WATER SUPPLY AND SANITATION SITUATION IN NAIVASHA MUNICIPALITY, KENYA

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DECLARATION AND RECOMMENDATION

DECLARATION

I declare that this thesis is my original work and has not been submitted to any other university for award of any other degree.

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RECOMMENDATION

This thesis has been submitted for examination with our approval as university supervisors.

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ABSTRACT

Water supply and sanitation are vital for human survival and for good health. Water supply problems and sanitation are a big challenge to many municipalities not only in Kenya but Africa as a whole. At the beginning of the year 2012, 780 million) of the world's population was without access to improved water supply and two-fifth's (2.4 billion people) lacked access to improved sanitation with the majority of these people living in Asia and Africa. Naivasha municipality is not an exception as the residents continue to live in poor sanitary conditions. Many activities within the municipality are dependent on the lake and a limited number of boreholes for water supply thereby creating pressure for water supply. Many studies have been done but there is little documentation on the water supply and sanitation situation. This study was a cross-sectional survey that sought to establish the water supply and the sanitation situation among households living in the high, middle and low income areas within the municipality. The study utilized data from a random sample of 384 households obtained the residential areas within the municipality. Secondary data on water supply was also used and obtained from the Naivasha Water and Sanitation Company. The study used the WHO definition of water access and sanitation and data collected was compared to the per capita WHO guidelines. Data was analysed using descriptive statistics, correlation and ANOVA. Results indicated that 29.1% of the residents used water purchased from mobile vendors and only 11% of respondents had water piped into their houses. There was no significant relationship between the place of residence and access to water. Majority of households (46.7%) used pit latrines for their sanitation requirements. The sanitation systems were found not optimal as defined by the WHO guidelines as they did not limit human exposure to faecal matter but provided avenues for contamination of water sources and food due to groundwater pollution, low hygiene and lack of emphasis for hand washing. There exist inequalities in the cost of water and the sanitation systems practised are a hazard to both the environment and human health. It is recommended that more efforts be increased on the access to water to mitigate the inequalities in water supply and hence improve residents' access to water and sanitation services. This will help reduce incidences of water related diseases and have an overall improvement on health.

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ACRONYMS AND ABBREVIATIONS

ADB – Asian Development Bank

ASALs – Arid and Semi-Arid Lands

CBD – Central Business District

JMP – Joint Monitoring Programme

MDGs – Millennium Development Goals

LNRA - Lake Naivasha Riparian Association

MGDs – Millennium Development Goals

NAWASCO - Naivasha Water and Sanitation Company

RVWSB – Rift Valley Water Services Board

UNICEF – United Nations Children's Fund

UNDP – United Nations Development Programme

WAGs – Water Action Groups

WHO – World Health Organisation

WSS – Water Supply and Sanitation

WASH – Water, Sanitation and Hygiene

WASREB - Water Services Regulatory Board

WSTF - Water Services Trust Fund

WSUP – Water and Sanitation for the Urban Poor

WRMA – Water Resources and Management Authority

CHAPTER ONE

INTRODUCTION

1.1 Background Information

The WHO/UNICEF JMP (2012) report showed that globally the MDG drinking water target of halving the proportion of the population without sustainable access to safe drinking water between 1990 -2015 was met in five years ahead of schedule, however, many still lack safe drinking water, and the world is unlikely to meet the MDG sanitation target. According to the report, continued efforts are needed to reduce urban-rural disparities and inequalities associated with poverty, to dramatically increase coverage in countries in Sub-Saharan Africa and Oceania, to promote global monitoring of drinking water quality, to bring sanitation on-track and to look beyond the MDG target towards universal coverage.

According to Kaufmann (2007) ten million people annually have gained access to improved drinking water over the years 1990-2004 in Sub-Saharan Africa. However, due to high rate of population growth, the absolute number of un-served people has increased by about 60 million over the same period. Therefore the number of additional people obtaining access to drinking water annually would need to triple to reach the MDG target by 2015. Kauffmann further argues that the situation is worse for sanitation both in low level of access and the limited progress made since 1990. For the MDG to be met, 35 million more people annually need access to improved sanitation compared with the current rate of 7 million. Furthermore, limited access to water and sanitation in Africa is not mainly a resource issue, but one of poor management, pollution and wastage, and lack of facilities except in Northern and Southern Africa. In most African countries, over 50% of the water supply is wasted or unaccounted for. Therefore Africa is unlikely to reach the drinking water and sanitation MDG target.

