DETERMINANTS OF WATER DEMAND IN KIBERA INFORMAL SETTLEMENT IN NAIROBI COUNTY, KENYA

BY

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DECLARATION

Declaration by Candidate

This thesis is my own original work and it has not been submitted for examination in any other institution of higher learning.

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Declaration by Supervisors

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ABSTRACT

In developing countries, it has become increasingly hard to keep up with the demand for proper sanitation and water treatment. Water is an essential component of life and its availability and quality are crucial. The daunting task facing local authorities is how to adequately supply clean potable water to the predominantly poverty-stricken urban dwellers. Although access to water in rural areas is lower than in urban areas, the proportion of the poor is higher than in the urban areas. The purpose of this study was to establish the determinants of water demand in Kibera informal settlement in Nairobi County. The objectives of the study were to establish the effect of price, household size, gender, income of household head, education, age and occupation on water demand in informal settlement of Kibera in Nairobi County. The study adopted a demand-responsive model and Stone-Geary model based on the explanatory research design. The target population was 15,000 individuals living in the Kibera informal settlement. Stratified and simple random sampling techniques were used to select respondents from the strata. From the target population of 15,000 a sample size of 390 respondents was selected. Data was collected using both a questionnaire and the interview guide and thereafter analysed using descriptive and inferential statistics. Regression results (R^2 =0.843) indicated that the determinants of water demand accounted for 84.3% of the total variation in water demand in the informal settlement. Variables such as age (β_1 =-0.091, P<0.01); household size (β_2 = 0.087, P<0.01); income (β_3 = 0.456, P<0.01); price (β_4 = -0.542, P<0.01); gender (β_5 = 0.105, P=0.01<); education (β_6 = -0.191 (P<0.01) and occupation (β_7 = -0.079, P<0.01) had significant relationship with water demand. Gender and income had positive and significant relationship with water demand while price, age, education, occupation and household size had negative and significant relationship with the demand for water. As such, the study recommends that the county government of Nairobi should establish a price policy which corresponds to the water demand in informal settlement. There is also need for the county government to improve the income generating activities in the informal settlement in order for residents to earn extra money to boost water consumption.

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ABBREVIATIONS AND ACRONYMNS

AICD	Africa Infrastructure Country Diagnostic
CP	Community Participation
GDP	Gross Domestic Product
GPS	Global Positioning Systems
MDGs	Millennium Development Goals
MoFED	Ministry of Finance and Economic Development
OECD	Organization for Economic Cooperation and Development
SDGs	Sustainable Development Goals
SPSS	Statistical Package for Social Sciences
UN	United Nations
UNDP	United Nations Development Program
UNICEF	United Nations International Children's Emergency Fund
US	United States
WB	World Bank
WHO	World Health Organization
WSP	Water and Sanitation Program

CHAPTER ONE

INTRODUCTION

1.1 Overview

The chapter presents information on water demand globally, regionally and then narrows down to Kenya in particular. This chapter covers background of the study, statement of the problem, objectives of the study, hypothesis, justification of the study, scope of the study as well as the limitations of the study.

1.2 Background of the Study

As global population increases, it continues to create new challenges on the management of natural resources. It is projected that the urban population growth on the continent double between the year 2000 and 2030 (Alabaster, 2010). The root of this unprecedented growth includes natural increase, reclassification of rural areas as urban centers, and most importantly, rural-urban migration (Chitonge, 2014; Hardoy *et al.,* 2014; Satterthwaite, 2014).

In developing countries, it has become increasingly hard to keep up with the demand for proper sanitation and water treatment. Water is an essential component of life and its availability and quality are crucial. The daunting task facing local authorities is how to adequately supply clean potable water to the predominantly poverty-stricken urban dwellers (Bakker *et al.,* 2008). Although access to water in rural areas is lower than in urban areas, the proportion of the poor is higher than in the urban areas. Many countries in both the developed and developing world face significant problems in maintaining reliable water supplies, and this is expected to continue in future years due in part to the impacts of global climate change.

Growing population further increases the demand for water, while there are limited cost-effective water supply augmentation options (Dharmaratna and Harris, 2010). As a result, reliable estimates of residential water demand, water source choice decisions and the factors affecting it have become more important for policy making in the water supply sector. According to Whittington (2009), there is a large group of households who live in the expanding slums of cities throughout the developing world earning incomes of less than 150 US dollars per month. Many of these households currently have neither private piped water connections nor the income to purchase. In densely crowded slums, there are often large benefits associated with improved sanitation and Kibera informal settlement in Nairobi County is not an exception.

Water use practices and willingness to pay for water services in urban areas depend highly on household income (Minten *et al.,* 2002). To expand water supply to urban areas, implementing proper demand management strategies is also required. Appropriate information on the domestic water demand by households is necessary to properly assess the factors that affect informal settlement water demand. There are several factors that affect the demand for residential water of the households (Arbues *et al.*, 2003). Some of these factors are income of the household, price of water, household size, age and sex composition of the family members and weather variables like temperature and precipitation.

In developing countries little is known about households' factors driving their water demand choices and relationships between piped and non-piped water from different sources. The policy decisions are often not very well informed and it is usually assumed that residential water demand in developing countries mirrors those of developed countries (Basania *et al.,* 2008). The study is seeking to unravel factors of water demand

in informal settlement. This would predict the water demand with respect to their household characteristic among the slum dwellers.

In Ethiopia the overall water supply and sanitation services performance of the country show that the national access to safe drinking water (both urban and rural) has increased from the previous 41.2% in 2003 to 47.3% in 2005/06 (MoFED, 2007; AICD, 2008). The urban water supply and sanitation system designs (structures) are obsolete but the rate of rehabilitation and expansion has been lagging behind. Most urban water utilities do not fulfill the principle of cost recovery and self-reliance, which has undermined the interests of the external borrowers. Contrary to its huge investment requirement of urban water supply, the flow of funds has remained very low (MoFED, 2007).

Towards the realization of commercialization of urban water supply systems, it is therefore, necessary to have an in-depth understanding of the factors that affect residential water demand and water source choice decisions in the Kibera slum of Nairobi informal settlement. In Kenya, about 43% of the total population can access quality water sources. (World Bank 2010). Kenya faces the challenges in realizing its 2030 vision for the water and sanitation sector "to ensure that improved water and sanitation are available to all". Kenya has about five percent growth rate of the informal settlement annually, which is the biggest in the globe and will probably be twice in the next thirty years. This is so if no interventions is going to be acted upon (UNDP, 2007).

Water supply in Nairobi has been plagued for many years with inefficiency, complex management and logistical problems. This has led to inadequate water services, with the poor suffering the most. The time spent on water collection per day varies significantly based on the level of service. Households with private connections spend about five minutes. Despite low average water use, estimated at only 40 litres per capita

per day, households are paying remarkably high unit prices for water. The average cost is estimated to be Ksh. 350 per cubic meter (US $ 3.50) (World Bank, 2004). Despite water service providers attempts to deliver a subsidy through the tariff, there is evidence that the poor, who are more likely to rely on water sold by third parties, pay more per unit of water (Gulyani *et al.,* 2005). In an attempt to partially address the problem, the water authority has established a flat rate of Ksh10 per cubic meter for bulk supply to water kiosks serving informal settlement.

Kibera is the largest and most densely populated informal settlement in sub- Saharan Africa. With an estimated population of at least 500,000 people, the informal settlement of Kibera is home to at least a quarter of the population of Nairobi. Inadequate water supply and sanitation presents serious environmental challenges to those living in Kibera (WSP, 1999). Kibera gets less water than other settlement in proportion to its size for two main pipe reasons. One is the limited capacity of the pumping station on the trunk main feeding this part of the city, and the other is the tendency to divert available water to neighbouring high income areas where both political influence and revenue collection are greater. Thus, there is need for a new approach to improving water provision in informal settlement.

Previous studies on water access in Kenya include: (Majale, 2003), which provides an insight into the state of water supply infrastructure in informal settlement. It also analyses the supply systems serving inhabitants of informal settlement which include water kiosks, communal water points, itinerant water vendors and on-plot connections. Ben Crow *et al.*, (2013), using global positioning systems (GPS) measures the time taken to collect water in informal settlement in Kenyan cities. Mutisya and Yarime (2011) focus on the three main concerns of slum dwellers with water which include

access, cost and quality. Njeru (2010) discusses how water crisis in Kenya has a tremendous impact to maternal care. In Mombasa it has been revealed that more than 50% of all the diseases reported in the county are associated with difficulty to access clean or good quality water as well as inadequate wastewater management (Munga, 2002). The difference in the amount paid is even more dramatic if the poor families have to supplement their water use from the kiosks or vendors.

Establishing the determinants of water demand in informal settlement would help the water authorities, county, national governments, policy makers and development sector in their efforts to meet one of the targets of the Sustainable Development Goals (SDGs. Lack of access to quality water is an issue of major concern which requires immediate intervention. This study sought to establish the determinants of water demand in informal settlement in Nairobi County with specific reference to Kibera slum.

1.3 Statement of the Problem

In Africa, privatization of water services has failed to achieve the intended benefits which were previously lauded especially for the poor who most often live in urban informal settlement. It is worth noting that informal settlement account for roughly 30 to 60 percent of the urban population (Uitto and Biswas, 2000; UNCHS, 2006). Those who live in these settlement are poor and most governments or private companies give lower priorities to issues affecting them. Consequently, millions of people are denied access to clean potable water. In the urban areas the poor reside in slums, lack of water supply and sanitation services represents a frightening challenge. A multiple strategic target initiative is required to meet one of the targets of the SDGs.

Consumption patterns of water in informal settlement have changed over time due to the expansion of private tap connections, increases in population, expansion of

household income generating activities that consumes water to a greater extent and improved sanitation. In Kenya, more than half a million people have little or no access to the water supply in the informal settlement of Kibera slum. Instead, their demand for water is met by an expanding informal water market in which more than 650 local entrepreneurs sell water through kiosks scattered throughout the settlement. Therefore, it was necessary to have an in-depth understanding of determinants of water demand in informal settlement such as in Kibera informal settlement in Nairobi County.

1.4 Objectives of the Study

1.4.1 General objective

To establish the determinants of water demand in informal settlement in Nairobi informal settlement.

1.4.2 Specific objectives

1. To determine the effect of price on water demand in informal settlement of Kibera slum in Nairobi County.
2. To establish the effect of household size on water demand in informal settlement of Kibera slum in Nairobi County.
3. To investigate the effect of gender on water demand in informal settlement of Kibera slum in Nairobi County.
4. To determine the effect of household head income on water demand in informal settlement of Kibera slum in Nairobi County.
5. To establish the effect of education on water demand in informal settlement of Kibera slum in Nairobi County.
6. To establish the influence of age on water demand in informal settlement of Kibera slum in Nairobi County.

7. To examine the effect of occupation on water demand in informal settlement of Kibera slum in Nairobi County.

1.5 Hypotheses

The study sought to test the following hypotheses:

Ho_1: Price does not significantly affect water demand in informal settlement of Kibera slum.

Ho_2: Household size does not significantly influence water demand in informal settlement of Kibera slum.

Ho_3: Gender does not significantly influence water demand in informal settlement of Kibera slum.

Ho_4: Income of household head does not significantly affect water demand in informal settlement of Kibera slum.

Ho_5: Education does not significantly influence water demand in informal settlement residents of Kibera slum in Nairobi County.

Ho_6: Age does not significantly affect water demand in informal settlement of Kibera slum.

Ho_7: Occupation does not significantly influence water demand in informal settlement of Kibera slum.

1.6 Justification for the Study

In Kenya, the UN-Habitat (2005) reports that over 50% of those living in slums have no access to drinking water. The problem of urban housing is characterized by an acute shortage of basic services as well as the existence of substandard human settlement such as slums. The provision of water and other social services have not adequately satisfied the demands of the growing population. The rapid urbanization in the informal

settlement has a particular huge and negative impact on the living conditions of the population particularly in the provision of water.

This study sought to fill a gap in knowledge on provision of water in developing countries in Africa and Kenya in particular. The findings of the study on water demand of households in developing countries may help policy makers understand the water demand needs in the informal settlement for planning purposes. The study may be important to environmental policy and urban planning perspective. Water problems in the informal settlement will be solved if the ministry of water develops and implement the correct policies on water demand.

Understanding socio-economic variables that affect households' water consumption decisions helps the water supply firms, county governments and policy makers in the water supply and development sectors in their efforts of demand management and improving water supply levels. The findings of the study will be significant to the national and county governments where there is rising demand for water with respect to the sustainable development goals and Vision 2030 roadmap.

1.7 Scope of the Study

This study sought to establish the determinants of water demand in informal settlement of Kibera slum in Nairobi County. This was achieved through identifying the price, household size, gender, income, education, age and occupation of household heads on water demand in informal settlement of Kibera slum in Nairobi County. The study was carried out between January and May 2018 and involved a sample size of 390 residents of informal settlement in Kibera, Nairobi County.

1.8 Limitations of the Study

This study was limited by the unwillingness of some of the respondents to participate in the study due to the status in the informal settlement. This was overcame by explaining to them the purpose of the study and assuring them that the information obtained would be kept strictly confidential.

CHAPTER TWO

LITREATURE REVIEW

2.1 Introduction

This chapter is a presentation of the litreature review on the determinants of water demand globally, regionally and locally depending on the goals of the study. It gives the introduction on the concept of informal settlement, then water demand in these settlement. Later, the determinants of water demand (price, income, age, gender, occupation, household size and education level) are given. Finally, the theoretical models and conceptual framework are discussed.

2.2 Informal Settlement

Eventually, an increasing percentage of urban population live in “housing poverty” (UN-HABITAT, 2006). The proliferation and expansion of slums and informal settlement is thus presenting a major challenge to city and municipal authorities in developing countries, as well as to the international community. The poor live in slums in very poor conditions and are the most vulnerable to the vagaries of urbanization (UNHABITAT, 2004).

