationship's important factors were identified. Finally, the interpretation phase which entailed interpretation of the analyzed data (Wahyuni, 2012; Al-Maskati, 2011). The analyzed data were then presented by use of frequency tables, graphs, histograms and pie charts.

3.9 Validity and Reliability of Instruments

Validity is the accuracy and truthfulness of scientific findings; it is the extent to which a study gives answers that reflects reality.

Reliability on the other hand relates to the consistency of a measure. It is the extent to which a research instrument consistently gives the same results over repeated testing periods (Heale & Twycross, 2015). Validity and reliability are key aspects of all research and attention to the two ensures credible and trustworthy results by minimizing the errors and bias in the research (Al-Maskati, 2011).

To test reliability of instruments, researchers conduct between 15 and 25 interviews to detect any problems that can be encountered in the course of the research by identifying questions that require further explanation and wording that respondents seemed to find confusing (Visser *et al*., 2000, chap. 16).

In this study, questionnaires were subjected to a rigorous scrutiny after which piloting was conducted prior to the main study. The researcher together with research assistant administered 20 questionnaires.

3.10 Pretesting of Instruments

Reliability of a research instrument was accomplished by doing a pilot test. In this case twenty respondents were selected randomly. They were given semi structured questionnaires with the aim of determining whether the questionnaires had the ability to provide desired results.

On the basis of the responses by the respondents, the researcher made modifications to the questionnaire to make them clearer to respondents and to make the administration of questionnaires to proceed smoothly. For instance, one of the questions had the word ‘ethnicity ‘which was omitted from respondent’s personal information in the questionnaire after the researcher found out that most of the respondents were hesitant in disclosing their ethnicity.

CHAPTER FOUR

RESULTS

4.1 Introduction

This chapter presents the results of the study as obtained from the field. The findings are presented systematically in the order of the study objectives namely: to determine household water use patterns, to establish the relationship between household socio-economic characteristics and water use and to establish household water conservation strategies practiced in Iten Town. The section begins with a brief account of the socio-economic characteristics of the respondents.

4.2 Household Socio-economic Characteristics

An accurate understanding of household characteristics is important as it has an influence on water consumption. The household characteristics examined include household size, education level and occupation of respondents, income levels and presence of gardens among others.

Findings revealed that many households (46.3%) have between one and three family members. Majority of the respondents have secondary education (36.8%) while a small percentage has primary level education (19.4%) with only 2.1% having no schooling as can be seen in Table 4.1.

Table 0.1: Summary of Household Characteristics

Household Characteristics		Frequency (f)	Percentage (%)
Household Size	1-3	76	46.3
	4-6	68	41.5
	7-8	20	12.2
Education Level	None	3	2.1
	Primary	28	19.4
	Secondary	53	36.8
	College	36	25
	University	24	16.7
Occupation	Housewife	23	14.6
	Private Business	46	29.1
	Private Sector Employee	23	9.5
	Government Employee	53	1.9
	Farmer	3	33.5
	Casual Labourer	18	11.4
Household Income	0-10,000KSH	25	29.4
	10,001-30,000 KSH	38	44.7
	30,001-50,000 KSH	14	16.5
	50,001-100,000 KSH	6	7.0
	Over 100,000 KSH	2	2.4
Presence of a garden	With Gardens	42	35
	Without Gardens	78	65

It can be further seen from Table 4.1 that most of the respondents are business people (46%) and government employees (53%).Majority of the respondents who are business people earn between ten thousand and thirty thousand shillings (KSH 10, 000-30, 000) with only a small percentage earning more than a hundred thousand shillings per month (KSH 100,000). Most of the respondents in the town do not have gardens (65%).

4.3 Household Water Use Patterns

The first objective of this study sought to determine household water consumption patterns in the study area. To understand water use patterns, this study sought data on sources of water, household water allocation to different uses and average quantities of water consumed per household per day.

4.3.1 Main Sources of Water

This study sought to determine the main sources of water in the study area. Respondents indicated that they draw water for domestic use from a number of sources including piped water (51.3%), combination of piped water and well (24.1%). Respondents who reported using only water from the well were 10.6%, those who use piped water as well as buying from water vendors were 4.5% and 5% of the respondents reported using water from communal water kiosk (5%). A very small number of respondents (1%) reported using spring water, roof catchment and combination of both piped water and roof catchment. In this case, respondents reported using piped water for uses that require portable water for instance water for drinking and use well water for washing clothes.

The various water sources used by residents of Iten are as presented in Figure 4.1.

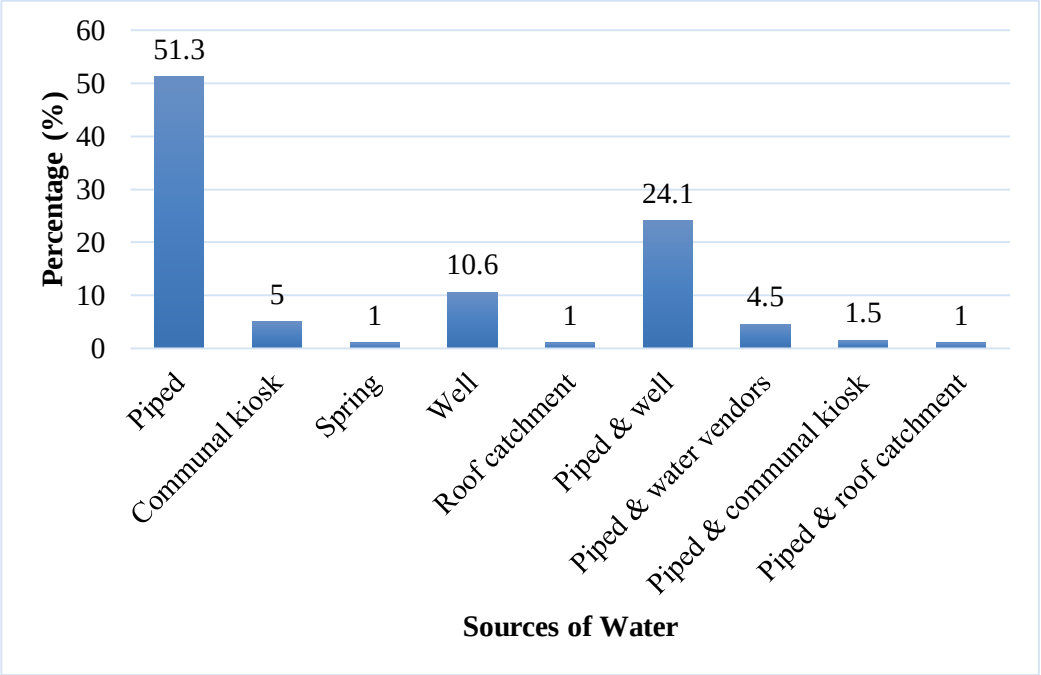

Figure 4. 1: Main Water Sources in Iten Town

Plates 4.1 and Plate 4.2 illustrates some sources of water for the residents of Iten town.

Plate 4.1 shows an overhead tank used to collect rain water in Mindililwo Estate.

Plate 4. 1: Roof Catchment in Mindililwo Estate

(Source: Author, 2017)

Plate 4. 2: Community Water Kiosk at Kariobangi Estate

(Source: Author, 2017)

It was established that municipal water network was fairly distributed. As can be seen in Figure 4.2, the blue dots represent water sources; a borehole, a dam and water kiosks. There is one dam, one bore hole and five water kiosks in the study area. The yellow dotted lines indicate the existing water distribution network. The pink triangles represent the town's estates.

Figure 4.2 shows the distribution of main water sources in the study area.