Water supply is the process of self-provision or provision by third parties in the water industry, commonly a public utility, of water resources of various qualities to different users. Water is indispensable for all forms of life. It is needed in almost all human activities and forms of life. Access to safe freshwater is regarded as a universal human right. The Millennium Development Goal 7 targets to halve the proportion of people without access to safe drinking water by 2015

(Kundzewicz *et al.*, 2007). Sustainable management of freshwater resources has gained importance at regional and global scales with integrated water resources management now becoming the new paradigm shift in sustainability of water resources.

Various activities need water supply for operations including residential/domestic, commercial, recreational, industrial and agricultural which takes up the largest amount of water supplies. Food and agriculture are the largest consumers of water, requiring one hundred times more than is used for personal needs. Up to 70% of the water taken from rivers, lakes, and groundwater goes into irrigation, about 10% used in domestic applications and 20% in industry (Lenntech Water Treatment & Purification Holding B.V., 2009). Globally, water for household consumption only accounts for less than 10% of the overall human water use, therefore does not pose a major threat to natural freshwater availability. This is in comparison to agriculture, and industry which account for a combined 90% of human water use (Kundzewicz *et.al,* 2007).

Improved sanitation is the means that hygienically separate human excreta from human contact and hence reduces health risks to humans. Inadequate sanitation is the lack of improved facilities (toilets, conveyance and treatment systems) and hygiene practices (such as hand washing, proper water handling, and personal hygiene) that exposes people to human excreta and thus to disease, causing faecal-oral pathogens through different transmission pathways such as faeces, flies, fingers and food (Water and Sanitation Program et.al. 2006).

The WHO/UNICEF JMP (2010) report describes shared sanitation facilities as facilities of an otherwise acceptable type shared between two or more households. Only facilities that are not shared or not public are considered improved. Sharing of improved sanitation facilities is most prevalent in urban areas. Often densely populated urban areas do not have sufficient space to construct private sanitation facilities and people rely on public or shared facilities. The report further explains that unimproved sanitation facilities are facilities that do not ensure hygienic separation of human excreta from human contact. Unimproved facilities include pit latrines without a slab or platform, hanging latrines and bucket latrines. Unimproved sanitation facilities are unsatisfactory in terms of public health, although existing facilities may be upgraded in various ways to prevent human contact with excreta.

Previous studies by the WHO/UNICEF (2010) on time to collect water by households indicate that those spending more than half an hour per round trip progressively collect less water, and eventually fail to meet their families' minimum daily drinking-water needs. Additionally, the economic costs of having to make multiple trips per day to collect drinking water are enormous. In various countries, notably in Eastern Africa, more than a quarter of the population spends more than half an hour per round trip to collect water. Previous surveys conducted over the past four years show that water collection trips of over 30minutes are most prevalent in Africa and other arid countries outside of Africa.

1.2 Statement of the Problem

Meeting the water and sanitation standards as provided in the Millennium Development Goals continues to be a problem worldwide especially in developing countries, Kenya included. Major developments in Naivasha including flower farms and other economic activities in the mid and lower catchment have had major effect on quality and quantity of water in the lake. Thousands of labourers and their families have moved from rural areas and work in the greenhouses and processing plants thus exerting more pressure on the limited water facilities. The population of Naivasha rose from 7,000 in 1969 to 300,000 in 2007. The rapid urbanisation and the continuous increase in population is likely to compromise the access to water and improved sanitation in Naivasha. Studies have been done on the Lake Naivasha ecosystem but there is little documentation on the water supply trends and the sanitation situation within the municipality.

This study was therefore aimed at determining the current status of water and sanitation with a view to recommending practical and policy actions needed for planning, equitable resource allocation, improvement of water and sanitation services and conservation of water resources among the different users within the municipality.

1.3 Objectives

1.3.1 Broad objectives of the Study

The broad objective was to determine the access to water and the sanitation situation within the Naivasha Municipality.