There are several definitions for the term urban informal settlement. The most prominent of these include unplanned settlement, squatter settlement, marginal settlement, unconventional dwellings, non-permanent structures, inadequate housing and slums (Hofmann et al., 2008; Huchzermeyer and Karam, 2006; Huchzermeyer, 2004). According to the UN (2007), informal settlement/neighbourhoods are settlement having the following characteristics: (1) lack structured planning, (2) has informal or insecure property tenure, (3) has limited participation in government activities, which leads to inadequate service provisioning, and (4) has a vulnerability to discrimination

for the residents. This study adopted the definition advanced by the United Nations (UN) because it encapsulates most of the essential characteristics of informal settlement.

Most informal settlement are faced with a myriad of problems ranging from inadequate infrastructure, poor sanitation to noise pollution, water pollution and poor water disposal system (GoK, 2001). Since construction is informal and unguided by urban planning, there is a near total absence of formal street grids, numbered streets, sewage network, electricity, or telephones. Informal settlement also tend to lack basic services present in more formally organized settlement such as policing, medical services and fire-fighting (GoK, 2009). In most studies informal settlement and slums take different meanings. However, for purposes of this study the two are taken to mean the same thing.

Water provision in Kenya is not done according to a desired standard in order to be certain that the MDGs for water and sanitation (Target 7) is reached (GOK, 2008). According to (GOK, 2010), Kenya has limited renewable water supply and is classified as a water scarce country. This situation coupled with unregulated urban growth and lack of effective urban services provision, planning and urban migration contribute to challenges in urban water services provision as people crowd into cities.

2.3 Water Demand

For the urban poor residing in such slums, lack of water supply and sanitation services represents a frightening challenge and multiple strategically targeted initiatives will be required to meet one of the targets of the MDGs; to reduce by half the proportion of people without accessible water to drink and fundamental sanitation (U.N., 2005). Many countries in both the developed and developing world face significant problems

in maintaining reliable water supplies, and this is expected to continue in future years due in part to the impacts of global climate change. Growing populations will further increase the demand for water, and there are limited cost-effective water supply augmentation options (Dharmaratna and Harris, 2010).

As a result, reliable estimates of residential water demand, water source choice decisions and the factors affecting it have become more important for policy making in the water supply sector. On the one hand, there is a debate around whether policies aimed at reducing water consumption should use price or non-price methods. On the other hand, supply augmentation requires several years of planning and large amount of capital investments before the water is available. In light of these challenges, governments are opting for strategies that promote water conservation, particularly with residential consumers (Dharmaratna and Harris, 2010).

During 2000 to 2006, the proportion of the population with access to an improved drinking water source in developing regions rose from 74 percent to 84 percent. However, nearly 1 billion people are still using water from unimproved sources such as shallow wells, rivers, streams, ponds and drainage ditches-with their attendant health and safety risks. Large numbers of those who lack access to improved water supply infrastructure live in urban areas (World Bank, 2009). Indeed, most work on water demand in developing countries has focused on households with access to a piped network (Zekri and Dinar, 2003

Moreover, studies on water use in Benin have combined urban and rural populations and targeted neither rural households nor households that lack access to private improved sources (Hadjer *et al.,* 2005). The average marginal effects provide additional insight into the factors affecting household water use. Water is one of the

most vital natural resources for all life on Earth, and it is a basic need. Health and safety are associated with water in daily living. Due to poverty and poor living conditions in the slums, water availability is a huge problem. Poor women bear the burden of unpaid chore of fetching water and are excluded from many opportunities to create wealth from water. Kibera slum dwellers face the problem of inadequate water supplies to clean the home, prepare the food, wash the utensils, do the laundry and bathe (Bapat *et al.,* 2003).

Most sewage in Kibera slums are dug so shallow that when it rains they fill up and overflow Nairobi River, which is usually the resident's source of water thus polluting the water. Due to the lack of water, the slum dwellers are forced to use the polluted water for basic needs leading to diseases which can lead to death of thousands of innocent lives (UNFPA, 2001). The rising problem of poor sanitation presents the most dehumanizing aspect of the daily battle for survival for the Slum dwellers. The poor pay an intense price for the lack of clean water and sanitation, in disease and filth (UN-Habitat, 2006). The water catastrophe in Kibera slums must be recognized for what it really is: a crisis of governance – of weak policies and poor management – rather than a crisis of scarcity, at least in the immediate term. An essential change is needed in the approach to urban governance if significant change is to be seen.

2.4 Theoretical Framework

This study adopted a demand-responsive model, Stone-Geary model and log-log model. Experts have proposed varied management mechanisms targeted at improving access to water in the developing world (Ghai *et al.,* 2014; Gleick, 2000; 2003; Mitchel, 2005; Pahl-Wostl, 2007; World Bank, 1993; 2004).

2.4.1 Demand-Responsive Model

The most notable among the suggested models is the demand- responsive approach as opposed to the traditional supply driven interventions (Naiga *et al.*, 2012; Nicole, 2000; World Bank, 1998). The demand-responsive approach was popularized in Africa in the 1990s by major development organizations such as the World Bank. The concept is anchored in the idea of Community Participation (CP) which advocates greater beneficiary involvement in water service production and management (Whittington *et al.*, 2009). It includes beneficiaries taking the initiative to demand improved water services while at the same time taking a leading role in project design, implementation, development and sustainability.

The demand-responsive approach requires beneficiaries to own the system by constantly making meaningful contributions either in the form of cash or labor to community-based water projects (Sara and Katz, 1998). It is premised on the belief that such involvement ultimately leads to better designed projects, better targeted benefits and more cost-effective and timely delivery of water. Most significantly, CP is seen as effective in terms of equitable distribution of water and in curtailing corruption and other rent-seeking activities (Asian Development Bank, 1998; DFID, 2000; World Water Forum, 2000).

Several water projects in rural villages in Africa and Asia have been established based on the demand-responsive model with the following studies heralding its success (Engel, Iskandarani and Useche, 2005; Cleaver, 1996; Isham and Kahkonen, 2002; Isham, Narayan and Pritchett, 1994; Kleemeier, 1995; 1998; 2000; Manikutty, 1995a; 1995b; 1997; Narayan, 1995; PGOKopy, 2004; 2005; 2009; Russ and Takahashi, 2013). Few studies have attempted to determine the tenability of CP theory in

explicating water production and management dynamics in urban informal settlement. Consequently, several gaps exist in knowledge of the value of this all- important theory for efforts to improve water service delivery in such settlement.

The main purpose of this study is to contribute to efforts addressed to filling these gaps. It accomplishes this objective mainly by exploring and evaluating the effectiveness of CP theory in water production and management in urban informal settlement/ neighbourhoods. World Health Organization and UNICEF (2006) estimates that in Sub-Saharan Africa between the year 1990-2004, the number of people without access to clean potable water increased by 23% . At the same time, the region experienced 85% increase in its urban population with the majority of people having no access to safe drinking water.

The relationships between population and the environment are complex and dynamic. Domestic water demand may vary according to economic matters (especially water price and income) but also according to socio-demographic variables (population and population growth; size and characteristics of households; age composition of household members; gender), cultural variables or even religious variables (nationality of residents in the household), educational levels and responsiveness to conservation campaigns, physical capital in the home (especially the presence of water efficient technologies), the predominant territorial urban form and climatic variables (Renwick and Green, 2000). All these factors produce a very complex picture with several possible interpretations as to which variables are more relevant. The focus of this study was to examine the determinants of water demand in Kibera.

2.4.2 Stone-Geary Model

The Stone-Geary model assumes consumers have a given level of income and prices. Consumers first purchase subsistence level of each good and then allocate leftover income in fixed proportions to each good according to their preference parameters (Deaton and Muellbauer, 1980). The main advantage of the Stone-Geary utility function is that it uses only two parameters for each good while allowing for non-constant elasticity that may increase with price.

The assumptions of the Stone-Geary utility function of strong separability, positive marginal propensity to consume and a positive threshold implying inelastic demand are appropriate here. Specifically, the assumption of strong separability between water and other goods is very common in all studies estimating a single water demand equation. Moreover, empirical evidence suggests water is a normal good and price inelastic, implying the rest of the assumptions are suitable for our analysis (Espey, Espey and Shaw 1997; Worthington and Hoffmann 2006).

In order to determine whether demand is elastic or inelastic the standard litreature primarily uses the Cobb-Douglas function (Beattie and Foster, 1981; Garcia and Reynaud, 2004; Hewitt and Hanemann 1995). Estimates are typically in the range of -0.25 and -0.75 (for example: (Chicoine, and Ramamurthy, 1986 and Chicoine, and Ramamurthy, 1986; Martinez-Espeneira, 2003). Higher elasticity estimates are found only with long-run analysis and data restricted to summer observations (Gaudin, Griffin and Sickles 2001; Hanemann, 1997; Nauges, and Martinez-Espineira, 2004; Pint, 1999).

Several factors contribute to the weak sensitivity of water consumption to price changes identified in empirical litreature: 1) the intrinsic nature of water as a necessity to life;

2) water bills constitute a small proportion of overall household budget and; 3) imperfect price information (Gaudin, 2006). However, water demand will exhibit different elasticity at different levels of use and in different price ranges (Nauges, and Martinez-Espineira, 2004). Moreover, the water volume required for the necessities of life, such as drinking and cooking, will be extremely inelastic.

Price is not the only factor determining household water consumption. The quantity of water consumed also depends on other factors including household income, number of household members, and weather variables (Arbues, Garcia-Valinas, and Martinez-Espineira, 2003; David, and Inocencio, 1998; Rietveld, Rouwendal and Zwart, Block 2000). Interpolation was used to derive the monthly income and number of household members for the intervening periods. Income is one of the main determinants of consumption and this may act as a proxy for water-using appliances. The income variable included in the analysis is monthly virtual income, which is computed by adding average household income to the instrument Nordin-difference variable. Instrumented Nordin-difference variable is derived from the intercept of the estimated theoretical water bills to derive instrumented marginal price variable.

Average household income is obtained by weighting the incomes from administrative districts. Empirical evidence suggests water demand is inelastic with respect to income and small in magnitude (Chicoine, and Ramamurthy, 1986; Espey, Espey and Shaw, 1997 and Deaton and Muellbauer 1980). This is to be expected as water bills often represent a small proportion of total household income (Arbues, *et al.*, 2003). Assuming water consumption increases with the level of income, the expected sign on the derivative with respect to income is positive.

Stone-Geary model includes number of household members to capture household water consumption decisions. Household size is expected to positively affect household water use. However, due to economies of scale, the increase in water use is less than proportional to the increase in household size (Hoglund, 1999 and Arbues, *et al.*, 2003). We expect our empirical results to conform with past empirical studies so that water consumption was positively related to the number of household members. Age distribution within the household members has varying impacts on residential water use (Nauges and Thomas 2000). Specifically, increasing the number of adults compared to children raised household water consumption, whereas, more seniors reduced consumption.

Many developed and developing countries are facing significant constraints on water supplies that continue over decades in light of projected climate change impacts. Growing populations and lack of available cost-effective supply augmentation options make reliable estimates of residential water demand important for policy making. In a developing nation setting where incomes are expected to rise over time, increases in water consumption is experienced even if prices rise. Further application of Stone-Geary using data from developing countries would provide a larger pool of results to determine whether this is in fact the case across most developing nations (Arbues, *et al.*, 2003).

Therefore, in an environment of increasing incomes policy makers should not rely solely on prices to lower consumption levels. Rather, they should employ a mix of instruments to effect reductions. The inelastic nature of water consumption means that by increasing prices water authorities raised revenue critical to maintain infrastructure and reduce transmission losses, as well as avoid low equilibrium traps (Gaudin, 2006).

Price increases had a negative impact on poor households but the revenue raised could be targeted to increase pipe-borne water supply to these groups. This would substantially improve their standard of living.

2.4.3 Log-Log Model

The thrust of the litreature on residential water demand takes a rather ad hoc approach to specifying the demand equations. The log–log model, where all variables enter the regression equation in logarithmic form, is used most frequently, for example in the recent studies by (Mazzanti and Montini 2006). Conveniently, the log–log model allows parameter estimates to be directly interpreted as elasticity of demand. Hence, price elasticity (in absolute terms) and if water is a normal good-also income elasticity decreases with higher water consumption levels. Somewhat implausibly though, semi-log model also implies that water demand will decrease to zero if the price reaches a sufficiently high level (Frondel and Messner, 2008).

In contrast, in semi-log model and in the log–log model, water demand falls to zero only asymptotically, which is intuitively more appealing because some minimum level of water use is a necessity (Olmstead *et al.,* 2007). Al-Qunaibet and Johnston (1985) and Martínez-Espiñeira and Nauges (2004), employ a Stone–Geary demand function which allows estimation of the level of water demand that is unresponsive to price changes and both semi-log and log-log models are estimated by OLS. Since the variables used are themselves observed averages rather than observations for individual households in the supply area, analytical weights need to be applied (Gaudin *et al.*, 2001).

In this case, an increase in water demand results in lower prices because the fixed cost components are distributed among higher consumption levels. Thus, water prices may

have to be treated as endogenous violating the orthogonality condition because one of the explanatory variables (i.e. prices) is correlated with the error component. There are inherent scale economies in capital costs for pipe networks and also in other business operations such as billing, purchasing or water quality testing. Shih *et al.* (2006) estimate that doubling a water system's output reduces per unit costs between 10% and 30% for community water supply in the US.

Similarly, Antonioli and Filippini (2001) in addition to economies of output density—also find economies of population density for water supply areas in Italy doubling output and customers, while holding all input prices and the size of the distribution network fixed, leads to a decrease in variable costs. Arguably, there may be better explanatory variables for the supply equation reflecting the cost or production structure of the utilities including labour cost, capital cost, or geological, hydrological, or topographical information.