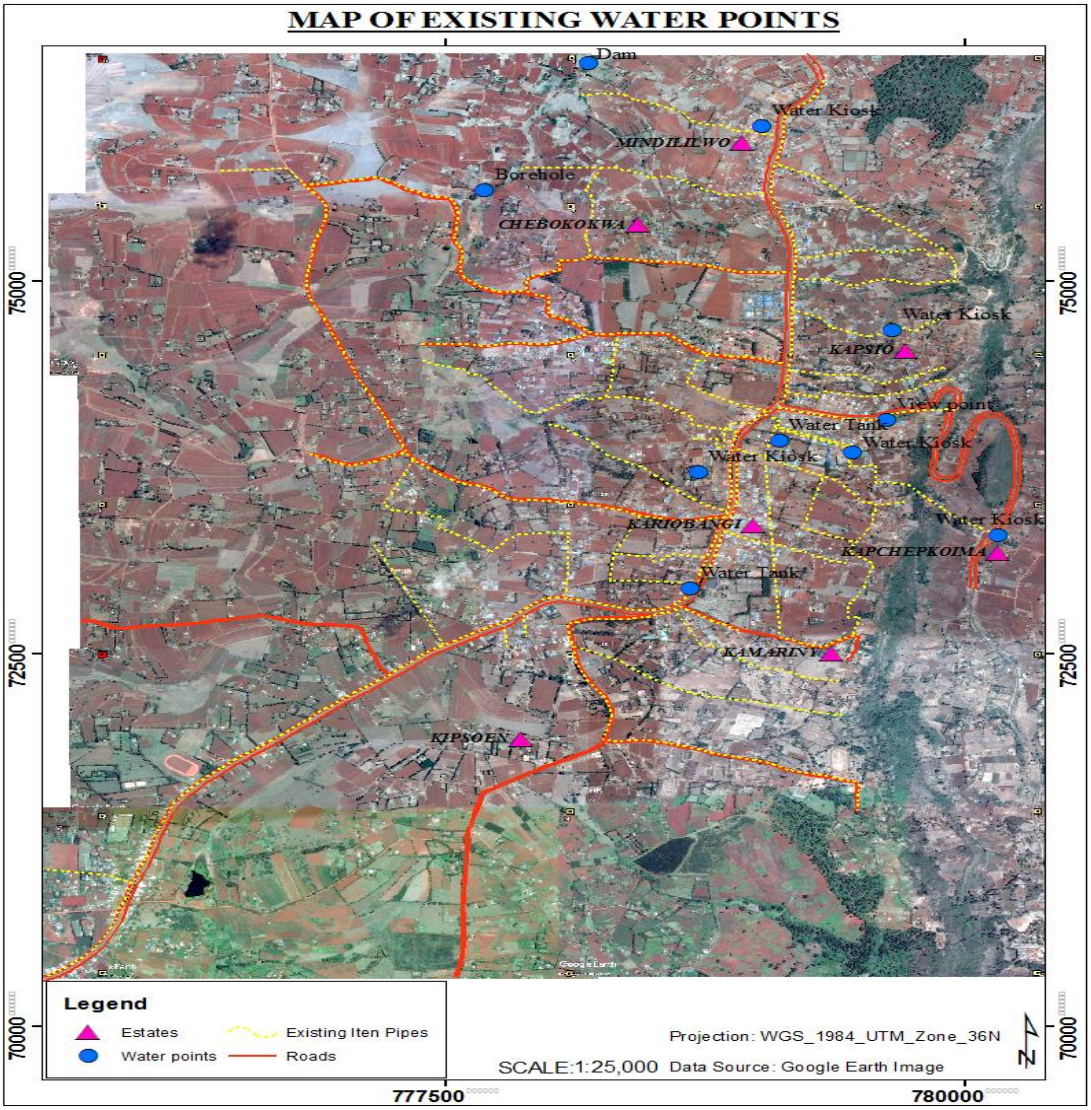

Figure 4. 2: A Map Showing Distribution of Water Sources in Iten Town

(Source: ITWASCO, 2017)

4.3.2 Water Use Patterns by Households

It was established that water in Iten is mainly used for drinking, cooking, washing utensils, showering/bathing, cleaning the house, laundry, watering animals and gardening.

The proportion for the various purposes was obtained by expressing the frequency for each water use as a fraction of the total number of the sampled households and multiplying the result by 100%. This is presented in Table 4.2

Table 0.2 Household Water Uses

Uses of water	Frequency (f)	Percentage (%)	Average amount per use Per day (Litres)
Drinking	192	96	1.5
Cooking	164	82	7.5
Washing utensils	164	82	12.5
Showering/bathing	190	95	30.5
Cleaning house	186	93	15.5
Washing clothes	153	77	30.5
Watering animals	27	14	50.5
Gardening	42	21	70.5

As can be seen from Table 4.2, 96%, 95% and 93% of the respondents in the study area use water for drinking, showering or bathing and cleaning the house respectively. A greater percentage use water to cook and clean utensils (82%). A good number of the respondents also use water for laundry (77%). A small percentage of the respondents use water for gardening (21%) and for watering their animals (14%).

4.3.3 Average water quantities used by households

Average quantities of water utilized by households per day was determined by estimating total volumes of water actually used daily by each household. This involved identification of the unit of drawing water and it was established that majority of respondents collected water using jerricans with the capacity of 20 litres. Consequently, the number of jerricans used in the family each day was counted to enable establishment of the total volume of water used in the household. The total amount consumed in the household was then divided with the number of occupants in the household in order to arrive at the per capita water consumption. Table 4.3 presents the results.

Table 0.3: Daily Household Water Use

No. of household members	Percentage (%)	Total water (in Litres) consumed per day/Household	Per capita water consumption (In Litres)
1	8.5	64	64
2	22	122	61
3	15.9	144	48
4	18.3	172	43
5	12.2	185	37
6	10.8	216	36
7	4.3	224	32
8	7.9	216	27

In Table 4.3, the total amount of water consumed in a household with a single occupant is 64 litres per day. In a three-member household the total amount increases to 144 litres. In a six-member household the total amount of water consumed in the household also increases to 216 litres.

On the other hand, the per capita consumption of water in a single member household is 64 litres, while in a three-member household is 48 litres. In a six-member household the per capita consumption in a day reduces to 36 litres.

4.4 Effects of Household Socio-economic Characteristics on Water Use

The second objective sought to establish the relationship between household socio-economic characteristics and water consumption in Iten Town. Table 4.4 gives a summary of the relationship between respondent's household socio-economic characteristics and water use.

Table 0.4: Summary of Respondent's Socio-Economic Characteristics and Corresponding Water Use

Household Characteristics		Frequency (f)	Total water consumption (Litres)	Average water consumption (Litres)
Household Size	1-3	76	4385	57.7
	4-6	68	2632	38.7
	7-8	20	590	29.5
Education Level	None	3	108	36
	Primary	28	1120	40
	Secondary	53	2544	48
	College	36	1944	54
	University	24	1248	52
Occupation	Housewife	23	1334	58
	Private Business	46	2254	49
	Private Sector Employee	23	1495	65
	Government Employee	53	3339	63
	Farmer	3	900	300
	Casual Labourer	18	756	42
Household Income	0-10,000 KSH	25	1125	45
	10,001-30,000 KSH	38	2280	60
	30,001-50,000 KSH	14	924	66
	50,001-100,000 KSH	6	492	82
	Over 100,000 KSH	2	304	152
Presence of a garden	With Gardens	42	3780	90
	Without Gardens	78	3276	42
Household head	Male	108	4968	46
	Female	25	1325	53
	Grand Parent	1	44	44
	Eldest child	6	378	63
	Others	12	720	60
Home ownership	Home owner	34	1734	51
	Renters	116	5568	48
	Relative's House	2	68	34

4.4.1 Qualitative Analysis of the Relationship Between Household Characteristics and Water Use

This involved the analysis of the relationship between occupation and Water Use, gardens and water use, household heads and water use and home ownership and water use.