1.3.2 Specific objectives

(i) To assess the water supply situation in high, middle and low income areas within the municipality

(ii) To determine the sanitation systems used by the residents in high, middle and low income areas within the municipality.

(iii) To determine the factors that influence water access and choice of sanitation systems in high, mid and low income areas within the municipality

(iv) To establish the prevalence of diseases related to water and sanitation

(v) To document the water conservation methods used by the residents in high, middle and low income households

(vi) To identify the solid waste collection methods used within the municipality

1.4 Research Questions

(i) How is the water supply situation within the high, middle and low income areas in the municipality?

(ii) Which sanitation systems are used in the high, middle and low income settlements within the municipality?

(iii) What influences water access and choice of sanitation systems in the high, middle and low income areas within the municipality?

(iv) Which are water and sanitation related diseases occurring in the study area?

(v) Which are water conservation methods applied by residents in the high, middle and low income areas?

(vi) How is solid waste collected within the high, middle and low income areas within the municipality?

1.5 Justification

The data collected in this study will contribute to the assessment of the current status of water and sanitation and related diseases within the municipality and act as a basis of the continuous evaluation of the progress towards achieving the MGD Goal of halving the proportion of population without access to safe drinking water and basic sanitation. This study will also contribute information building towards the realisation of the provisions of the Kenyan Constitution that provides that every person has the right to a clean and healthy environment which includes the right to accessible and adequate housing, and reasonable standards of sanitation, and to clean and safe water in adequate quantities. The Social Pillar in Kenya's Vision 2030 envisions "water and improved sanitation availability and access to all". It provides that efficient water management will contribute to sustainable long term economic growth, poverty reduction, improved health and security. It projects that the poor will gain directly from improved access to water and sanitation through improved health costs and time saved. This study envisions contributing to the achievement of the laid out visions by providing information on water and sanitation situation within the municipality. The study will contribute to exposing deficit areas that still need more investment and effort in order to improve the WASH services provided by the water company, NGOs, and other stakeholders within Naivasha municipality.

The data collected will also highlight to different stakeholders in the WASH services sector on their progress towards achieving the goals of improving access to water and sanitation and this will be a measure against their achievements so as to determine which areas needs more effort and investment geared towards improving WASH services. The performance of the major stakeholder involved on waste disposal and in this case the municipality of Naivasha will be gauged on the performance using the information collected in this study. The data will contribute to the assessment of the performance of service provision in this sector.

1.6 Scope of the Study

The study covered Naivasha Municipality. The area was chosen as it encompasses a fresh water lake whose ecological character is threatened due to the encroachment by human activities. The

municipality is plagued with problems of water supply and sanitation yet there is a fresh water lake that could be tapped to provide water for the residents and in turn improve the sanitation situation. The target population were the households living within the municipality who were stratified into high, middle and low income classes. The study used both primary and secondary data. Household questionnaires, in-depth interviews and physical observations were used to collect data. Households provided information on their income levels, their access to water and sanitation services within their residential area and also the incidences of water-related diseases that had affected the adult members and children in the households within six months of the study.

Interviews with the municipality and other stakeholders provided information on the water demand for the municipality, the deficit and alternatives that can be used to meet the demands of the population. The interviews also provided information on the water conservation methods that were used, their performance and options for improvement.

1.8 Definition of Terms

Sanitation - is access to, and use of, excreta and waste water facilities and services that ensures privacy and dignity, ensuring a clean and healthy environment for all (WHO, UNICEF and Water Supply and Sanitation Collaborative Council, 2000)

Sanitation systems – mechanisms for the collection, transport (including sewerage network), treatment and disposal or reuse of human excreta (WHO and UNICEF, 2010).

Affordable sanitation – sanitation that is available at a price that everyone can afford without compromising their ability to acquire other basic goods including food, housing, health services, and education(WHO and UNICEF, 2010).

Water access – access to safe water is measured by the proportion of population with access to an adequate amount of safe drinking water located within a convenient distance from the user's dwelling (WHO and UNICEF, 2010)

Water supply – is the provision of water by public utilities, commercial organisations, community endeavours or by individuals usually via a system of pumps and pipes (Lenntech Water Treatment & Purification Holding B.V., 2009).