Unfortunately, such data is not available for the large set of utilities used in our data set. The use of log–log models, semi-log models and specifications in levels has sometimes been criticized for their (apparent) lack of inconsistency with utility maximization (Al-Qunaibet and Johnston, 1985). However, Hanemann (1998) points out, these rather simple demand functions are in line with utility theory under the assumption that all commodities other than water may be lumped into a single aggregate commodity. In this case, the consumer exhibits preferences for two commodities only, water and the aggregate commodity.

The log-log functional form provides direct estimates of the respective elasticity of the independent variables with respect to the dependent variable. The semi-log function is often used to compare the results with the linear and log-log functions (Garcia *et al*.,

2001). As there is no *prior* basis for choosing a functional relationship, the model is provided with the options to analyze water use/demand using three popular functional forms as follows:

Log-log model:

$$LnY = \beta_0 + \beta_1 Ln(x_1)$$

$$lnY = b0 + b1\ ln\ (X1) + b2\ ln\ (X2) + b3\ ln\ (X3) +. \ldots bn\ ln\ (Xn) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.1)$$

Where, b_0 is the model content parameter

One drawback of the log–log model is that it presumes elasticity to be constant over the entire domain of the variables. The study applies a log–log model, but add the squared term of (the natural log of) income as well. This specification allows income elasticity to differ over the domain of income levels and may thus capture the effects on water use stemming from large income differences across supply areas. This study adopted Stone–Geary demand function with the following specifications; linear and log-log model.

2.5 Determinants of Water Demand

The economic instruments, especially prices, are among the major factors considered in influencing domestic water demand. Interest in pricing and other economic instruments arose as part of a more general approach to water management emphasizing control actions over demand. Thus, demand management has been postulated as an alternative to the 20th century hydraulic paradigm (Kallis and Cocossis, 2003; Saurí and Del Moral, 2001). Under the ideological construct of the alleged supremacy of the market as the instrument to manage and efficiently allocate natural resources (Andersen and Sprenger, 2000), price represents one of the most relevant tools to manage water demand (Arbues *et al.,* 2004; Garcia and Reynaud, 2004; Rogers *et al.,* 2002).

Lux (2008) links the decreases of water consumption in East Germany after the unification to financial incentives (price increases) and technological changes. The addition of other explanatory factors to the models of domestic water consumption is necessary in order to verify both the robustness of price and income elasticity estimates across different specifications and to explore further water demand determinants (Mazzanti and Montini 2006, Nauges and Thomas, 2000, Renzetti 2002). In fact, increases in water price are sometimes associated with increases, rather than reductions, in water use in the following years. According to Baumann *et al.*, (1998), such casual observations fail to recognize that water use may increase in response to changing weather, population and housing.

Domestic water-demand management may help to reduce water shortages, and lessen the growing pressure on the environment. Moreover, it may reduce the necessity for the construction of major infrastructure, reducing the need for new investments, and decreasing costs (Corbella and Saurí, 2009). For this reason, a deep knowledge of the behavior of household users in relation to water consumption is crucial for policy makers and water utilities managers. Exploring the determinants of water consumption requires consideration of the effects of tariffs and income, but also of many other factors, such as weather conditions, geographical or population characteristics, and household features.

Beyond the traditional variables analyzed in the litreature (weather, geographical location, household features), scant attention has been dedicated to variables, such as water utilities ownership, that could affect household water consumption (Kallis, Ray, Fulton, McMahon, 2010 and Barrett, Wallace, 2011). Further research is needed on the role of utility ownership because, as (Saurì, 2013) argues, it remains unclear whether

changes in governance toward a larger presence of non-public actors have by themselves led to improved water-conservation practices and, therefore, to reductions in water consumption. This lack of clarity is due to the fact that reductions in water consumption seem to affect cities with different systems of water ownership and management.

Domene and Saurì (2006) demonstrated that consumer behavior was an important explanatory factor in household water consumption, albeit to a lesser extent than other variables socio-demographic and economic variables, such as house type and income). Nieswiadomy 1992, Michelsen *et al.,* 1999, Hurd 2006, Lee *et al.,* 2011 and March *et al.,* 2013 found a discernible influence of the existence of water-conservation programs on water demand. Nauges and Thomas 2000 reported that residential water consumption was significantly lower when individual housing with meter recording was present, and they thus encouraged the installation of water metering in collective housing.

Similarly, Fielding *et al.*, (2013) analyzed 221 households fitted with smart water meters and demonstrated that interventions (water-saving information alone, water-saving information, as well as a descriptive norm manipulation, and water-saving information, as well as tailored end-user feedback) led to significant water savings. However, long-term household usage data has demonstrated that in all cases, the reduction in water use resulting from interventions eventually dissipated, with water consumption returning to pre-intervention levels after approximately 12 months.

2.5.1 Price of Water

Demand theory states that, as the price of a good increases, the demand for that good, *ceteris paribus*, decreases (Zekri and Dinar, 2003; Froukh, 2001). Therefore, it is expected that price will negatively influence the quantity of water use from purchased

sources. According to the U.N.'s Millennium Development Report of 2005, the urban population was projected to exceed the rural population in developing regions of the world. A market that operates under competitive conditions, the price of water would be determined by the interaction of demand and supply to reflect the actual marginal costs of water usage. This price will induce users to purchase the optimum quantity of water.

The economic characteristics of the water sector, in combination with the fundamental social perception that water is a socially sensitive good related to human existence and health, led to a strict administrative framework for the operation of the water supply sector and hence of the water market (OECD, 1989). To enable marginal pricing, metering is critical. Without metering it is impossible to track household water consumption and test the effectiveness of other demand management actions, especially prices. Eventually, as Gaudin (2006) argues, information is also important for the citizen, as the lack of transparency and detail in price information is a possible factor contributing to low price elasticity in water demand.

Moreover, household price responsiveness may not only vary depending on income but it may also vary seasonally, for example, increasing the responsiveness during summertime (Renwick and Green, 2000). The essential logic is that higher water prices lead to lower consumption (Shaw, 2005), which makes sense if water is treated as a pure economic good. However, as Savenije (2002) notes, water is far from behaving as a normal economic commodity as for most uses water is irreplaceable. Most of economists working on domestic water generally recognize that domestic water consumption tends to be price-inelastic which means that the decrease in demand is lower than the increase in price.

For domestic consumption price-elasticity oscillates between 0 and -1, and also may vary over time (Arbues *et al.,* 2003; Hoffmann *et al.,* 2006; Martinez-Espineira and Nauges, 2004; Mazzanti and Montini 2006; Renwick and Green. 2000; Savenije and Van der Zaag. 2002). Scholars working with domestic water consumption models have proven that, in general, the price elasticity of water demand varies according to the use given (Billlings and Aghte, 1980; Thomas and Syme, 1988). The more basic and essential use is, the closer to zero the price-elasticity of this demand will be.

As a result, price mechanisms would not make a great difference in the demand for those quantities of water (Dalhuisen *et al.,* 2003; Renwick and Green, 2000). Contrarily, when dealing with water-related leisure activities such as watering the garden or making use of swimming pools, price-elasticity of the demand approaches -1. This information is critical to set pricing schemes in order to balance equity with efficiency and to achieve the greatest conservation potential in outdoor uses while not translating the conservation burden to essential uses (Renwick and Green, 2000).

In addition to the variation of elasticity that follows the use given to water, Martínez-Espiñeira and Nauges (2004) demonstrate that the water demand function presents different elasticity for different levels of consumption in different price ranges. A great deal of economic litreature has specifically focused on water pricing schemes and several price mechanisms approach has been proposed (Bar-Shira *et al.,* 2006; Dalhuisen and Nijkamp, 2002); García-Valiñas, 2005; Kulshrestha, 1996; Martínez-Espiñeira, 2002a; Nieswiadomy, 1992; Nieswiadomy and Cobb, 1993). Thus, moving from a uniform to an increasing block structure tariff can significantly impact demand (Whittington, 1992).

Other authors point out that progressive block structures may increase revenue instability for the water utility. This may be corrected by introducing some kind of fixed fee in the bill independent of the water consumed (Dandy *et al.,* 1997; Taylor *et al.,* 2004). There is usually no water in Kibera slums and only one tap that ought to provide water to a thousand residents is available. Water from that one tap is not even enough for everyone. Women spend the whole day and night queuing to get some water and even sometimes they end-up going home with empty containers (Dalrymple *et al.,* 2002). Women face problems with water accessibility, cost and quality. They also have inadequate access to water points, which are often located far from their houses. The landlords also ratio water such that it is only available on specific days of the week and at specific times (Nyamongo *et al.,* 2004).

2.5.2 Household Income

Water use practices and willingness to pay for water services in urban areas depend highly on household income. A fee on public taps is advisable because water for free leads to less sustainability, does not give any incentive for the distributor to expand networks, and might therefore, be a bad policy for the poor overall (Minten *et al.*, 2002). For those organizations and individuals charged with service delivery in urban areas, a key challenge will be keeping up with the rapid pace of urban population growth.

It is widely accepted and empirically demonstrated, that domestic water consumption is positively correlated with income (Arbues and Villanua, 2006; Arbues *et al.,* 2003; Gaudin *et al.,* 2001; Hoffmann *et al.,* 2006; Renzetti, 2002). Importantly, this variable, being a proxy of affluence, affects water consumption in different ways. On one hand, higher levels of income may increase in living standards, which could imply a higher quantity of water-consuming appliances and a higher probability of the presence of

high-water demanding outdoor uses such as lawn gardens and swimming pools (Cole, 2004).

Domene and Saurí (2006), analyzing domestic water consumption in Barcelona's metropolitan region, argued that the income effect is more evident when outdoor uses exist. Garden watering reflects to a large extent household income and class (Domene, *et al.,* 2005). On the other hand, income importantly affects the responsiveness to price mechanism. Thus, while low income families may not respond to price because they are using water mostly to fulfill basic needs, well-off individuals or households fail to respond because the price signal is not strong enough to curb their consumption (Renwick and Green, 2000).

The literature has shown a positive relationship between wealth and water use (Sandiford *et al.,* 1990). It is assumed that poverty negatively affects water use because poor people cook less and often have less clothing to wash. In this study, household asset expenditure is used as a proxy for wealth. In fact, the economic development literature supports the notion that, when dealing with household surveys in developing countries, household expenditure is a better proxy for household welfare than income (Deaton 1997).

The extreme case could be found where piped water supply is not available (slums in Third World cities and rural poor regions in which Kibera Slum is not an exception) and water vendors sell pricey water to the citizens. This suggests that a conservation campaign based on price mechanisms may probably achieve larger reductions in domestic demand in lower income zones than in higher income communities (Hajispyrou *et al.,* 2002). In turn, questions about equity and distribution of the environmental burden among citizens may appear in this process.

2.5.3 Occupation of Household Head

According to Whittington (2009), there is a large group of households who live in the expanding slums of cities throughout the developing world earning incomes of less than 150 US dollars per month. Many households currently have neither private piped connections nor the income to obtain them. The households, water planners need a better understanding of both (a) the factors that determine households' water source choice decisions, and (b) the quantity of water used, so that piped services can be offered to the minority of households that can afford them, and other households can be served by cheaper, more basic levels of service.

The household head's occupation significantly determines the amount of domestic water use, but the magnitude of the impact depends on the type of activities (Acharya and Barbier, 2002). It is hypothesized that farming households will use less water than non-farming households. In densely crowded slums, there are often large benefits associated with improved sanitation. As improved sanitation is crucial for public health, improvements in water supply must compete with sanitation investments for the limited public subsidies. The challenge is to design tariffs and subsidies so that the basic needs of all households can be met.

2.5.4 Household Size

The household is increasingly seen as a key unit of inquiry to analyze changing socio-demographic structures (Buzar *et al.*, 2005) and may become also a key scale in environmental and resource analyses. The household size, i.e. the number of people living in a household, influences water consumption in different ways (Arbues *et al.*, 2003; Nauges and Thomas 2000, Renwick and Green, 2000; Zhang and Brown, 2004). The changing structures and ways of living have two main and interrelated implications

as (Lux 2008) points out that the decrease in the numbers of members living in the household and the increase in the number of households.

In principle, the higher the number of people living in a household is, the larger the aggregate demand is supposed to be. Nonetheless, economies of scale regarding the optimization of water use could not be generally achieved in small households (Arbues *et al.,* 2000). In addition, Arbues *et al.,* 2003) argue that, there is an optimum household size beyond which these economies of scale tend to vanish. On the other hand, the increasing number of small households intensifies the effect of inefficient water use in small households (Hummel and Lux, 2007; Lux 2008).

In general terms, the western world has been (and still is) undergoing a second demographic transition (Ogden and Hall 2004). For instance, a general phenomenon occurring throughout urban regions of the developed world is the decrease in the number of people in the household (Ogden and Schnoebelen, 2005), and more specifically the increase in the number of people who live alone (Chandler et al. 2004), especially non-retired people. The use of water for domestic purposes depends on the size of the household, a factor that affects how water is consume. Furthermore, people in the study area can only collect a fixed quantity of water in order to allow everybody to have at least a small quantity of water. Conclusively, there will be a negative relationship between the two.

2.5.5 Age Structure

The age structure of a given population is another relevant driver of domestic water consumption (Murdock *et al.,* 1991). Though there are not many studies on ageing and resource consumption, it seems that older people tend to spend less water per capita than the young. Moreover, families with children or teenagers can be expected to use

more water, principally related to outdoor uses, as elements of the built environment such as swimming pools are largely targeted for them.

Nauges and Thomas (2000) suggest that older people may show more saving attitudes and the young might use water less carefully, have more showers, and demand more frequent laundering and Kibera informal settlement is not an exception. Shove (2003) and Binet *et al.,* 2006), similarly argue that the elderly are not generally used to the comfort conditions of 21st century. Finally, due to the generally lower incomes of elderly, Nauges and Reynaud (2001) argue that, they are more vulnerable to water price mechanisms. The research therefore, establishes the effect of age of household on the water demand in Kibera informal settlement.