Effect of Occupation on Water Use

Government employees formed majority of the respondents numbering 53, followed by those owning private businesses (46 people). The number of employees working in the private sector was 23, housewives were also found to be 23. The least reported occupations are casual labourers and farmers who were found to be 18 and 3 respectively. Findings revealed that farmers consumed the highest amount of water (300 litres) followed by private sector employees who consumed 65 litres, government employees used (63 litres), housewives (58 litres), business people (49 litres) and finally the least consumers were the casual labourers (42 litres). Figure 4.3 puts this into perspective.

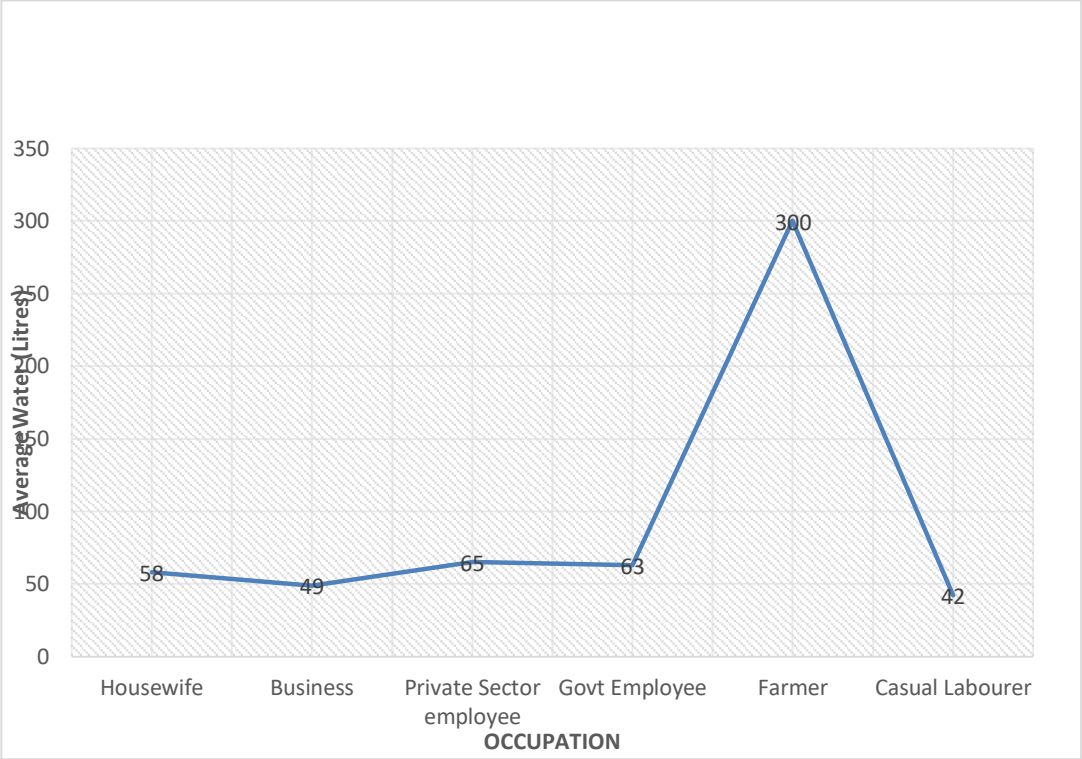

Figure 4. 3: Occupation and Water Use

Relationship Between Gardens and Water Use

The study found out that 65% of the households had no gardens while 35% had gardens within their plots. It was further established that, households with gardens consume more water (90 litres) than those who do not have who were found to consume an average of 42 liters per person per day. Table 4.5 puts this into perspective.

Table 0.5: Effect of Gardens on Water Use

Plot Type	Average water (Litres)	Frequency	Percentage (%)
With gardens	90	42	35
Without gardens	42	78	65

Plate 4.3 shows a garden in Kapsio Estate in Iten Town. In the garden there are flowers, maize, beans and traditional vegetables black night shade *(solanum nigrum*). There are also straw berry plants in the middle of the garden. These plants need watering during dry seasons.

Plate 4. 3: A Garden of Flowers and Vegetables in Kapsio Estate

(Source: Author, 2017)

Plate 4.4 shows a garden in Lilies Estate. At the middle of the Photograph is a drum which is used to store water for watering the vegetables dry during the dry season.

Plate 4. 4: A Garden of Vegetables in Lilies Estate

(Source: Author, 2017)

Relationship Between Household Heads and Water Use

From Table 4.4, it is evident that majority of the households are headed by males (70.8%) who consumed 46 litres of water per person in a day. Those headed by females (16.4%) consumed 53 litres of water per an individual per day, those headed by others representing a group of students and athletes living together (8.3%) consumed 60 litres of water per person per day.

Finally, households headed by eldest children (4.1%) consumed the highest amount of water (63 litres) per person per day and grandparents representing 0.5% consumed the least amount of water (44 litres per person per day). Figure 4.4 shows the relationship between household heads and per capita water used in the household.

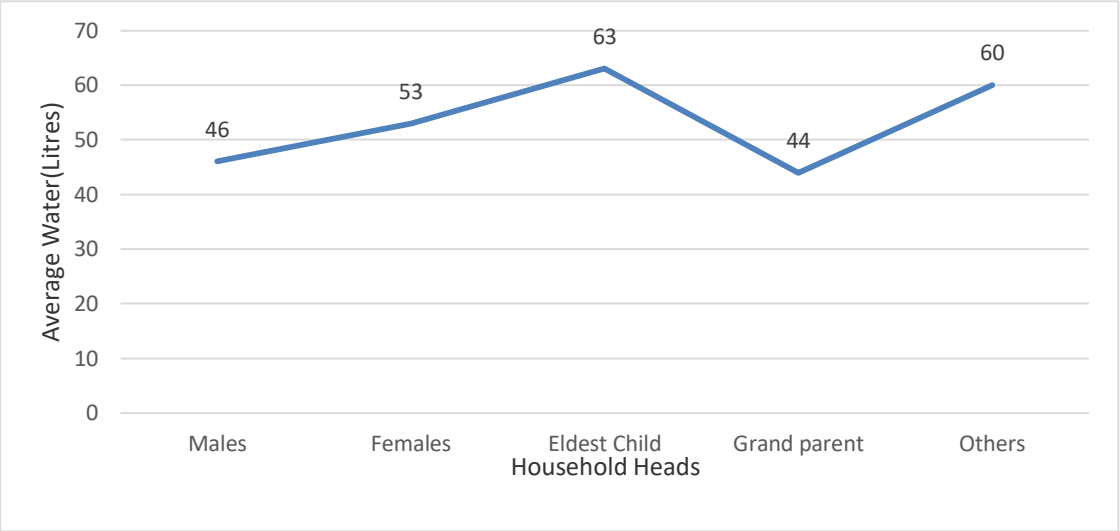

Figure 4. 4: Household Heads and Water Use

Home Ownership and Water Use

With regard to home ownership, it was found out that most people rent their dwelling units (76.9%) followed by homeowners at 22.1% and those who live in their relative's house represent 1%. Residents who live in their own houses were found to consume more water (51 litres) than those who live in rented homes (48 litres). Those who live in relative's houses were found to consume the least amount of water (34 litres). The results are presented in Figure 4.5.