Optimum sanitation – sanitation that promotes safe treatment of human waste for health and the environment, limits human exposure to faecal matter and avoid contamination of water and food sources, provides secure spaces for men, women and children to defecate, each with their unique needs, and encourages hygienic practices including hand washing (The United Nations University, 2010).

Water conservation – any beneficial reduction in water loss, use or waste as well as the preservation of water quality (Kato, E. *et. al.* 2009) .

Safe water – water that does not contain biological or chemical agents directly detrimental to health. It includes treated surface water and untreated but uncontaminated water from protected springs, boreholes and sanitary wells (WHO, 1996b).

Adequate amount of water – 20 litres of safe water per person per day (WHO, 1996b).

Access to water – in urban areas a distance of not more than 200m from a home to a public stand post may be considered reasonable access. In rural areas, reasonable access implies that a person does not have to spend a disproportionate part of the day fetching water for the family's needs (WHO, 1996).

Convenient distance – in urban areas, to fetch 20litres of safe water per person per day, 200m would be a reasonable distance from the home (WHO, 1996b).

Improved sanitation facilities – are facilities that ensure privacy and hygienic use including facilities that are connected to a public sewer, connected to a septic system, a pour-flush latrine, a simple pit latrine and a ventilated improved pit latrine (WHO, UNICEF and Water Supply and Sanitation Collaborative Council, 2000).

Improved drinking water sources – sources that provide safe drinking water including household connection, public standpipe, boreholes, protected dug well, protected spring and rainwater collection (WHO, UNICEF and Water Supply and Sanitation Collaborative Council, 2000).

Water-borne diseases – diseases transmitted by drinking contaminated water. Water borne diseases include those transmitted by the faecal-oral route including diarrhoea, typhoid, viral hepatitis A, cholera, dysentery and drancuculiasis (WSP et.al. 2006)

Water-washed diseases – these are diseases that occur when there is lack of sufficient quantities of water for washing and personal hygiene. Without enough water, skin and eye infections including trachoma are easily spread, including the faecal-oral diseases (WSP et.al. 2006).

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Access to water and sanitation is a fundamental right and essential to life, health and dignity (ECOSOC, 2002). The provision of adequate sanitation services is important. Proper disposal of waste as well as control of the carriers of communicable diseases is crucial to mitigate health risks and prevent epidemics. The optimum benefit from water and sanitation interventions can only be achieved if communities and individuals are made aware of the links between hygiene practices, poor sanitation, polluted water sources and disease (ECOSOC, 2002). According to the World Water Council (2012) the government has an obligation to ensure that citizens realise their human right to access to water and sanitation.

Improved sanitation facilities are used by less than two thirds of the world population. Globally, there is great disparity between regions where virtually the entire population of the developed regions uses improved facilities but in developing regions only around half the population uses improved sanitation (WHO and UNICEF, 2010). Notable increases in the use of improved sanitation have been made in Northern Africa, South-eastern Asia and Eastern Asia. Among the 2.6 billion people in the world who do not use improved sanitation facilities, by far the great numbers are in Southern Asia but there are also large numbers in Eastern Asia and Sub-Saharan Africa (WHO and UNICEF, 2010).

Progress in improved access to water sanitation has been mixed. Through the efforts of governments, support agencies and other stakeholders, an additional 1.3 billion people are using improved sanitation facilities and 1.8 billion are using improved drinking water systems since 1990 (the MDG baseline year),(UNICEF, 2010). This notwithstanding, 2.6 billion people around the world still do not have adequate sanitation and 884 million people in the world still do not get their drinking water from improved sources, almost all of them in developing regions. Sub-Saharan Africa accounts for over a third of the 884 million, and is lagging behind in progress towards the MDG target of halving by 2015 the proportion of the population without sustainable access to safe drinking water, with only 60% of the population using improved sources of

drinking water (WHO and UNICEF, 2010). While the world as a whole is on track to meet the MDG drinking water target, most countries in Sub-Saharan Africa are not. The majority of countries in Asia and Sub-Saharan Africa as a whole are not on track to meet the sanitation target (UNICEF, 2010).