2.5.6 Education

Education is argued to be related to environmental consciousness and awareness (Syme *et al.,* 1991; Syme *et al.,* 2000). In what concerns water, this could be translated in the purchase of water conserving appliances or the planting of drought-tolerant garden species (Geller *et al.,* 1983). However, few studies deal with the influence of people's education in water use (Howarth and Butler, 2004). Water conservation in the context of attitudes towards environmental issues in general has been examined (Gilg and Barr 2006).

It is expected that, as the level of education increases among household members, the level of household awareness about the health benefits of water use (quantity and quality) also increases (Keshavarzi *et al.,* 2006; Sandiford *et al.,* 1990). It will be hypothesized that education level positively affects the level of water demand. As a proxy for education level, this study used the education level of the household head.

This variable accounts for not only the education level of the household's head, but also those of other household members, including the wives.

2.6 Summary of Literature Review

In most developing countries, the quality of datasets on residential water consumption often poses a problem for demand estimation, especially as metering is not common. In contrast to developed countries, where almost all households obtain water from the utility through a piped network, the market for residential water demand in many developing countries shows much more variation. As a result, policy decisions are often not very well informed; it is usually assumed that residential water demand in developing countries mirrors those of developed countries (Basania *et al.,* 2008).

Households may have a connection to the piped network and use water exclusively from their private tap, but they may also combine piped water with water collected from wells, public taps, or purchase water from vendors; or they may have no connection and rely exclusively on non-piped water. Little is known about households' behavior in developing countries with Kenya not an exception regarding the factors driving their choices and in particular the substitution or complementary relationships between households' water demand from different sources and its determinants.

2.7 Conceptual Framework

The conceptual framework provides an illustration of independent and dependent variable. The dependent variable was water demand achieved by looking at water sources and the quantity of water demanded. In the study the dependent variable was the water demand. Independent variables were age, gender, income, occupation, price, education and household size. The water demand was determined from the primary water source, the quantity of water consumed in litres per day, its frequency and

reliability for family use. The price is the cost paid on the water consumed in litres per month.

The education of the respondents was the highest education of the household head. The age of household head was considered as one of the independent variables. The gender of the respondent is the state of the household head being male or female. The household size was the number of children and adults of the household. The income was the amount of revenue earned by the family members in Kenyan shillings. The household occupation is the type of activities the respondents engage in to earn a living. This is shown in the Figure 2.1.

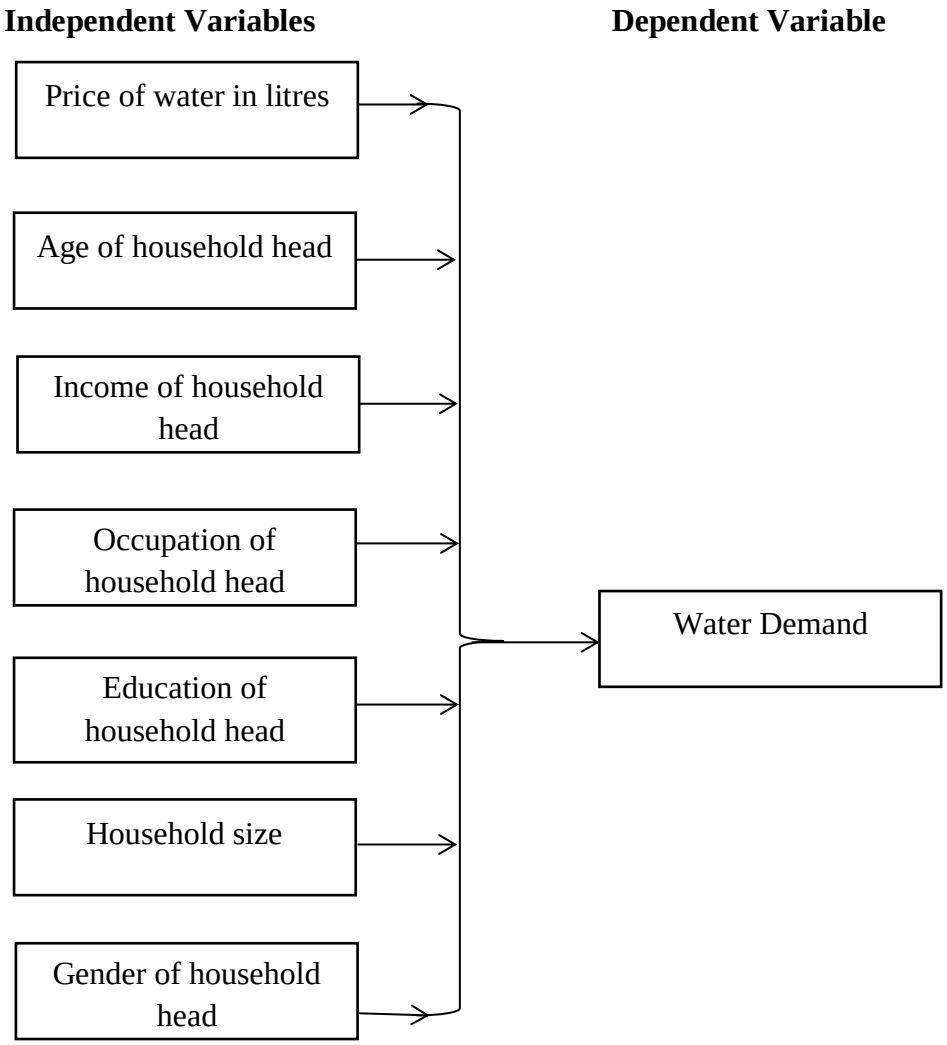

Figure 2.1 Conceptual Framework
Source: Author, 2019

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The aim of this chapter is to provide an understanding of the research methodology applied in the study. This chapter concerns the various steps that facilitated the execution of the study to satisfy the objectives of this study. These steps included the research design, population of interest, data collection instruments and procedures and data analysis

3.2 Study Area

This research was performed in Kibera. Kibera, situated 5.8km South West of Nairobi. It has been quoted as the second biggest slum in the entire Africa with an official estimated population of approximately 200,000 inhabitants living on 256 hectares of land (GOK, 2009). This official estimate is contested, however, with many unofficial estimates placing the population between 500,000 and 1,000,000 (Robbins, 2012; Warah, 2010). The 2009 Kenya Population and Housing Census reported Kibera's population as 170,070 (Muchiri 2010*).*

The area was originally traditional Maasai grazing land, which was turned into a Kings African Rifles (KAR) military reserve camp and, in 1945 at the end of World War II, was subsequently allocated as a temporary settlement to people of Nubian descent who had served as porters for the KAR during the period between 1912 and 1928 (Mukua, 2011). In 1992, the settlement was transferred to the local authorities. The settlement comprises of 12 villages: Lindi, Makina, Gatuikira, Kisumu Ndogo, Silanga, Raila and Gichinjio a few to mention (UN-Habitat, 2004).

Kenya has a great water shortage. The Kibera residents rely on various sources of water including piped water, boreholes and the polluted Nairobi River. Drinking water is pumped through plastic pipes alongside sewage trenches (Karanja *et al.,* 2002). The lack of access into the community makes the provision of such vital urban services like health, water/sanitation facilities, and solid waste collection and management difficult.

3.3 Research Design

The research applied quantitative explanatory research design with hypotheses tested by measuring the relationships between variables. These quantitative research techniques included identifying causal and effect relationships between variables (Maxwell and Mittapalli 2008). This enabled the researcher to collect quantitative data from various residents from the Nairobi County informal settlement in Kenya to the determinants of water demand in Kibera informal settlement in Nairobi County.

3.4 Target Population

The population is an aggregate of all that conform to a given characteristic. It is a group of individuals taken from the general population who share common characteristics and can be used to generalize certain phenomena found in informal sector. A population of 15,000 residents of Kibera informal settlement was targeted (KNBS)

3.5 Sampling Procedures and Sample Size

The research used stratified sampling approach. Stratified random sampling was appropriate as it enabled the researcher to cover not only the overall population but also to divide them into key sub-groups of the population up to ward level. Stratification helped to reduce standard error by providing some control over variance and also provided a better comparison across strata (Saunders *et al.,* 2007).

Simple random sampling technique was used to select the informal settlement households from each stratum in the study area. Simple random sampling was used so that each respondent has an equal chance of inclusion in the sample. It was appropriate because the entire population is relatively large and diverse. Using Yamane's (1972) sample size, e= 0.5,

$$\mathbf{n} = \frac{N}{1 + N(e)^2} \quad \text{..........} \quad (3.1)$$

Whereby;

n is the size of the sample,

N is the size the population,

e is error of the acceptance sampling

$= 15000/1+15000(.05)^2$

= 15000/1+37.5

= 15000/38.5

= 390 respondents

From the target population of 15,000 a sample size of 390 respondents was selected.

3.6 Research Instruments

3.6.1 Questionnaire

A questionnaire was preferred in the study for collecting information from informal settlement residents on their water demand. It had an advantage of obtaining standard responses to items, making it possible to compare between sets of data. It allowed the participants to give their own opinion on the issue at stake (Matthews and Ross 2010).

The questionnaire was designed to address specific aims. Closed-ended as well as open-ended questionnaires were administered to respondents sampled for the study. The closed ended questions gave precise information and were intended to generate data for quantitative analysis.

3.6.2 Interview Schedule

The study was able to clarify any queries concerning the questions. A structured interview schedule was also carried out to collect data from employees of Nairobi Water and Sewerage Company. The interview schedule was designed and structured and aligned with research objectives to generate qualitative data.

3.7 Piloting of Research Instruments

A survey was done using pilot-test of the instrument to determine how reliable and valid the instrument of the study was. Orodho (2008), posits that a pilot study is necessary for testing the reliability of data collection instruments and to refine the questionnaire before the actual data collection. The actual data was therefore, collected after conducting a pilot study in the Kisumu City where the informal settlement like Kibera slum exists.

3.7.1 Validity of Research Instruments

During questionnaire development, various validity checks were conducted to ensure the instrument was appropriate for what it was supposed to capture or measure. There are three important approaches to assessing measurement validity: content validity (also referred to as face validity), construct validity and criterion validity. To ensure content validity, discussions were held with experts during the instrument formulation stage. Face validity of the instruments was achieved by giving them to experts to obtain

suggestions for modification. The study observed this to ensure that the instruments provide adequate coverage of the study concepts.

Construct validity was maintained through anchoring of the constructs to the theory from which they were derived. Before the research was conducted, individual discussions were held with key informants such as experts in the water supply offices, Nairobi county administration and other knowledgeable experts, who are responsible for supplying water. These discussions helped to make modifications to some of the survey questions and assisted to further understand the situation of water demand in the City. Such suggestions were used in making necessary changes.

3.7.2 Reliability of Research Instruments

Regardless of the research procedure used and the method employed, researchers need to critically assess to what extent it is likely to be consistently accurate in measuring what it ought to. According to Orodho (2008), reliability refers to the degree in which the outcome of the research remains consistent throughout. This is made possible by the use of retesting the results.

The questionnaire was given during the pilot study. A reliability coefficient of over 0.7 was found and assumed to reflect the internal reliability of the instruments (Fraenkel and Wallen, 2000). The entire questionnaire deemed as reliable because they were retested and errors found were corrected thus giving confident that the outcome of the study was positive and effective.

3.8 Data Collection Procedure

Before actual data gathering exercise took place, the research undertook a preliminary survey in the water supply offices and Nairobi County administration, to familiarize with the study area and also make appointment with the identified persons. The permit

was presented to the administration of Nairobi County for authorization to conduct the study. The researcher then proceeded to the sub county with the documents to collect data by distributing the questionnaires as well as conducting personal interviews.

3.9 Data Analysis

Immediately after completing data collection, data was cleaned, which involved identification of incomplete responses to improve the quality of the data. Qualitative data was analysed qualitatively using content analysis based on themes emanating from respondent's information and documented data. Quantitative technique was used to understand relationships between different variables. The descriptive statistical analyses that were used included mean, percentages, standard deviation and frequencies. Inferential statistics employed the Pearson product moment correlation and multiple regressions to analyze relationship between variables. Pearson product moment correlation was used to establish the determinants of water demand in informal settlement. It was appropriate to use the technique since the data used was of interval scaled variables. The multiple regression analysis was used to explain the extent to which determinants that is, price, age, gender, education, household size, income and occupation (independent variables) explains the variation in water demand (dependent variable).

3.9.1 Specification of the Model

For this study, standard multiple regression models for the water demand was employed. Standard multiple regression analysis estimates the coefficients of the linear equation involving multiple independent variables, that best predict the value of the dependent variable (Greene, 1990). Linear demand functions are often chosen because of their ease of estimation (Nauges and Martinez-Espineira, 2004). However, they do not yield constant elasticity at all points of the demand function.

The model specification is given by the form:

$$D = \beta_o + \beta_1 P + \beta_2 A + \beta_3 G + \beta_4 E + \beta_5 Hs + \beta_6 I + \beta_7 Occ + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.1$$

Where;

D = Water demand (Quantity of water consumed in litres)

P= Price per litre of water (Ksh)

A= Age (Years)

G= Gender (male =1 female=2)

E=Education (Primary, Secondary, Tertiary, University)

Hs= Household size (number)

I= HH income per month (Ksh)

Occ= Occupation (Employed, Not employed)

β_o =α constant

ε= is error term

β_1- β_7 = Coefficients of parameters to be estimated

The demand model using Stone-Geary functional form, proposed that households could not reduce their water consumption to zero. Stone-Geary gives estimates of price elasticity that increase with income but decrease with price and quantity. For this reason, the Stone-Geary functional form has two main advantages over Cobb- Douglas; it allowed for non-constant price elasticity and it considers that water consumption includes two components: a fixed quantity that cannot be adjusted immediately after a price increase and a residual that can adapt instantaneously. This allowed us to establish a minimum water use threshold below which water consumption is insensitive to price changes.