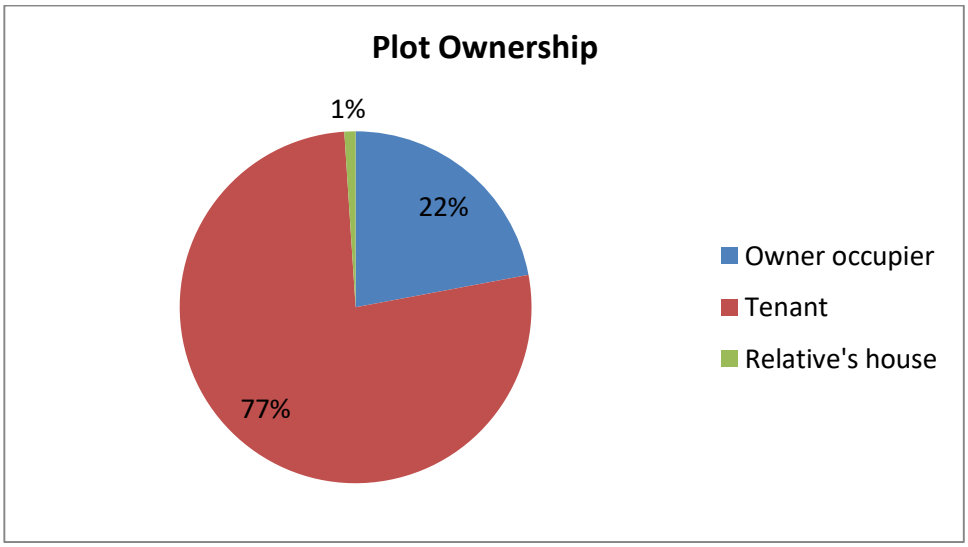

Figure 4. 5: Home Ownership and Water Use

4.4.2 Statistical analysis of the relationship between household characteristics and water use

Table 4.6 shows the relationships between level of education, household income and household size and their association with water use.

Table 0.6: Table of Correlations

Correlations	Pearson Correlation (r)	Significance (2 tailed)
Level of Education and Water Use	-0.018	0.811
Household Income and Water Use	0.015	0.851
Household Size and Water Use	-0.024	0.749

Level of Education and Water Use

Table 4.6 depicts a significant negative correlation between level of education and the amount of water used in the household (r=-0.018; sig. 0.811) at 0.05 level, meaning that as the level of education increases there is a significant decrease in the amount of water used and vice versa.

Level of Household Income and Water Use

It was also found out that there is a significant correlation between monthly household income and the amount of water used in the household per day (r=0.015; sig. 0.851) at 0.05 level. As the monthly household income increases, there is also a significant increase in the amount of water used.

Level of Household Size and Water Use

Finally, there is a negative association (r= -0.024; sig. 0.749) between household size and water use. The relationship suggests that as the number of household members increase, the average amount of water used in the household decreases.

4.5 Household Water Stress Management Strategies in Iten Town

The third objective of this study was to establish household water stress management strategies practiced in Iten Town. The findings revealed that households manage water stress by reusing water, using latrines instead of flush toilets, turning off taps while brushing teeth and practicing positive household water behaviours, Table 4.7 gives the summary of the findings.

Table 0.7: Water Stress Management Strategies

Water Coping Strategies	Activity	Frequency	Percentage (%)
Reuse of wastewater	From washing clothes	84	56.1
	From cleaning utensils	29	19.1
	From cleaning the house	14	9.5
Use of latrines	During water shortage	67	60
	Presence of many visitors	19	17.1
	Latrine use during the day	16	13.9
	Latrine use for long calls	10	9
Turning off taps	Brushing teeth	36	30
	Washing fruits/vegetables	34	28
Household water saving behaviours	Reuse	49	35.1
	Using minimal water	23	16.4
	Water storage	32	23.1
	None	36	25.4

4.5.1 Main Uses of Wastewater

The study sought to find out uses of wastewater generated in the home. It was established that Iten residents reused wastewater from washing clothes, utensils and cleaning the house.

Uses of Wastewater from Clothes Washing

The responses given for using wastewater from washing clothes as presented in Figure 4.6 shows that they use waste water to clean the house (30.6%) and 16.7% used to clean the toilet or latrine. A few residents (7.8%) used it to water grass or flowers and small percentage (1%) used it for other purposes such as cleaning shoes.

Figure 4.6 various uses of wastewater arising from washing clothes

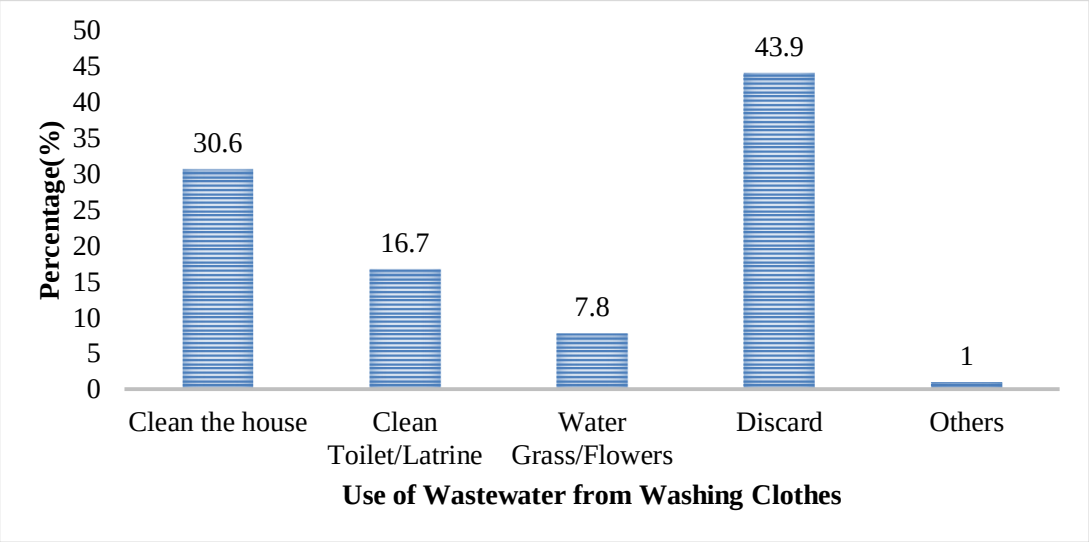

Figure 4. 6: Use of Wastewater from Washing Clothes

Uses of Wastewater from Cleaning Utensils

The study revealed that a small percentage of respondents (16.2%) used water arising from cleaning utensils to water grass and flowers, 1.7% used it to clean the house and 1.2% cleaned the toilet or latrine with it. Figure 4.7 on use of wastewater from cleaning utensils puts this into perspective.

Uses of wastewater arising from cleaning utensils are explained in Figure 4.7

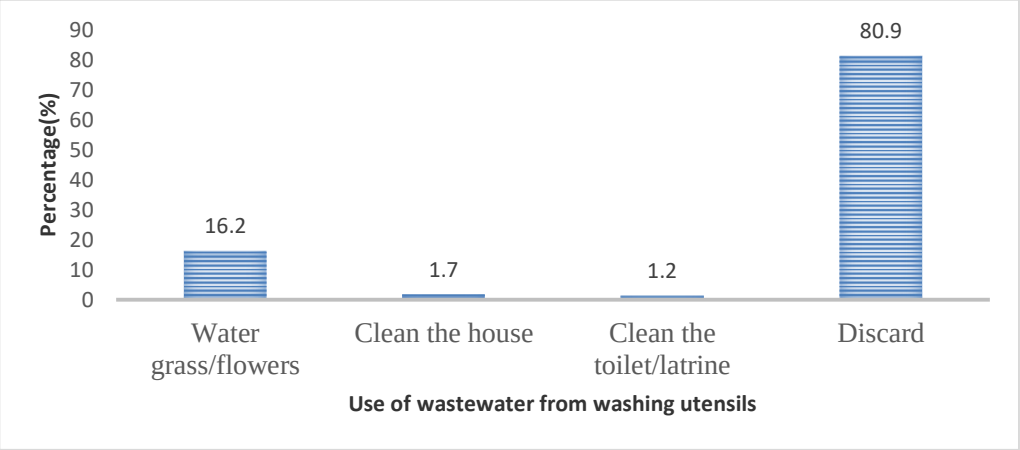

Figure 4. 7: Use of Wastewater from Cleaning Utensils

Uses of Wastewater from Cleaning the House

It was found out that almost that the 9.5% of respondents who reuse water from cleaning the house used it to water grass or flowers. This is explained by Figure 4.8 on use of wastewater from cleaning the house.