2.3 Access to Water and Sanitation

At the beginning of the year 2000, one-sixth (1.1 billion people) of the world's population was without access to improved water supply and two-fifth's (2.4 billion people) lacked access to improved sanitation (WHO and UNICEF,2010). The majority of these people live in Asia and Africa, where fewer than one-half of all Asians have access to improved sanitation and two out of five Africans lack improved water supply. Further, rural services still lag far behind urban services. Sanitation coverage in rural areas is less than half that in urban settings, even though 80% of those lacking adequate sanitation (2billion people) live in rural areas, 1.3 billion being in China and India alone. The water supply and sanitation sector is expected to face enormous challenges over the coming years due to dramatic increase in urban populations of Africa and, Asia and Latin America and the Caribbean (WHO and UNICEF, 2010).

Access to water is measured by the proportion of population with access to an adequate amount of safe drinking water located within a convenient distance from the user's dwelling. The average water use for drinking, cooking and personal hygiene in any household is at least 15 litres per person per day and the maximum distance to the nearest water point should be at least 500m with queuing time at a water source no longer than 15min (UNICEF and WHO, 2008). The WHO/UNICEF Joint Monitoring Programme describes reasonable access as the availability of at least 20 litres per person per day from a source within one kilometre of the user's dwelling (WHO/UNICEF JMP, 2000). Depending on the water source, water should be available for approximately eight hours a day to enable people collect the minimum 15 litres of water needed per person per day (UNICEF and WHO, 2008).

The international target for sanitation "to halve the proportion of people living without access to basic sanitation by 2015" under the Millennium Development Goals (MDG's) framework, remains one of the most off track. At current rates of progress it will be missed globally by half a decade. In sub-Saharan Africa the MDG target will not be met until 2076 (COHRE *et al.* 2008).

Almost one billion people around the world mainly in rural and per-urban areas and informal settlements of developing countries live without access to safe and reliable water (Kundzewicz *et.al* 2007). This reduces life expectancy, adds extra burdens to domestic work (mostly undertaken by women), and denies people a life of dignity, especially where sanitation is also poor (Kundzewicz *et.al* 2007).

The achievement of the Millennium Development Goal to increase the number of people with access to water and sanitation has been successful in some parts of the world including Asia, Latin America, the Caribbean and Europe, but not in Sub-Saharan Africa. This is especially so in rural areas which have experienced little or no change with conditions even becoming worse in some instances (Kundzewicz *et.al* 2007). According to the UN Water (2009) in Sub-Saharan Africa, the progress towards achieving the MDGs lags behind that of other regions. About 340 million Africans lack access to safe drinking water and almost 500 million lack access to adequate sanitation. Furthermore to meet the MDG targets of reducing by one-half the proportion of people without access to hygienic sanitation facilities and to reduce by one-half the proportion of people without sustainable access to adequate quantities of affordable and safe water, it will mean that in Africa, Asia and Latin America and the Caribbean, an additional 2.2 billion people will need access to sanitation and 1.5 billion people will need access to water supply (WHO and UNICEF, 2000).

2.2 Standards on Water Supply and Sanitation

The standards provided for water supply and sanitation is provided by the WHO guidelines. The average water use for drinking, cooking and personal hygiene in any household is at least 15 litres per person per day and the maximum distance to the nearest water point should be at least 500 metres.(UNICEF and WHO, 2008). Improved sanitation facilities are considered to be facilities that ensure hygienic separation of human excreta from human contact. The aim of safe excreta disposal is to ensure that the environment is free from contamination by human faeces. They include flush or pour flush latrine to piped sewer system or septic tank or pit latrine, or ventilated improved pit (VIP) latrine or pit latrine with slab or composting toilet (UNICEF and WHO, 2008).

The maximum number of users per toilet should be 20 and when toilets are shared, they should be cleaned and maintained in such a way that they are used by all intended users. Where one toilet is shared by four or five families, it is generally better kept, cleaner and regularly used when the families have been consulted about its siting and design, and have the responsibility and the means to clean and maintain it. Access to shared facilities should be organised by working with the intended users to decide who will have access to the toilet and how it will be cleaned and maintained. Toilets should also not be more than 50 metres from dwellings to allow for rapid, safe and acceptable access at all times of the day and night (UNICEF and WHO, 2008).