Moreover, while Stone-Geary has been used widely to analyze private consumption patterns for food, energy, transportation, and labor, only three studies apply it to the water sector (Al-Quanibet and Johnston, 1985; Gaudin, Griffin and Sickles 2001 and Nauges and Martinez-Espineira, 2004). This was particularly true given the debate around whether policies aimed at reducing water consumption should use price or non-price methods.

Let Q_w *and* Q_z *be* demands for water and all other goods respectively, while *Pw* and *Pz* *are* unit prices. γw and γz are minimum amounts (subsistence level) and βw and βz are preference parameters (marginal budget shares) and *I* is income (Nauges and Thomas. (2000).

The Stone-Geary utility function:

$$U = \beta_w \ln (Q_w - \gamma_w) + \beta_z \ln (Q_z - \gamma_z) \quad \text{.....3.2}$$

Where

$\beta_w > 0$, $\beta_z > 0$, $\beta_w + \beta_z = 1$, $(Q_z - \gamma_z) > 0$ and $(Q_w - \gamma_w) > 0$, $\beta_w > 0$, $\beta_z > 0$, $\beta_w + \beta_z = 1$, $(Q_z - \gamma_z) > 0$ and $(Q_w - \gamma_w) > 0$

Normalizing the price of the aggregate goods to one result following budget constraint:

$$I = Q_w P_w + Q_z$$

The dependent variable, monthly average household water quantity is calculated by dividing monthly total residential water quantity by total number of residential connections for each household. Marginal price measures the changes in the price of the final units of water purchased by the consumer and is calculated for each sub county and month from the rate schedules for the relevant period and the average water

quantity. Assuming people purchase lower volumes of water as price increases, the expected sign is negative.

Most of the models that are employed in residential water demand study both in the developed and developing countries are regression models. They typically use the form Q=f (P, Z) where P is the price variable and Z are factors or arrange of shifters of demand such as income, household demographics and other characteristics such as weather variables (Arbues *et al.,* 2000). This implies that the water demand equation included a relevant set of exogenous variables, and the estimated coefficients from this model indicated elements of both water demand and the likelihood that the household had piped water.

The log-log functional form provides direct estimates of the respective elasticity of the independent variables with respect to the dependent variable. The semi-log function is often used to compare the results with the linear and log-log functions (Garcia *et al*., 2001). As there is no *prior* basis for choosing a functional relationship, the model is provided with the options to analyze water use/demand using three popular functional forms as follows:

Linear model:

$$Y = b0 + b1\,(X1) + b2\,(X2) + b3\,(X3) + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + bn\,(Xn) \quad (3.3)$$

Log-log model:

$$lnY = b0 + b1\,ln\,(X1) + b2\,ln\,(X2) + b3\,ln\,(X3) + \ldots\ldots\ldots\ldots\ldots\ldots + bn\,ln\,(Xn) \quad (3.5)$$

Where, $b0$ is the model intercept. The values of the parameters of all two functional forms; linear and log-log equations are obtained through multiple regression analysis using excel and SPSS software package.

3.10 Measurement of Variables

The dependent variable is the water demand measured in litres per day. The independent variables comprise age, gender, occupation, education, price of water, income of household head and household size. The gender, education and occupation were the dummy variables. Age was taken to be how old the household head was in years. The price was the cost paid for a litre of water purchased per month. The education of the respondents was measured through identifying the highest education the household head had attained. The gender of the respondent was the state of the household head being male or female. The household size was measured using the number of children and adults of the household. The income was measured using the amount earned by the household head in Kshs. The occupation was the type of activities the household head engage in to earn a living. The price was measured using the cost per unit of water used or utilized by the Household.

Table 3.1:Variables Expected Signs

Variable code	Variable Name	Description/ Measurement	Expected Sign
P	Price	Cost paid for water per litres (Ksh/litre)	(-)
A	Age	How old is the household head (years)	(+/-)
G	Gender	State of household head being male or female	(+/-)
E	Education	The highest education attained by HH.	(+)
Hs	Household size	Number of children and adults in the household	(+)
I	Income	The income was measured using the amount earned by the HH in Kshs	(+)
Occ	Occupation	The activities the household engage in to earn a living.	(+)

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

The current chapter describes the methods applied chapter three to achieve the study objectives. The data analysis was carried based on the goals of the research investigated, interpretations done and conclusions drawn.

The chapter is organized as follows: response rate, descriptive analysis, Pearson product correlation and hypothesis testing and discussion of the results of the research. In this study, both correlation and regression analyses were used as inferential statistics. In order to fit the data into the conceptualized model in the conceptual framework, ordinary regression analysis was chosen since the dependent variable was in ratio scale (Quantity of water demanded per month). The researcher used regression analysis to test the seven null hypotheses. In this section the coefficient of determination (R square) was used as a measure of the explanatory power, to show how the independent variables explain the dependent variable.

4.2 Response Rate

A total of 390 questionnaires were issued from which 332 were filled and returned which represents a response rate of 85.1%. The response rate was considered satisfactory since Nyamjom, (2013) argues that a response rate of 75% was considered excellent and a representative of the population. The success rate was attributed to the self-administration of the questionnaires applied by the researcher from which the intended respondents were pre-notified prior to the date of data collection from which the researcher agreed on the actual date for the data questionnaire administration.

Follow-up calls to clarify queries were made thus enhancing the high response rate. The response rate is represented below;

Table 4.1: Response Rate Questionnaire

	Count	Percentage
Returned	332	85.1
Non-returned	58	14.9
Total	**390**	**100**

Source: Author, 2019

4.3 Descriptive Results

Descriptive statistics like deviation were utilized to summarize the Gender, Education level and Occupation of respondents. Most of the respondents (61.7%) were Male compared to 38.3% Female. The academic levels of respondents were varied; 38.9% had diploma qualification, 35.2% had degree, 20.5% having secondary and 5.4% completed primary education. Many of the respondents had at least a diploma highest level of Education. 26.2% of respondents were not employed, 204(61.4%) were employed and 12.3% were trader or owned business. The findings showed that most of the heads of household heads were either professionals or traders who owned their business.

Table 4.2: Descriptive Analysis Results of Gender, Education and Occupation of Respondents

Variable	Category	Frequency	Percent	Cumulative Percent
Gender	Male	205	61.7	61.7
	Female	127	38.3	100.0
	Total	**332**	**100.0**	
Education Level	Primary	18	5.4	5.4
	Secondary	68	20.5	25.9
	Tertiary	129	38.9	64.8
	University	117	35.2	100.0
	Total	**332**	**100.0**	
Occupation	Employed	204	61.4	61.4
	Not employed	87	26.2	87.7
	Trader/own business	41	12.3	100.0
	Total	**332**	**100.0**	

Source: Author, 2019

Descriptive statistics such as mean and standard deviation were used to summarize the respondent's water demand per day, week and month, income per month for the water used, price of water, household size, Age and dependants as summarized in Table 4.3. The mean water demand/day was 20 litres, weekly 140 litres and monthly was 560 litres. The mean household size in Kibera informal settlement was 3, while the dependants were 3 per household as presented in Table 4.7. The mean household size

of the study was 4 persons and 4 dependants per household. The study findings showed that the mean income of informal settlement was Ksh. 27599.40. The mean age of Kibera informal settlement was 38.404 years. This indicated that majority of the respondents were in their youthful age.

Table 4.3: Descriptive Statistics

	Min	Max	Mean	Std. Dev
Age of HH	20.00	100.00	38.40	18.30
HHsize	1.00	16.00	3.60	3.43
Dependants	1.00	20.00	3.79	3.93
Income	4000.00	200000.00	27599.40	37485.94
Price/litre	0.25	1.00	0.50	0.40
Water demand/day (in litres)	20.00	60.00	45.21	32.30
Water demand/wk. (in litres)	170.00	260.00	180.40	170.01
Water demand/month (in litres)	300.00	1000.00	507.77	632.87

Source: Author (2019)

4.4 Correlation Analysis

The researcher ran the correlation matrix in order to check whether there was association between variables. To achieve this Pearson's correlation was carried out. It was appropriate because all the variables were in interval scale. Correlation coefficient showed the magnitude and direction of the relationship between the study variables as showed in Table 4.4.

Correlation analysis indicates that the explanatory variables Price (r=0.805), and Income (r=0.772) had positive correlation with variable water demand. However, Age (r=-0.134 had negative correlation with water demand in informal settlement. There

was no significant influence of household size (r=0.007, p=0.893) and water demand in informal settlement. The correlation analysis indicated that the explanatory variables: Price and Income positively influenced Water Demand in informal settlement. However, Age negatively affects water demand in informal settlement. Household size had no significant effect on water demand in informal settlement.

Table 4.4: Correlation Analysis

	Collinearity Statistics						
	Tolerance	**VIF**	**1**	**2**	**3**	**4**	**5**
1. Demand			1				
2. Age	.646	1.548	-.134*	1			
3. HHsize	.782	1.278	-.007	.208**	1		
4. Income	.140	7.133	.772**	.104	.040	1	
5. Price	.131	7.637	.805**	-.181**	.001	.553**	1

Source: Author (2019)

4.5 Multicollinearity

Multicollinearity occurs when several independent variables correlate at high levels with one another (Keith, 2006). The more variables overlap (correlate) the less able researchers can separate the effects of variables. Tolerance measures the influence of one independent variable on all other independent variables. Tolerance levels for correlations range from zero (no independence) to one (completely independent) (Keith, 2006).

When a predictor variable has a strong linear association with other predictor variables, the associated VIF is large and this is evidence of Multicollinearity (Shieh, 2010). The rule of thumb for a large VIF value is less than ten (Keith, 2006; Shieh, 2010). Small values for tolerance and large VIF values show the presence of multicollinearity (Keith,

2006). Tolerance and Variance Inflation Factor (VIF) statistics were used to carry out the diagnosis to test whether there was collinearity as shown in Table 4.4.

The results of the multicollinearity revealed that the tolerances coefficients ranged from 0.140 to 0.871 and VIF scores ranged from 1.15 to 7.64. The results indicated that tolerance and VIF were within normal bounds, indicating multicollinearity was not present among the explanatory variables.

4.6 Estimation of Water Demand Model

The initial effort to examine the relationships proposed by the research model involved conducting multiple regression analysis. Multiple regression analysis analyses the relationship between a single dependent variable and several predictor variables (Hair *et al*., 2006). The regression coefficient summary was then used to explain the nature of the relationship between the two variables. To determine the factors that influence water demand the researcher used multiple regression analysis for overall hypothesis.

The F-test was used further to determine the validity of the model, while R squared was used as a measure of the model goodness of fit. The independent variables were entered to the regression analysis at the same time using the entry method. Multiple regressions were used to assess the ability of independent variables (price, size, occupation, age, gender, education and income) to predict the dependent variable (water demand). The value of the R^2 indicates how much of the variance in the dependent variable (water demand) is explained by the model. The explanatory variables in the model explain 84.3 percent of the variance in water demands (Table 4.5). According to the guidelines provided in Pallant (2010), this is a respectable result for household-level cross-sectional data.

The regression model with (price, size, occupation, age, gender, education and income) as a predictor was significant. (F=247.71, p value =0.000) shows that there is a significant relationship between determinants and water demand. The age and household size had a negative relationship as summarized in the model as:

$D = 0.013 - 0.542X_1 + 0.456X_2 - 0.191X_3 - 0.091X_4 + 0.105X_5 - 0.087X_6 - 0.079X_7$……...……....Equation 4.1

Where:

D = Water demand; X_1= price; X_2= income; X_3= education; X_4= Age; X_5= Gender; X_6=HH size; X_7= Occupation.

Variables age ($\beta 1$ = -0.091, P=0.000); household size (β_2 = 0.087, P=0.001); income (β_3 = 0.456, P=0.000); price (β_4 = - 0.542, P=0.000); gender (β_5 = 0.105, P=0.000) education (β_6 = -0.191 (P=0.005) and occupation (β_7 = -0.079, P=0.002) had significant relationship with water demand.

The variables gender and income had a positive significant relationship with water demand. This agrees with Renwick and Green, (2000) that income importantly affects the responsiveness to price mechanism. Thus, while low income families may not respond to price because they are using water mostly to fulfil basic needs, well-off individuals or households fail to respond because the price signal is not strong enough to curb their consumption. The results also concur with those of Cole, (2004) that higher levels of income may increase in living standards, which could imply a higher quantity of water-consuming appliances and a higher probability of the presence of high-water demanding outdoor uses such as lawn gardens and swimming pools.

Table 4.5: Water Demand Coefficients

Variable	Linear model	Log-log
Price	-0.542 (.029)**	-0.537 (0.059)**
Income	0.456 (.029) **	0.074 (0.077)**
Education	-0.191 (025) **	
Age	-0.091 (.026) **	-0.299 (0.195)**
Gender	0.105 (.027) **	
Household size	-0.087 (.025) **	0.017 (0.092) **
Occupation	-0.079 (.025) **	
Constant	0.013 (1.000)	4.555 (0.833) **
R^2	0.843	0.222
Adjusted R^2	0.839	0.213
Sample size	332	332
F-value	247.71	23.39

** indicates significance in two-tailed t-test at p=5%, (Standard errors are in parentheses)

Source: Author (2019)

The findings showed a negative relationship between price (β_1 = -0.542, P=0.000) and water demand in informal settlement. Increase in price of water leads to a decline in water demand in informal settlement. The price of water had a significant effect on water demand in informal settlement. Therefore, an increase in price of water led to a significant decline in demand of water in informal settlement by 54%. This agrees with Martínez-Espiñeira and Nauges (2004) findings on the inverse and significant relationship between price of water and water demand.