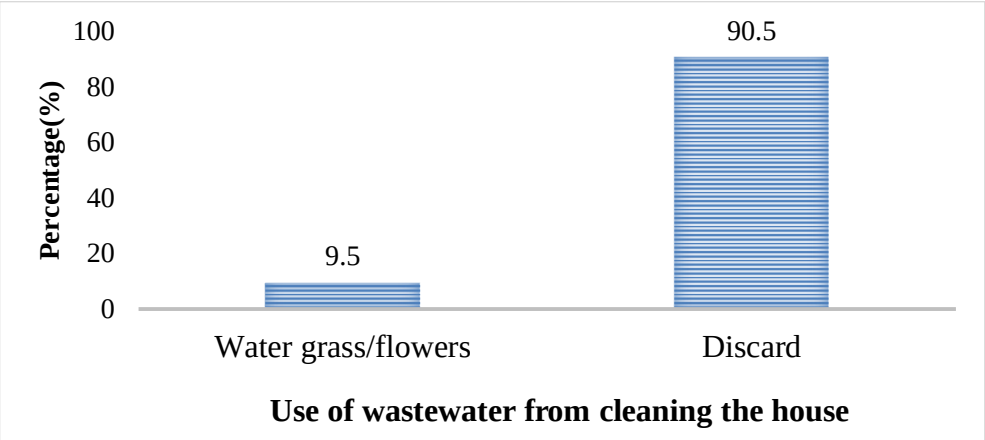

Figure 4. 8: Use of Wastewater from Cleaning the House

4.5.2 Use of Water Conservation Sanitary Facilities

The study found out that ITWASCO does not have a conventional sewerage system. Due to the absence of a sewerage system, residents use pit latrines and septic tanks.

The study found out that most residents in Iten Town use pit latrines even with the presence of a flush toilet in the home. A significant percentage of the respondents (54 %) use pit latrines to conserve water when there is water shortage. Others (11.1%) use pit latrines when they have many visitors while 7.9 % of the residents use pit latrines during the day to conserve water and flush toilets during the night. 3.2% of the respondents use flush toilets for short calls and use pit latrines for long calls where as 23.8% of the residents do not use pit latrines at all since they only have flush toilets in their households as presented in Figure 4.9.

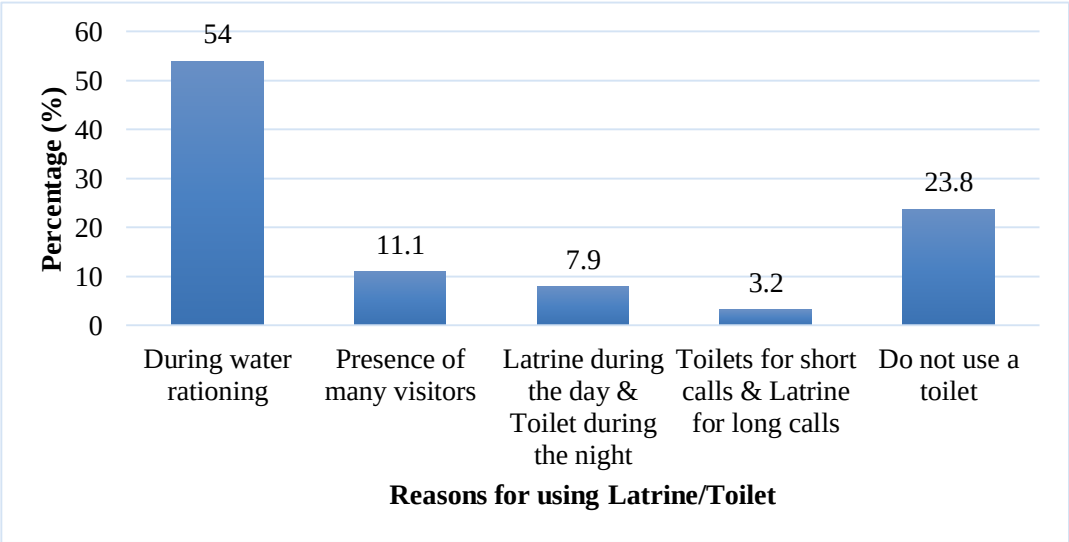

Figure 4. 9: Reasons for Pit Latrine Use among Respondents

4.5.3 Saving Water through Turning off taps

From the study, different household strategies to conserve water were established including turning off of taps while brushing teeth.

The researcher sought to find out if residents of Iten Town practice any household strategies to conserve water and the responses were made clear by Figure 4.10 where 25% of the respondents turn off their taps while 13% do not, the rest 62% do not have taps in their household.

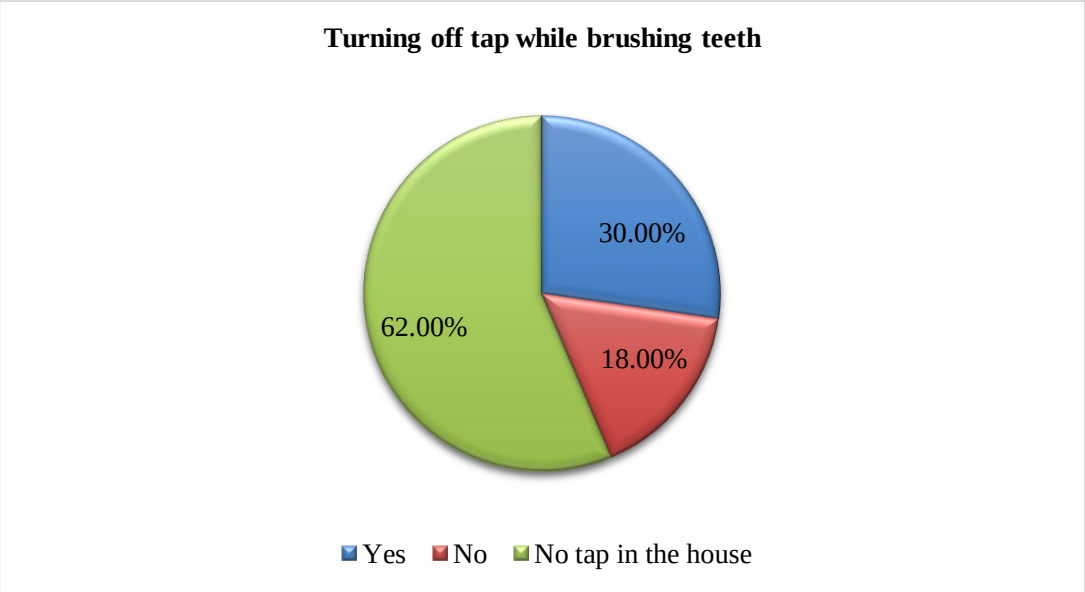

Figure 4. 10: Respondents Who Turn off Taps while Brushing Teeth

Regarding saving of water while washing fruits and vegetables, 28% of the respondents reported that they turn off their taps, 7% do not while 65% do not have taps in their households. Saving of water by turning off taps is as presented in Figure 4.11.

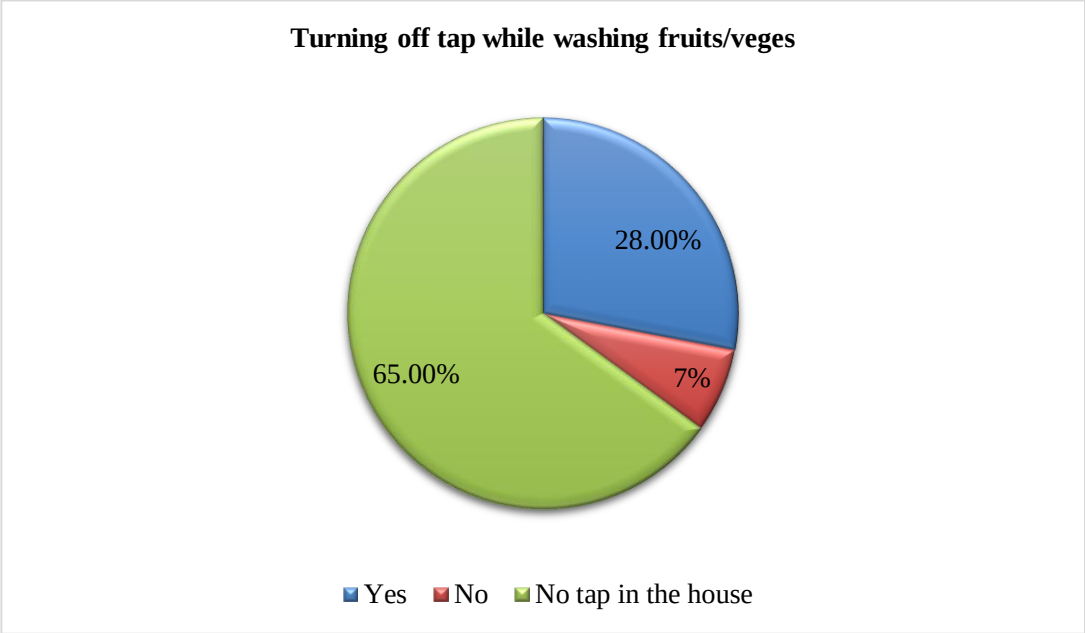

Figure 4. 11: Respondents Who Turn off Taps while Washing Fruits/Vegetables

4.5.4 Household Water Conservation Measures

The respondents were asked to identify the type of water conservation measure they practice in their households.

A good number of the respondents (35.7%) reported reusing their water while almost a quarter (23.13%) conserve their water by storing it using containers of various sizes and plastic tanks. Stored water is used to cope with the intermittent water supply during periods of water shortages. A small percentage (16.42%) reported using minimal water. Finally, a quarter of the respondents (25.37%) do not practice any water conservation measures. The responses are as presented in Figure 4.12

Figure 4.12 shows various household water conservation measures practiced by the residents of Iten Town

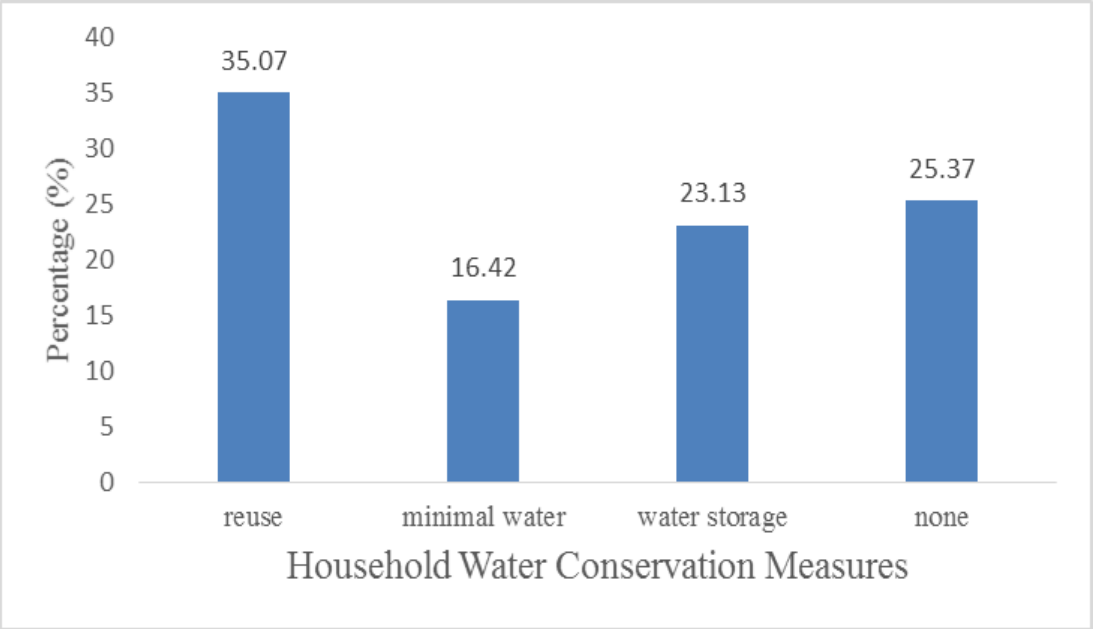

Figure 4. 12: Household Water Conservation Measures

Plate 4.5 and 4.6 form part of evidence of water storage as one of the water conservation measures practiced by the residence of Iten Town. Plate 4.5 shows several plastic containers used by a household in Kariobangi Estate to store water.

Plate 4. 5: Water Storage Containers of Different Sizes in Kariobangi Estate

(Source: Author, 2017)

Plate 4.6 shows a plastic water tank used by a resident of Kapchepkoima Estate to conserve water that will be used during the next period of rationing.

Plate 4. 6: large Plastic Water Tank in Kapchepkoima Estate

(Source: Author, 2017)

4.6 Analysis of Factors Affecting Water Use

Regression analysis on the effect of individual household characteristics on overall household water use was done to estimate the significance of each household characteristic.

It was chosen due to its ability to determine which variables are most significantly associated with water use. Regression analysis was run using SPSS. Table 4.8 shows the summary of the results.

Table 0.8: Effects of Various Variables on Water Use

Independent Variables	Pearson Correlation (r)	Significance (2 tailed)
Household Number	-0.145	0.898
Occupation of Respondent	0.125	0.912
Monthly Household Income	0.140	0.446
Level of Education	-0.173	0.879
Size of Plot	0.058	0.959
Owner of Plot	-0.072	0.949
Presence of a Garden	0.111	0.922
Number of Children	0.071	0.950
Water Sources	0.048	0.966
Distance to Source of water	-0.332	0.772

When household characteristics are looked at jointly, most variables exhibit positive association while a few show negative association. Variables that show positive association are occupation of respondent, household income, size of plot, presence of a garden, number of children and water sources.

Those that display negative association are household number, level of education, plot ownership and distance to source of water. Among the various variables, water source (r=0.048; sig. 0.996) at 0.05 level is the most significant in regards to water use.

CHAPTER FIVE

DISCUSSION

5.1 Introduction

This chapter discusses the findings presented in Chapter Four. Discussions are presented as per the objectives of this study of determining water use patterns, establishing the relationship between household socio economic characteristics and water and establishment of household water conservation strategies.

5.2 Household Water Use Patterns

In the first objective, the study revealed that average water use in a one-member household is 64 litres, in a three-member it is 48 litres and in an eight-member household the average amount decreases to 27 litres. This means that as the size of households increases, the average amount of water consumed in the household decreases and vice versa. Use of little water by many people in a household can be attributed to the fact that activities such as washing of clothes and cooking are done collectively hence saving on water.