The study hypothesized that there is no significant influence of household size on water demand in informal settlement. There was negative significant relationship of

household size and water demand in informal settlement (β_2= -0.087 and p value <0.05). Household size has a significant influence on water demand in informal settlement. Such that an increase in the household size by one member will lead to a decrease in aggregate water demand by the household. Similarly, the increasing number of small households intensifies the effect of inefficient water use in small households (Hummel and Lux 2007; Lux 2008). In principle, the higher the number of people living in a household is, the larger the aggregate demand is supposed to be (Arbues *et al.,* 2003).

This result agrees with (Arbues *et al.,* 2003; Nauges and Thomas 2000, Renwick and Green, 2000; Zhang and Brown, 2004) that the household size, which is the number of people living in a household, influences water consumption in different ways. The changing structures and ways of living have two main and interrelated implications as (Lux 2008) points out the decrease in the numbers of members living in the household and the increase in the number of households. Also agrees with Keshavarzi *et al.,* (2006) and Froukh (2001) that both household size and composition affect water use, and moreover, household size has been found to be the most important factor affecting water consumption.

There was a positive significant relationship between gender and water demand in informal settlement (β_3= 0.105 and p value<0.05). This implies females demand for water is 10.5% more compared to water demanded by males in informal settlement of Kibera. Female-headed households will use higher daily per capita water consumption than male-headed households (Zhang and Brown, 2004). Thus, only alternative hypothesis was important

The findings indicated that there was a positive significant relationship between income (β_4 = 0.456, P=0.000) and demand of water in informal settlement. Therefore, an

increase in income led to rise in demand of water in informal settlement. The alternative hypothesis accepted. In summary, income had a significant relation with demand of water in informal settlement. This agrees with (Arbues and Villanua, 2006; Arbues *et al.*, 2003; Gaudin *et al.*, 2001; Hoffmann *et al.*, 2006; Renzetti 2002) that it is widely accepted and empirically demonstrated, that domestic water consumption is positively correlated with income.

There was a negative and significant key relation between education and water demand in informal settlement (β_5= -0.191 and $p<0.05$). Those who are more educated tend to demand less water by 19.1% compared to the less educated 9n informal settlement of Kibera. Similarly, the alternative hypothesis was acceptable. Therefore, education had a negative significant effect on water demand in informal settlement. Also concurs with Keshavarzi *et al.*, (2006) that, as the level of education increases among household members, the level of household water efficient usage increases.

The study hypothesized that there is no significant influence of age (β_6 = -0.091, P=0.000) on water demand in informal settlement. A negative relation between age and water demand in informal settlement was found. An increase in age of respondent led to a decrease in water demand in informal settlement. This showed that the more the respondents grow old the water demand decrease in the household. Therefore, age had a significant negative influence on water demand in informal settlement. This agrees with Nauges and Thomas (2000) that older people may show more saving attitudes and the young might use water less carefully, have more showers and demand more frequent laundering and Kibera informal settlement is not an exception.

There was significant negative relationship between occupation (β_7 = -0.079, P=0.002) and water demand in informal settlement. Therefore, those who are not employed tend

to use water sparingly by 7.9% compared to residents who are employed. Alternative hypothesis was considered here. Occupation had a significant influence on water demand in informal settlement. This agrees with Acharya and Barbier (2002) that household head's occupation significantly determines the amount of domestic water use, but the magnitude of the impact depends on the type of activities.

The log-log analysis with price, income, gender and occupation reveals that these variables are significant ($p<0.05$) and these variables together in the model can explain 22.2% variation in water demand (Table 4.5). The elasticity of water demand with respect to the price is 0.537 indicating that a 1% increase in the price of water will result in 53.7% increase in the water demanded. The relation of age to the water demand is found to be negative, indicating the decrease in supplied water use with respect to increase in age of household head. The price elasticity of water is found to be −0.299. This implies that water demand will decrease by 29.9% as one ages. This result is obvious because older people tend to use water efficiently and their usage decline with their age.

The analysis also shows that the water use is increasing with the income of household head. The elasticity of water use in the Kibera slum with respect to income is 0.074. This can be interpreted as the increase in water use with the overall increase in the income of the household head. The elasticity of water demand with respect to the household size is 0.017 indicating that a one member increase in the household size will result in 1.7% increase in the water demanded. This indicated an increase in water use with respect to increase in household size. From Log-log results the income, price, age and household size are the four variables found to be capable of explaining the water demand in the area under study.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This is the last chapter and it aims at giving a general overview of the entire study by presenting a brief discussion and possible recommendation to solve the problem under discussion. Recommendations as well as suggestions for further research.

5.2 Summary of Findings

The core purpose of carrying out this study was to determine the factors affecting the water demand in Kibera informal settlement. Specifically, it sought to establish; impacts of price, household size, gender, income of household head, education, age and occupation on water demand in informal settlement of Kibera slum in Nairobi County.

Determining the effect of price on water demand in the area under study was the key goal of this task. A negative relationship between the two was found in informal settlement (β=-0.542, p =0.00). A decrease in price led to an increase in demand for water in informal settlement. There was a negative and significant relationship between price and water demand in informal settlement. Increase in price of water led to a drop in water demand in informal settlement.

Another goal was to determine the effect of household size on the need of water in the area. At the end of the study, it was concluded to be negative (β = -0.087, p =0.000) on demand for water in informal settlement. The mean household size was 4 persons and dependants per household. Household size had a negative and significant influence on the demand for water in informal settlement. Household size had negative significant influence on water demand in informal settlement.

A positive result was obtained on the relationship between gender and the demand for the water in informal settlement ($\beta = 0.105$). Most of the respondents 61.7% were male compared to 38.3% female. There was a significant and positive relationship between gender and water demand in informal settlement. Female-headed households will use higher daily per capita water consumption than male-headed households.

The influence of income of household head on water demand in informal settlement had a positive relation in informal settlement ($\beta = 0.456$, $p = 0.00$). The mean income of informal settlement was Ksh. 27599.40 There was a positive significant relationship between income and demand for water in informal settlement. Income had a significant relationship with demand for water in informal settlement.

The academic levels of respondents were varied; 38.9% had diploma qualification, 35.2% had degree, 20.5% having secondary and 5.4% had primary education. Majority of the respondents had at least a diploma highest level of Education. A change in education leads to a decrease in water demand in informal settlement. Education negatively affected water demand in informal settlement ($\beta = -0.191$ and $p<0.05$).

The sixth objective of the study was to establish the effect of age on water demand in informal settlement of Kibera slum in Nairobi County. The mean age of respondents from Kibera informal settlement was 38.40 years. Majority of the respondents were in their youthful age. There was a negative significant relationship between age ($\beta = -0.091$ and $p<0.05$) and water demand in informal settlement. An increase in age of respondent led to a decrease in water demand in informal settlement. This showed that the more the respondents grow old the water demand decreases in the household.

The academic levels of respondents were varied; 204(61.4%) were employed, 26.2% not employed and 12.3% were trader or owned business. Majority of the heads of HHs

were either professionals or traders owning business. There was a significant negative relationship between occupation (β= -0.079 and $p<0.05$) and water demand in informal settlement. An increase in occupation activities leads to a decline in water demand in informal settlement.

The β- coefficients of all the determinants contributed to the approach. The variables gender, income and price had positive significant relationship with water demand. However, age, education, occupation and household size had negative significant relationship with water demand.

The log-log analysis of income, price, age and household size variables are significant at 0.05 significance level and these four variables together in the model can explain 22.2% variation in water demand. The relation of age to the water demand is found to be negative, indicating the decrease in supplied water use with respect to increase in age of household head. The price elasticity of water is found to be −0.299. This implies that water use will be less by 29.9% if age increase.

The analysis also shows that the water use is increasing with the income of house head. There was an increase in water use with the overall increase in the income of the household head. The elasticity of water demand with respect to the household is 0.017 indicating that a member increase in the household size will result in 1.7% increase in the water demanded. From Log-log results the income, price, age and household size are the four variables found to be explaining the water demand in Kibera Slum. Therefore, to predict the water demand in Kibera slum, the forecast of these four variables is mandatory.

5.3 Conclusion

Increase in price of water leads to a drop-in water demand in informal settlement. The cost of water had negative impact on water demand in informal settlement. Household size had negative and significant influence the demand of water in informal settlement.

Gender had positive and significant relationship with demand of water in informal settlement. Female-headed households will use higher daily per capita water consumption than male-headed households.

An increase in income led to rise in demand of water in informal settlement. Education had negative and significant relationship with water demand in informal settlement. A change in the education of respondent led to a decline in demand of water in informal settlement.

Age of residents had negative and significant relationship with water demand in informal settlement. An increase in age led to a decrease in demand of water in informal settlement. There was a significant and negative relationship between occupation and demand for water in informal settlement. Increase in occupation activities among the respondent leads to a decline in demand for water in informal settlement. Occupation had a significant negative effect on water demand in informal settlement.

The variables gender and income had positive significant relationship with water demand in informal settlement while price, age, education, occupation and household size had negative significant relationship with water demand.

The price elasticity of water demand was negative. Since water is a normal good, its consumption in Kibera slum decreases with respect to higher prices. The estimates for the income elasticity of water demand in Kibera slum was positive, thus its

consumption decreases than proportional to higher household income. The elasticity of water demand with respect to the household size was also positive implying that an increase in the household size led to a rise in water demand. However, age elasticity was negative suggesting that water demand in Kibera would respond less to further increase in age of household head.

5.4 Implication of the Findings

Since water demand in the domestic sector is a complex function of different factors which may vary spatially and temporally, planning and management of water supply systems should be a continuous process with due consideration to ever-changing socio-economic conditions, technological changes, improvements in water use efficiency and government policy decisions related to water use and conservation that can affect the use of water by the people. It is therefore suggested that the concerned authorities realize the importance of and give emphasis to the collection of data and information essential to make management modelling a tool for the analysis and development of demand management policies and strategies, which are necessary to address the challenge of water scarcity being faced by many countries.

5.5 Recommendations of the Study

The county government should establish a price policy which corresponds to the water demand in informal settlement. There is need for residents in informal settlement to ensure that their household size uses the water only for the right purpose. There is need for county government to improve the income generating activities in the informal settlement in order for residents to have extra money to pay for the water used and demanded.

There is need for national government to enhance education in informal settlement to enable residents conserve water utilizations. Water planners should give due emphasis in the type of employment of the residents so that these HHs would be served by more cheap and reliable services as water is not only a consumable good but also means of earning livelihood for these HHs. It is, therefore, recommended that Nairobi County should adopt water demand models and elasticity on a regular basis, as developed in the present study, so as to provide more accurate and reliable demand estimates for the future planning and management of water supply systems.

5.6 Recommendations for Further Study

The abovementioned topic under discussion focused only on the effect of price, household size, gender and income of household head, education, age and occupation on water demand in the area under study. Other studies should be carried out in other areas of the society apart from informal settlement. It is recommended that the variables identified as influencing residential per capita water demand in informal settlement should be considered when planning water supply.

Other studies on agricultural, industrial and commercial water demand should be done to estimate the total per capita water demand in formal and informal settlement. There should be extensive and detailed studies done by the Ministry of water and irrigation to have a clear picture of the factors that affect consumers decisions of water source choice and residential water uses at a HH, in order to implement proper demand management strategies and policy options in the face of growing demand for improved water services in the supply sector of informal settlement. It is necessary to conduct further research based on price elasticity for individual data rather than average households in order to

obtain deeper insights of elasticity on the relationship between water consumption patterns, age and other socio-economic and behavioral factors.

REFERENCES

Acharya, G., & Barbier, E. (2002). Using domestic water analysis to value groundwater recharge in the Hadejia-Jama'are floodplain, Northern Nigeria. *Am J. Agric Econ* 84:415 - 426

AICD (2008). Sudeshna B., Heather S., Vivien F., Cecilia B., Elvira M. and Tarik C; Urban Water Supply in sub Saharan Africa, Africa Infrastructure Country Diagnostic.

Al-Quanibet, M., & Johnston, R. (1985). Municipal Demand for Water in Kuwait: Methodological Issues and Empirical results. *Water Resources Res.* 21 433 - 438.

Andersen, M.S., & Sprenger, R. (2000). *Market- based instruments for environmental management politics and institutions*. Cheltenham, UK; Northampton, MA, USA. E. Elgar.

Antonioli, B., & Filippini, M., (2001). The use of a variable cost functions in the regulation of the Italian water industry. *Utilities Policy* 10, 181–187.

Arbues, F. Garcia-Valinas, M., & Martinez-Espineira, R. (2003). Estimation of Residential Water Demand: A State-of-the-art-review. *J. Socio-Econ*. 32 81 - 102.

Arbues, F., Barberán, R., & Villanúa, I. (2000). Water Price Impact on Residential Water Demand in the City of Zaragoza: A Dynamic Panel Data Approach, *40th European Congress of the European Regional Studies Association,* 30-31 August 2000.

Arbues, F.; Barberàn, R., & Villanùa, I. (2004). Price impact on urban residential water demand: A dynamic panel data approach. *Water Resource. Res. 40*, doi:10.1029/2004WR003092.

Arbues, F., & Villanùa, I. (2006). Potential for pricing policies in water resource management: Estimation of urban residential water demand in Zaragoza, Spain. *Urban Stud. 43*, 2421–2442.

Asian Development Bank (1998) (Consultation Draft online). The Banks Policy on Water: Working Paper. Consultation Draft 3.

Babel, M.S., Gupta, A.D., & Pradhan P (2007). A multivariate econometric approach for domestic water demand modeling: an application to Kathmandu, Nepal. *Water Resource Management 21*(3):573-589.

Balling, R.C., Jr., & Gober, P. (2007). Climate variability and residential water use in the City of Phoenix,Arizona. *J. Appl. Meteorol. Climatol., 46*, 1130–1137.