Drinking water per person was found to be an average of 1.5 litres. This is slightly lower than what is proposed by World Health Organization (WHO) which assumes that an adult requires about two litres of drinking water every day. Water used for food preparation was found to be an average of 7.5 litres. This is also slightly lower than what was proposed by Brown & Matlock (2011) where they argued that the water uses for food preparation is 10 liters per day.

The difference might have been brought about by preparation of many parts of a meal in the western world, for instance dinner may consist of soups, salads, snacks, main course, desserts and drinks, on the other hand a meal in the developing country like Kenya may consist of rice and beans only.

Due to scarcity of water experienced in Iten town, the residents reported using water from different sources. Most of the respondents however used treated water from the area water service provider – ITWASCO. The reason given was that the water from the company is portable. Respondents who use both well and piped water reported using water from the wells when they cannot access piped water for instance during periods of water rationing. This means that the most preferred water source is piped water.

Water from roof catchment is available only during rainy season making it unreliable; spring water is also unreliable because on average, the distance is more than one kilometer for most of the respondents. Water from the well is not treated and its quality is not ascertained, hence not reliable. However, it was found out that many households in Iten Town rely on more than one source of water to satisfy their water needs. Some residents use different sources for different types of use. For instance, some respondents reported using water from the well to wash clothes and cleaning the house since these uses do not require potable water. Other respondents used the clean tap water for drinking and cooking. The tap water is from the area water service provider (ITWASCO). The water from the company is treated and its quality ascertained to be good hence, piped water is the preferred choice of water source for the residents.

5.3 Socio-economic Characteristics and Water Use

The second objective sought to establish the relationship between household characteristics and water use. The study revealed that households headed by eldest children used an average of 63 liters of water per day. Households headed by eldest children were probably children who were orphaned or their parents are working or staying in other parts of the country. The higher consumption of water can be ascribed to the presence of children and teenagers in the household and absence of mature adults like parents to advise them on optimal and wise use of water.

Another reason is that children's clothes become dirty as they play thereby requiring frequent cleaning. Children also require more meals in a day than adults thus more water is needed for cooking. Teenagers on the other hand are known to use water wastefully, play with water and wash their clothes more frequently. The findings of the study resonate with Nauges and Thomas (2000) who did a study touching on residential water demand and noted that young persons use water less cautiously, have extra showers, and do more laundering.

On the other hand, the least consumers of water are those headed by grandparents. households headed by grandparents could be as a result of death of their children or are staying in other parts of the country and the children are still young to live on their own. This might have necessitated them to look after their grandchildren. These households were found to consume an average of 44 litres. This can be attributed to them being more careful on the use of water and that they have less showers or bathing and do less cleaning. The findings are in agreement with a study by Nauges & Thomas (2000) who argued that older people are known to save water more compared to the young and that they are more susceptible to water price mechanisms hence use water more efficiently.

Findings showed that households with gardens used additional water than those without. This means that gardening as an outdoor activity has a positive effect on water consumption. It can be deduced therefore that, despite the number of households with gardens being less than a half (35%) of the total respondent's, gardening has an impact on the overall water use in the study area. This means that gardening increases the total amount of water used in the household and consequently the overall water use in the study area.

The relationship between tenancy type and water use showed that residents that own homes consumed more water than those who rent. Increased use of water among home owners can be attributed to presence of gardens that need watering during dry season. Watering gardens consume extra water in the household making the total water consumption in a household to increase. Increased use of water can also be attributed to presence of domestic animals owned by homeowners that consume water every day.

Statzu & Strazzera (2009) note in their study that property holders used less water as compared to tenants. He further explained that it is likely because water bills are mostly covered in rent thus, tenants do not get the exact price indications for their water consumption behaviour. Homeowners in Sardinia may not be having gardens as well as domestic animals as the residents of Iten Town thus the use of water in their households.

The correlation results between the level of education and water use portrays a strong negative correlation (r=-0.018; sig. 0.811). This means that as the level of education increases there is a significant decrease in the amount of water use and vice versa.

This probably means that residents who are more educated understand more ways of conserving water compared to those who are less educated. However, Gilg & Barr (2006) in a study done in Devon, England, disagree with this study. They argued that families with advanced education levels usually have stronger intents to preserve water. Although according to them, in real sense households with lower education take part in more water conservation behaviours and use less water than households that are highly educated. Also in agreement is Fielding *et al.* (2012) who notes that households with little education participate in water conservation more often and use less water than households with higher education.

Results also showed a strong positive correlation between household income and water use (r=0.015; sig. 0.857). This means that higher incomes households consume more water than low income ones. Probably households with higher incomes live in big houses with many rooms that require more water to clean. They also possibly have many clothes that require more water to clean.

In addition, households with higher incomes perhaps can afford different kinds of food for a meal than low income households; hence require more water for cooking and cleaning utensils. Romano *et al.* (2014) in their study in Italy agrees with the findings of this study, that there is a positive effect of income on water utilization, that is, more affluent families utilize more water than less affluent ones. UNDP (2006) also notes that high-pay family units use undeniably more water than poor families. The study gives an example of Dar es Salaam, Tanzania in East Africa and Mumbai, India in Asia, where per capita water use is 15 times higher in high-pay neighbourhoods connected to the utility than in slums.

Corbella & Pujol (2009), in a study carried out in Barcelona (Spain) share the same views as this study. They argued that more levels of income may lead to an increase in standards of living which may imply increase in number of water-consuming appliances.

Table 4.5 showing household size and water use which depicts a strong negative correlation between the two variables of household size and water use (*r*=-0.024; sig. 0.749). This means that as the household size increases, the average amount of water consumed in the household decreases.

5.4 Household Water Demand Management Strategies

The third objective sought to establish household water conservation strategies practiced in Iten Town. A good number of the respondents practice household water management through reuse of wastewater from clothes washing. Instead of discarding water from rinsing clothes, the residents reported using it to clean the house, water flowers or clean latrine and save on water. Water demand management was also achieved by storing water in both small and large water storage containers. Stored water is later used when there is water shortage. A small percentage of respondents practiced water demand management through use of minimal water for instance some respondents reported that instead of using a bucket full of water (which is normally18-20 litres) to take a bath, they use between 5 and 10 litres.

Therefore, more water could be conserved if the residents were to practice other water conservation measures such as the other “R” s’ for instance ‘Repair’ where households can save on water by repairing leaks in their homes.

Findings also showed that water from clothes washing is the mostly re-used waste water. This is probably because water from washing clothes especially that used to rinse is thought to be less dirty.

Conservation of water was also realized by using pit latrines instead of flush toilets. These findings agree with that of Narain (2002) who notes that toilet flushing consumes maximum amount of water and that other alternative technological advancement which use very limited amounts of water or no water at all should be considered.

It was found out from the study that most of the residents manage the demand for water in their households by turning off taps while brushing teeth and while washing fruits, vegetables and utensils. Instead of letting the water to run from the tap as they brush their teeth, the respondents reported using a cup. A small basin was reported to be used when washing fruits and utensils in order to avoid leaving the tap running, hence wasting more water.

Fielding *et al*. (2012), notes that ongoing everyday behaviours like shorter showers and turning off the tap when brushing teeth help to conserve water in the households. According to the findings of their study, these are positive water use habits which when done continually with time impacts on the overall amount of water used in the home.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Overview

This Chapter gives the summary of the study findings that have been identified from the research with regard to the research questions. It presents conclusions and recommendations as per the findings of the study and proposes further research areas.

6.2 Conclusions

The major conclusion for objective one was that as the size of households increases, the average amount of water used in the household decreases. Many members in a household use less water on average per individual in a day, while households with few members use more water on average. This could be as a result of economies of scale relating to the optimization of water which is realized in large households.