Bapat, J. D., & Desai, S. K. (2003). *In United Nations World Water Development Report* 2. Water a shared responsibility.

Barrett, G., & Wallace, M. (2011). An institutional economics perspective: The impact of water provider privatization on water conservation in England and Australia. *Water Resour. Manag. 25*,1325–1340.

Bar-Shira, Z., Finkelshtain I., & Simhon A. (2006). Block-Rate versus Uniform Water Pricing in Agriculture: An Empirical Analysis». *American Journal of Agricultural Economics*, nº 88, 986-999.

Basania, M., Ishamb, J., & Reilly. (2008). The determinants of water connection and water consumption: Empirical evidence from a Cambodian household survey. *World Development* 36 (5), 953—968.

Baumann, D.D., Boland, J.J., & Hanemann, W.M., (1998). *Urban Water Demand Management and Planning.* New York: McGraw-Hill.

Beattie, B., & Foster, H. (1981) on the specification of price in studies of consumer demand under block price scheduling. *Land Econ.* 57 624 - 629.

Billings, B., & Agthe, D. (1980). Price Elasticity for Water: A Case of Increasing Block Rates. *Land Econ*. 56 73 - 85.

Buzar, S., Ogden, P.E., & Hall, R. (2005). Households matter: the quiet demography of urban transformation. *Progress in Human Geography*, nº 29(4), 413-436.

Chandler, J., Williams, M., Maconachie, M., Collett, T., & Dodgeon, B. (2004). Living alone: its place in household formation and change in *Sociological Research Online*, Vol. 9, Issue 3, 31st August 2004. University of Surrey, the University of Stirling, the British Sociological Association and Sage Publications. Available at http://www.socresonline.org.uk/9/3/ contents.html.

Chicoine, D., & Ramamurthy, G. (1986). Evidence in the Specification of Price in the Study of Domestic Water Demand. *Land Econ*. 62 26 - 32.

Cleaver, F. (1996). Community management of rural water supplies in Zimbabwe, unpublished PhD Thesis, University of East Anglia, Norwich.

Cole, M. A. (2004): Economic growth and water use. *Applied Economics Letters*, 11, 1-4.

Cooper, S. S., & Yoder-Wise, P. S. (2003). Teaching with slides, PowerPoint, and overhead projectors. *The Journal of Continuing Education in Nursing*, *34*(6), 245-246.

Corbella, H.M., & Saurí, D. (2009). What lies behind domestic water use? A review essay on the drivers of domestic water consumption. *Boletín de la Asociación de Geógrafos Españoles*, *50*, 297–314.

Dalhuisen, J. M, Florax, R. J. G. M., de Groot, H., & Nijkamp, P. (2003). Price and Income Elasticities of Residential Water Demand: A Meta-Analysis. *Land Economics* 79 (2), 292–308.

Dalhuisen, J.M. & Nijkamp, P. (2002). Critical factors for achieving multiple goals with water tariff systems: Combining limited data sources and expert testimony. *Water Resour. Res.* 2002, *38*, 1–11.

Dandy, G., Nguyen, T., & Davies, C. (1997). "Estimating Residential Water Demand in the Presence of Free Allowances". *Land Economics*, 73, pp. 125–139.

David, C.C., & Inocencio, A.B. (1998). *Understanding Household Demand for Water*: The Metro Manila Case, EEPSEA

Deaton, A. (1997). *The analysis of household surveys: a micro econometric approach to development policy.* The Johns Hopkins University Press, Baltimore, Maryland.

Deaton, A., & Muellbauer, J. (1980). *Economics and Consumer Behaviour*. Cambridge University Press, Cambridge.

DFID (2000). Strategies for achieving the International Development Targets: Addressing the Water Crisis, Healthier and more productive lives for the people.

Dharmaratna, D., & Harris, E. (2010). *Estimating Residential Water Demand Using the Stone-Geary Functional Form: The Case of Sri Lanka.*

Domene, E., Saurí, D., & Pares, M. (2005). Urbanization and sustainable resource use: The case of garden watering in the Metropolitan Region of Barcelona. *Urban Geography*, V. 26, 520-535.

Domene, E., & Saurí, D. (2006). Urbanization and water consumption: Influencing factors in the Metropolitan Region of Barcelona. *Urban Stud. 43*, 1605–1623.

Espey, M., Espey, J., & Shaw, W.D. (1997). Price Elasticity of Residential Demand for Water: A Meta-analysis. *Water Resources Res*. 33 1369 – 1374.

Fielding, K.S., Spinks, A., Russell, S., McCrea, R., Stewart, R., & Gardner, J. (2013). An experimental test of voluntary strategies to promote urban water demand management. *J. Environ. Management. 114*, 343–351.

Fraenkel, J.R., & Wallen N.E. (2000). *How to Design and Evaluate Research in Education.* (5th ed) New York: McGraw Hill Inc.

Frondel, M., & Messner, M. (2008). Price perception and residential water demand: evidence from a German household panel. *Paper to be presented at the 16th Annual Conference of the European Association of Environmental and Resource Economists in Gothenburg*, Sweden.

Froukh, L.M. (2001). Decision-support system for domestic water demand forecasting and management. *Water Resource Management* 15(6):363-382.

Garcia, A.F., Valinas Garcia, A.M., & Espineria-Martinez, R. (2001). The literature on the estimation of residential water demand. Elsevier Science.

Garcia, S., & Reynaud, A. (2004). Estimating Benefits of Efficient Water Pricing in France. *Resource Energy Econ.* 26 1 - 25.

Garcia, S., & Reynaud, A. (2004). Estimating the benefits of efficient water pricing in France. *Resour. Energy Econ.*, *26*, 1–25.

García-Valiñas, M.A. (2005). Efficiency and equity in natural resources pricing: A proposal for urban water distribution service. *Environ. Resour. Econ.*, *32*, 183–204.

Gaudin, S. (2006). Effect of price information on residential water demand. *Appl. Econ. 38*, 383–393.

Gaudin, S., Griffin, R., & Sickles, R. (2001). "Demand Specification for Municipal Water Management: Evaluation of the Stone-Geary Form. *Land Economics*, 77, pp. 399–422.

Geller, S.E., Erickson. J. B., & Buttram, B.A. (1983). Attempts to promote residential water conservation with educational, behavioral and engineering strategies. *Population Environment*, nº 6, 96-112.

Ghai, D., & Vivian, J. (2014). *Grassroots environmental action: people's participation in sustainable development*. London: Routledge.

Gilg, A., & Barr S. (2006) Behavioural attitudes towards water saving? Evidence from a study of environmental actions. *Ecological Economics*, 57(3), 400-414.

Gleick, P. H. (2003). Water Use. *Annual Review of Environment and Resources,* 28, 275-314.

GOK (2009). Census Kenya: National Bureau of Statistics (2009) Kenya Population and Housing: Census Highlights.

Government of Kenya (GOK) (2005). *National Poverty Eradication 2005-2015*. Government Printers, Nairobi.

Government of the Republic of Kenya (2008). *Kenya Vision 2030: A Globally Competitive and Prosperous Kenya, First Medium-Term Plan 2008-2012*, Nairobi Kenya, GoK Office of the Prime Minister, Ministry of State for Planning also referred to as Kenya Poverty Reduction Strategy.

Greene, W. (1990). *Econometric Analysis*; MacMillan Publishing Company. Hillsdale, NJ.

Gulyani, S., Debrabrata T., & R. Mukami, K. (2005). Water for the Urban Poor: Water Markets, Household Demand and Service Preferences in Kenya. *Water Supply and Sanitation Sector Board Paper Series Paper* No. 5.

Hadjer, K., Klein, T., & Schopp, M. (2005). Water consumption embedded in its social context, north-western Benin. *Phys Chem Earth* 30(6):357-364.

Hajispyrou, S., Koundouri, P., & Pashardes, P. (2002). Household demand and welfare: Implications of water pricing in Cyprus. *Environ. Dev. Econ., 4*, 659–685.

Hanemann, W.M. (1997). Price Rate and Structures. in *Urban Water Demand Management and Planning*, (D.D. Baumann, J.J. Boland and W.M. Hanemann, Ed.), McGraw-Hill, New York.

Hanemann, W.M. (1998). Determinants of urban water use In: Baumann, D.D., Boland, J.J., Hanemann, W.M. (Eds.), *Urban Water Demand Management and Planning.* Mc Graw-Hill, Colorado, pp. 31–75.

Hewitt, J.A., & Hanemann, W.M. (1995). A discrete/continuous choice approach to residential water demand under block rate pricing *Land Econ*. 173 - 192.

Hoffmann, M., & Worthington, A.C. (2008). "An Empirical Survey of Residential Water Demand Modelling". *Journal of Economic Surveys*, 22, pp. 842-71.

Hoffmann, M., Worthington, A.C., & Higgs, H. (2006). "Urban Water Demand with Fixed Volumetric Charging in a Large Municipality: The Case of Brisbane, Australia". *Australian Journal of Agricultural and Resource Economics*, 50, pp. 347–359.

Hoglund, L. (1999). Household Demand for Water in Sweden with Implications of Potential Tax on Water Use. *Water Resources Res.* 35 3853 - 3863.

Howarth, D., & Butler, S. (2004). Communicating water conservation. How can the public be engaged?. *Water Supply*, nº 4, 33-34.

Huchzermeyer, M. (2004). *Unlawful occupation: Informal settlement and urban policy in South Africa and Brazil*. Africa World Press.

Huchzermeyer, M., & Karan, A. (2006). *Informal settlement, a perpetual challenge?* Juta and Company Ltd.

Hummel, D., & Lux, A. (2007). Population decline and infrastructure: The case of the German water supply system. *Vienna Yearbook of Population Research,* 2007, 167-191.

Hurd, B.H. (2006). Water conservation and residential landscapes: Household preferences, household choices. *J. Agric. Resour. Econ., 31*, 173–192.

Isham, J., & Kahkonen, S. (2002). How do participation and social capital affect community- based water projects? Evidence from Central Java, Indonesia. *The role of social capital in development: An empirical assessment* 155-87.

Isham, J., Narayan, D., & Pritchett, L. (1994). Does participation improve project performance? Establishing causality with subjective Data. *The World Bank Economic Review, 9(2),175-200.*

Kallis, G., & Cocossis, H. (2003). Managing Water for Athens: From the Hydraulic to the Rational Growth Paradigms. *European Planning Studies,* 11(3), 245-261.

Kallis, G., Ray, I., Fulton, J., McMahon, J.E. (2010). Public *versus* private: Does it matter for water conservation? Insights from California. *Environ. Manag. 45*, 177–191.

Kenya National Bureau of Statistics (2009). *Economic Survey 2009*. Nairobi. KNBS

Kleemeier, E. (1995). *From supply driven to demand driven provision of rural drinking water. A Tanzanian Case Study of the Arguments for a Transition*. Centre for Udviklings forkning.

Kleemeier, E. (1998). *The operation and maintenance of small rural piped gravity schemes in Malawi*. Center for Development Research, Copenhagen.

Kleemeier, E. (2000). The impact of participation on sustainability: An analysis of the Malawi Rural Piped Scheme Program. *World Development, 28*(5), 929 - 944.

Kombo, D., &Tromp, D. (2006). *Proposal and Thesis writing*. Nairobi: Paulines publications.

Lee, M., Tansel, B., & Balbin, M. (2011). Influence of residential water use efficiency measures on household water demand: A four-year longitudinal study. *Resour. Conserv. Recycl.*, *56*, 1–6.

Lux, A. (2008). Shrinking Cities and Water Supply. in *Population Dynamics and Supply Systems* (Hummel, D., ed.). Frankfurt am Main: Campus, 161-179.

Majale, M. (2003). An integrated approach to urban housing development: Has a case been made? Paper presented at the *World Bank Urban Research Symposium 2003*: *Urban Development for Economic Growth and Poverty Reduction*. Washington, DC, 15-17: 1-14.

Manikutty, S. (1995a). *Community participation in water and sanitation projects: Kerala Case Study*. Available from UNDP/World Bank Regional Water and Sanitation Group, New Delhi.

Manikutty, S. (1995b). *Community participation in Water and Sanitation Projects: Karnataka case study*. Available from UNDP/World Bank Regional water and sanitation group, New Delhi.

Manikutty, S. (1997). Community participation: So what? Evidence from a comparative study of two rural water supply and sanitation projects in India. *Word Development Policy review,15*(2), 115-140.

March, H., Domenech, L., & Saurí, D. (2013). Water conservation campaigns and citizen perceptions: The drought of 2007–2008 in the Metropolitan Area of Barcelona. *Nat. Hazards, 65,* 1951–1966.

Martinez-Espeneira, R. (2003). Price Specification Issues Under Block Tariffs: A Spanish Case Study. *Water Pol.* 5 237 - 256.

Martínez-Espiñeira, R. (2002a). Residential water demand in the Northwest of Spain. *Environ. Resour. Econ.21,* 161–187.

Martínez-Espiñeira, R., & Nauges, C., (2004). Is all domestic water consumption sensitive to price control? *Applied Economics* 36, 1697–1703.

Matthews, B., & Ross, L. (2010). Research Methods: *A practical Guide for the Social Sciences.* Edinburgh Gate: Pearson Education Ltd.

Mazzanti, M., & Montini, A., (2006). The determinants of residential water demand. Empirical evidence for a panel of Italian municipalities. *Applied Economics Letters* 13, 107–111.

Mazzanti, M., & Montini, A. (2006). The determinants of residential water demand: Empirical evidence for a panel of Italian municipalities. *Appl. Econ. Lett. 13*, 107–111.

Michelsen, A.M., McGuckin, J.T., & Stumpf, D. (1999). Nonprice water conservation programs as a demand management tool. *J. Am. Water Resour. Assoc., 35*, 593–602

Minten *et al.,* (2002). Water Pricing, the New Water Law, and the Poor: An Estimation of Demand for Improved Water Services in Madagascar.

Mitchell, B. (2005). Integrated water resource management, institutional arrangements, and land- use planning. *Environment and Planning, 37*(8), 1335 – 1352.

MoFED (2007). A Plan for Accelerated and Sustained Development to End Poverty (PASDEP), Ministry of Finance and Economic Development of Ethiopia, Building on Progress; *Annual Progress Report,* 2005/06, Addis Ababa.

Muchiri Karanja, (2010). *"Myth shattered: Kibera numbers fail to add up"*. *Daily Nation. Retrieved 4 September 2016*.

Munga, D. (2002). *Freshwater Shortage and Groundwater Quality in Mombasa*, KMFRI, Mombasa.

Murdock, S.H., Albrecht, D.E., Hamm, R.R., & Backman, K. (1991). Role of Socio-demographic Characteristics in Projections of Water Use. *Journal of Water Resources Planning and Management,* nº 117, 235–251.

Naiga, R., Penker, M., and Hogl, K. (2012). From supply to demand driven water governance: challenging pathways to Safe Water Access in Rural Uganda.

Narayan, D. (1995). The contribution of people's participation: evidence from 121 rural water supply projects. In *Environmentally Sustainable Development Occasional Paper Series* No. 1. The World Bank.

Nauges, C., & Martinez-Espineira, (2004). Is All Domestic Water Consumption Sensitive to Price Control? *Applied Econ*. 36 1697 - 1703. 399 - 422.

Nauges, C., & Thomas, A. (2000). Privately Operated Water Utilities Municipal Price Negotiation, and Estimation of Residential Water Demand: The Case of France. *Land Econ*. 76 (2000) 68 - 85.

Nauges, C., & Whittington, D. (2009). "Estimation of Water Demand in Developing Countries: An Overview". World Bank Research Observer, Advance Access DOI 10.1093/wbro/lkp016.

Nauges, C., & Reynaud, A. (2001). Estimation de la demande domestique d'eau potable en France, *Revue Economique,* vol. 52, n.1, pp.167-185.

Nauges, C. & Thomas, A., (2000). Efficient Estimation of Residential Water Demand with panel data: the Case of France, *Land Economics,* vol. 76, n.1, pp.66-85.

Nicole, A. (2000). Adopting a sustainable livelihood to water projects: Implications for policy and practice. OD1 Working paper 133, Overseas Development Institute, London UK.

Nieswiadomy, M., & Cobb, S. (1993). "Impact of Pricing Structure Selectivity on Urban Water Demand". *Contemporary Policy Issues*, 11, pp. 101–113.

Nieswiadomy, M.L. (1992). Estimating urban residential water demand: Effects of price structure, conservation, and education. *Water Resour. Res., 28,* 609–615.

OECD, (1998). *Pricing of Water Services in OECD Countries: Synthesis Report.* Paris: OECD.

Ogden, P.E., & Hall, R. (2004). The second demographic transition, new household forms and the urban population of France during the 1990s. *Transactions of the Institute of British Geographers,* 29, 88-105.

Ogden, P.E., & Schnoebelen, F. (2005). The rise of the small household: demographic change and household structure in Paris. *Population, space and place*, 4(11), 251-256

Olmstead, S., Hanemann, M.W. & Stavins, R.N. (2007). Water demand under alternative price structures. *Journal of Environmental Economics and Management* 54, 181–198.

Orodho J.A. (2008). *Techniques of Writing Research Proposals and Reports in Education and Social Sciences.* Maseno: Kanezja Hp Enterprises. OSCE

Pahl-Wostl, C. (2007). Transitions towards adaptive management of water facing climate and global change. *Water Resources Management, 21*(1), 49 – 62.

Pearce, D. (1999). *Pricing Water: Conceptual and Theoretical Issues, Paper for European Commission for the Conference on Pricing Water: Economics, Environment and Society*. Portugal: Sintra.

PGOKopy, L. S. (2004). Women participation in rural water supply projects in India: is it moving beyond tokenism and does it matter? *Water Policy, 6*(2), 103 - 116.

PGOKopy, L. S. (2005). The relationship between participation and project outcomes: Evidence from rural water supply projects in India. *World Development, 33*(11), 1801-1819.

PGOKopy, L. S. (2009). Determinants and benefits of household level participation in rural drinking water projects in India. *The Journal of Development Studies, 45*(4), 471-495.

Pint, E.M. (1999). Household Responses to Increased Water Rates during the California Drought. *Land Econ.* 75 246-266.

Renwick, M., & Green, R. (2000). "Do Residential Water Demand Side Management Policies Measure Up? An Analysis of Eight California Water Agencies". *Journal of Environmental Economics and Management*, 40, pp. 37–55.

Renzetti, S. (2002). The Economics of Water Demands. *Kluwer Academic* Press, Norwell.

Republic of Kenya, (2010). *The Constitution of Kenya.* Government Printer, Nairobi.

Rietveld, P., Rouwendal, J., & Zwart, B. B. (2000). Rate Pricing of Water in Indonesia: An analysis of welfare effects. Bull. Indonesian *Econ. Stud*. 36,73 - 92.

Rogers, P., De Silva R., and Bhatia, R. (2002). Water is an economic good: How to use prices to promote equity, efficiency and sustainability. *Water Policy*, V4, 1-17.

Russ, L. W., and Takahashi, L. M. (2013). Exploring the Influence of Participation on Programme.

Sandiford P, Gorter AC, Orozco JG, Pauw JP (1990). Determinants of domestic water use in rural Nicaragua. *J Trop Med* Hyg 93(6):383-38917.

Sara, J., and Katz, T. (1998). Making rural water supply sustainable: *Report on the impact of project rules*. Washington DC. The World Bank.

Saunders, M., Lewis, P. and Thornhill, A. (2007). *Research methods for business for Students:* 4th edition. Pearson Education Limited.

Saurì, D. (2013). Water conservation: Theory and evidence in urban areas of the developed world. *Ann. Rev. Environ. Resour., 38*, 227–248.

Saurí, D. and Del Moral, L. (2001). Recent developments in Spanish water policy. Alternatives and conflicts at the end of the hydraulic age. *Geoforum,* nº 32(3), 351-362.

Savenije, H. (2002). Why water is not an ordinary economic good, or why the girl is special. *Physics and Chemistry of the Earth*, nº 27, 741-744.

Savenije, H., and Van Der Zaag, P. (2002). Water as economic good and demand management: paradigms and pitfalls. *Water International*, nº 27, 98-104.

Shaw, W. D. (2005). *Water resource economics and policy: an introduction*. Cheltenham, UK; Northampton, MA, USA. E. Elgar.

Shih, J., Harrington, W., Pizer, W., Gillingham, K., (2006). Economies of scale in community water systems. Journal of the American Water Works Association 98, 100–108.

Syme, G.J., Nancarrow, B.E. and Selingman, C. (2000). The evaluation of information campaigns to promote voluntary household water conservation. *Evaluation Review,* 24, 539-578.

Syme, G.J., Seligman, C. and Thomas, J.F. (1991). Predicting water consumption from homeowners' attitudes. *Journal of Environmental Systems*, 20, 157–168.

Taylor, R.G., McKean, John R., Young, Robert A (2004). Alternate Price Specifications for Estimating Residential Water Demand with Fixed Fees, *Land Economics* 80 (3), 463-475.

The Millennium Development Goals Report. (2008). New York, NY: United Nations, 2008. Print.

Thomas, F. and Syme, G. (1988). "Estimating Residential Price Elasticity of Demand for Water; A Contingent Valuation Approach". *Water Resource Research*, 24, pp. 1847–1857.

UN (2005). The Millennium Development Goals Report, New York. Available at www.un.org/2005/ MDGBook.pdf.

UN-Habitat (2004). Cities-engines of rural development, World Habitat Day award winning essays from Kenya, Nairobi.

UN-Habitat (2004). Dialogue on the Urban Poor: Improving the Lives of Slum-Dwellers, paper prepared for the World Urban Forum, Barcelona. Sept: 13-17.

United Nations Habitat (2005). The Unique Challenges of Improving Peri-Urban Sanitation.

United Nations Habitat (2006). A shared vision for hygiene, sanitation and water supply and a framework for mobilisation of action.

United Nations Population Fund *(*2007*).* State of the world population 2007*: Unleashing the potential of urban growth, report, New York.*

Water and Sanitation Program (WSP). 1999. Water and Environmental Needs of Kibera. Fieldnote, UNDP-World Bank Water and Sanitation Program, Nairobi.

Whittington, D. (1992). Possible adverse effects of increasing block water tariffs in developing countries. *Economic Development and Cultural Change*, 41, 75-87.

WHO, UNICEF (2006). Coverage estimates: Improved drinking water, Benin. Available at http://wssinfo.org/pdf/country/BEN_wat.pdf. Accessed Sept 2008.

World Bank (1993). Water Demand Research Team, The demand for water in rural areas: Determinants and policy implications, *The World Bank Research Observer*, Vol.8, No.1, pp.47-70.

World Bank (1998). *Demand Responsive Approaches to community water supply;* Moving from policy to practice, East and Southern Africa World Bank.

World Bank (2009). Water and Sanitation Program (WSP): Guidance Notes on services for the Urban Poor: *A Practical Guide for Improving Water Supply and Sanitation Services.*

World Bank. (2004). *Project Appraisal Document, Nairobi Water and Sewerage Restructuring Project, Water and Urban Unit 1*, Kenya Country Department, Africa Region, Report No: 28825-KE, The World Bank, Nairobi.

World Water Forum, (2000). Ministerial Declaration on The Hague on Water Security in the 21st Century. http://www.worldwaterforum.coin/journalist/frameset.html.

Worthington, A.C. and Hoffmann, M. A (2006). *State of the Art Review of Residential Water Demand Modelling,* Faculty of Commerce - Papers, University of Woolongong, Woollongong.

Worthington, A.C.; Hoffmann, M. (2008). An empirical survey of residential water demand modeling. *J. Econ. Surv.*, *22*, 842–871.

Zekri S, Dinar A (2003). Welfare consequences of water supply alternatives in rural Tunisia. *Agric Econ* 28:1-12.

Zhang, H.H. and Brown, D.F. (2004). Understanding urban residential water use in Beijing and Tianjin, China. *Habitat International,* V. 29(3), 469-491.

APPENDICES

Appendix I: Introductory Letter

Dear Respondent,

My name is John Omollo, a Master's student of Moi University. I am undertaking a study entitled, "**DETERMINANTS OF WATER DEMAND IN INFORMAL SETTLEMENT IN NAIROBI COUNTY-KENYA**". You have been identified as one of the respondents for this study. Kindly assist me in filling in this questionnaire. Your responses will be treated with utmost confidentiality and will be used for purposes of this study only.

Thank you.

Yours faithfully,

John Omollo

Appendix II: Questionnaire

Instructions

Please tick (√) or fill in the blanks as appropriate and respond to all items.

1. Gender? Male [ ] Female [ ]
2. Age of household head in years.....
3. Highest level of Education of household head?

   Primary [ ] Secondary [ ] Tertiary [ ] University [ ]
4. What is the size of your household?.....
5. How many dependants do you have? .....
6. What is your occupation?.....

   Employed [ ] Not employed [ ] Trader/own business [ ]

   Others (specify)……..
7. What is your monthly income in Kshs?.....
8. What is the primary (main) source of your water supply for the house hold?

   Tap water [ ] Borehole [ ] Wells [ ] Water vendors [ ]

   Private connections [ ] Public stand taps [ ] Rain water [ ]
9. How much money do you pay per month for the water used? Kshs .....
10. How many litres of water does your household use per

    day?.....
11. How many litres of water does your household use per

    week?.....
12. How many litres of water does your household use per

    month?.....

Appendix III: Research Authorization

NATIONAL COMMISSION FORSCIENCE, TECHNOLOGY ANDINNOVATION

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax: +254-20-318245,318249
Email: dg@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/17/83540/18280** Date: **18th July, 2017**

John Oima Omollo
Moi University
P.O. Box 3900-30100
ELDORET.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Determinants of water demand in informal settlement in Nairobi County-Kenya, a case study of Kibra,"*** I am pleased to inform you that you have been authorized to undertake research in **Nairobi County** for the period ending **18th July, 2018.**

You are advised to report to **the County Commissioner and the County Director of Education, Nairobi County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Nairobi County.

COUNTY COMMISSIONER
NAIROBI COUNTY
P. O. Box 30124-00100, NBI
TEL: 341666

The County Director of Education
Nairobi County.

Appendix IV: Research Permit

CONDITIONS

1. The License is valid for the proposed research, research site specified period.
2. Both the Licence and any rights thereunder are non-transferable.
3. Upon request of the Commission, the Licensee shall submit a progress report.
4. The Licensee shall report to the County Director of Education and County Governor in the area of research before commencement of the research.
5. Excavation, filming and collection of specimens are subject to further permissions from relevant Government agencies.
6. This Licence does not give authority to transfer research materials.
7. The Licensee shall submit two (2) hard copies and upload a soft copy of their final report.
8. The Commission reserves the right to modify the conditions of this Licence including its cancellation without prior notice.

REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No.A 14979

CONDITIONS: see back page

THIS IS TO CERTIFY THAT:
MR. JOHN OIMA OMOLLO
of MOI UNIVERSITY, 2314-100
NAIROBI,has been permitted to conduct research in *Nairobi County*

on the topic: *DETERMINANTS OF WATER DEMAND IN INFORMAL SETTLEMENT IN NAIROBI COUNTY-KENYA, A CASE OF KIBRA*

for the period ending:
18th July,2018

Permit No : NACOSTI/P/17/83540/18280
Date Of Issue : 18th July,2017
Fee Recieved :Ksh 1000

.....
Applicant's Signature

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