Several socio economic factors were found to influence demand on water use, for instance household head, level of education, household income, home ownership and gardening. Among the various uses of water, gardening consumed the most amount of water.

Research on water demand management options for Iten Town found that reusing water, minimal water use, use of pit latrines instead of flush toilets, water storage and turning off taps while brushing teeth conserves water.

6.3 Recommendations

Based on the findings of the study, the following recommendations can be made:

1) The study recommends activities such as washing clothes and utensils to be done when full load in order to conserve water and avoid doing them as soon as they get dirty since this ultimately consumes more water.
2) Besides controlling gardening and livestock keeping in the urban areas, the study recommends exploration of alternative sources of water such as rain water harvesting particularly by households that have gardens and livestock as a means of reducing pressure on municipal water supply.
3) The homeowners and private property developers should put into consideration roof water harvesting in their building plans and during construction of homes so as to collect water during the rainy seasons. The collected water will then be used during dry periods when there is water scarcity.

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APPENDICES

Appendix I: Household Questionnaire

Preamble

Good morning/afternoon. My name is Mercy Ngetich a student at University of Eldoret, School of Environmental Studies (Environmental Planning Monitoring and Management). I am interested in assessinghousehold socio-economic characteristics in relation to water consumptionin Iten Town. If you allow me, I would like to ask you some questions. Some of these questions are personal, but the answers you provide shall remain confidential and will not be shared with any one. I will not write your name in these papers. The information you provide will only help me to learn more about management of available water resources in order to meet the town's water demand and shall not be used at any time for any other purpose other than for this study. Please feel comfortable to answer all questions. You are however free not to answer any question(s) you feel uncomfortable to respond to. Filling of the questionnaire is expected to last for about 25 minutes. Thank you for your time.

1. [Yes] 2. [No]

Start time:……End time……

Background information

Name of the Respondent (optional)……Date of Interview……

Name of the Interviewer……Questionnaire No…….

Respondent Information

1. Sex: Male [ ] Female [ ]
2. How many persons live in your household? Total No……
3. Who is the household head? Father [] 2. Mother [] 3. Eldest child [] 4. Grandparents []
4. Please provide the following details of your household members:

Household member	Gender	Age

5. What is your marital status? Tick where appropriate

(i) Married [] (ii) Single [] (iii) Widow/er [] (iv) Separated [] (v) Others (specify) []

6. Please indicate the monthly household income bracket.

Income bracket in Ksh	Tick where applicable
Less than 5000	
5001-10000	
10001-30000	
30001-50000	
50001-100000	
Over 100000	

7. What is your education level?

(i) None (ii) Pre-primary (iii) Primary (iv) Secondary (v) College (vi) University

8. What is your occupation?

1. Private Business [] 2. Employed with private sector [] 3. Farmer [] 4. Government Employee []

9. Who owns the place you live? Self [] Rented [] Other (specify)[]
10. Household Typology

Presence of a latrine	Presence of a garden

11. What type of sanitary facilities do you have in your household? 1. Flush toilet [] 2. Pit latrine [] 3. Ventilated improved pit latrine (VIP) [] 4. Any other (name it…….)

b). Migration trends

12. Place of birth of the respondent……..

If this is not your place of birth, how long have you lived in this town (i) <5 years (ii)

6-9 years (iii) 10-14years (iv) 15-19 years (v) > 20 years

13. Were your children born here? Yes [] No []. If yes, how many? One [] more than one [] All []

c). Access to Water

14. What is the source of water for your household? More than one source is permissible.

Water sources	**Distance to water source**	**Quality:** Treated/ Not treated	**Reliability:** Always available/Not available always	**Cost:** Free/Not free
Piped				
Public stand pipe				
Communal water kiosk				
Water vendors				
Spring				
River				
Well				
Borehole				
Roof catchment				
Any other (specify)				

15. What are the uses of water in your household?

Water use		Amount used per day
Domestic	Showering	
	Cooking	
	Cleaning the house	
	Washing clothes	
	Washing utensils	
	Drinking	
Gardening		
Washing cars		
Watering animals		
Any other (specify)		

16. How much water do you use in your household per day?.....
17. How much do you pay for water per month?
18. What do you do with the wastewater from washing/cleaning:
    (a) Clothes……
    (b) Utensils……..
    (c) House……

19. How do you conserve water in your household? 1. Use minimal water [] 2. Reuse water [] 3. Store water [] 4. Do not conserve water []

20. In your opinion what factors affect availability of water in adequate quality and quantity in Iten Town?
    1. Nonpayment of bills [] 2. Population increase [] 3. Leakages [ ] 4. Rationing [] 5. Lifestyle changes [] 6. Limited water sources []

21. In your opinion what do you think are problems faced in accessing water in Iten Town? *More than one problem is permissible*.
    1. Rationing [] 2. Expensive [] 3. Far way [] 4. Long queues [] 5. Frequent breakdowns [ ]6. Others []

22. What can be done to improve water access?

a) Rain water harvesting [] b) Development of new water sources (dams, weirs etc.) []

c)Maintenance of water supply infrastructure, e.g. repairing of leaking types []

d) Household water conservation measures e.g. water minimization and water reuse []

23. If your answer is (d) above,
    a) Do you turn off the water tap when:
        (i) Brushing teeth Yes [] No []
        (ii) Washing vegetables, fruits and utensilsYes [] No []
        (iii) Lathering up with soap and shampoo Yes [] No []

Appendix II: Interview Schedule for Iten-Tambach Water and Sanitation Company (ITWASCO) Staff

1) Please tell me about the coverage of your water supply network, the number and distributions of households you serve.
2) What is the amount supplied per day to households ofIten Town?
3) Kindly give statistics of how this supply has changed over time.
4) How much do you charge for water supply?
5) What is the total revenue generated from water supply?
6) How many people are connected to water supply system?
7) Who are the major consumers of water?
8) What are the water sources for the company?
9) What is the rate of connections for the town?
10) What is the rate of consumer satisfaction in water supply?
11) What challenges do you face in water provision in the town?
12) How do you deal with these challenges?
13) What do you envision as the future of Iten town in terms of water supply and demand?
14) Please provide the following documents if you have;

a) Strategic plan
b) Action plan
c) Annual Reports

Appendix III: Observation Schedule

1) What are the sources of water for Iten Town?
2) Do residents of Iten Town have water storage facilities?
3) What is the state of water supply infrastructure in Iten Town?
4) What challenges do residents of Iten Town face in relation to water provision?
5) Are water demand management measures practiced in Iten Town?

Appendix IV: Research Permit

THIS IS TO CERTIFY THAT:
MISS. MERCY JELAGAT NGETICH
of UNIVERSITY OF ELDORET, 0-30100
ELDORET,has been permitted to conduct
research in *Elgeyo-Marakwet County*

Permit No : NACOSTI/P/17/53929/16875
Date Of Issue : 4th May,2017
Fee Recieved :Ksh 1000

on the topic: *EFFECTS OF HOUSEHOLD CHARACTERISTICS ON WATER DEMAND IN ITEN TOWN ELGEYO MARAKWET COUNTY KENYA*

for the period ending:
4th May,2018

.....
Applicant's Signature

.....
Director General
National Commission for Science, Technology & Innovation

Appendix V: Photographs Showing Water Collection Containers

A woman carries water on her back in Kariobangi estate

A boy draws water from a tap in Lilies Estate

Appendix VI: Photographs Showing Non-Revenue Water

A Leaking Water Tank at Yokot Reservoir

A Leaking Water Pipe at Kapsio Estate

Appendix VII: Similarity Report

Turnitin Originality Report

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