2.3 Water, Sanitation and Related Diseases

According to Copeland *et.al.* (2009) the quality of drinking water directly affects the well-being of individuals with cumulative effects at every social level. The World Health Organization attributed 4.0% of all deaths and 5.7% of the global disease burden to water related illnesses, which stemmed from poor water quality, hygiene and sanitation. In addition, these diseases disproportionately affect the developing world and young children. As opposed to the developed world, which has nearly complete coverage, less than half of sub-Saharan Africa has access to safe drinking water.

Furthermore as the combination of unsafe drinking water, absence of acquired immunity and lack of hygienic facilities increase the risk of infection, young children in developing regions are especially vulnerable. A review of studies between 1992 and 2000 found that, annually, 2.5 million deaths in children less than five years old are accounted for by diarrhoea (Copeland *et. al.*, 2009,pp 324-331), the primary component of the water-related disease burden. While mortality is an overwhelming impact of contaminated drinking water, early childhood diarrhoea has a myriad of debilitating effects that contribute to the disability- associated burden.

Diarrhoea is the most important public health problem affected by water and sanitation and can be both water-borne and water-washed. Adequate quantities of safe water for consumption and its use to promote hygiene are complimentary measures for protecting health. The quantity of water people use depends upon their ease of access to it. If water is available through a house or yard connection people will use large quantities for hygiene, but consumption drops significantly

when water must be carried for more than a few minutes from a source to the household(WSP, et. al. 2006).

Water-borne disease transmission occurs by drinking contaminated water. Outbreaks of water-borne diseases occur across the developed and developing world, and out breaks of faecal-oral diseases such as cholera and typhoid continue to occur. The water-borne diseases include those transmitted by the faecal-oral route including diarrhea, typhoid, viral hepatitis A, cholera, dysentery and dracunculiasis (guinea worm disease)(WHO, 2000). Water-washed diseases occur when there is lack of sufficient quantities of water for washing and personal hygiene. When there is not enough water, people cannot keep their hands, bodies and domestic environments clean and hygienic. Without enough water, skin and eye infections including trachoma are easily spread (WHO, 2000).

2.4 Water and Sanitation situation in Kenya

Globally, a country is categorised as "water stressed" if its annual renewable fresh water supplies are between 1,000 and 1,700 cubic metres per capita per annum, and "water scarce" if its renewable fresh water supplies are less than 1,000 cubic metres per capita per annum (World Water Assessment Programme,2006). Kenya is classified as a water-scarce country with only $647m^3$ of renewable freshwater per capita (Kenya National Water Development Report, 2006). This water supply is characterised by high spatial and temporal variability and extremes of drought and floods. Kenya faces a number of challenges related to water resources management. Climate variability and increasing demand for water as a result of development and population pressure are factors that the country grapples with. Kenya's water targets aimed at ensuring sustainable water resource development include increasing water coverage from 70% urban and 48% rural (2000 estimates) to 85% urban and 75% rural by 2010 (Kenya National Water Development Report,2006) . Kenya is also committed to meeting the MDGs and providing clean and potable water at source less than 1km in high potential areas and less than 5km in ASALs, together with the commitment of having universal access to sanitary means of excreta disposal (Kenya National Water Development Report, 2006).

In Kenya, the Water Supply and Sanitation situation is poor for the majority of people. Approximately 57% of households use water from sources considered safe. Sustainable access to safe water is around 60% in the urban setting with as low as 20% coverage in the urban poor settlements where half of the urban population lives (UNDP, GoK, WGF and SIWI, 2007). In the rural setting, sustainable access to safe water is estimated at 40%. Due to the inadequate sanitation services (only 50% countrywide), uncontrolled disposal of excreta pollutes water sources from which most urban poor dwellers draw. Water Supply and Sanitation service in urban poor in informal settlements is mainly the domain of unregulated small scale providers whose tariffs range between 5 to 20 times more than the formal tariff applied to a metered water supply(UNDP, GoK, WGF and SIWI, 2007).

In order to address water supply and sanitation challenges in Kenya, the government commenced on water sector reforms. The reforms were committed to the principles and targets of the MDGs, good governance and human rights. The institutionalisation of the Water Act (2002) was to effectively manage and protect the water resources in a sustainable manner. The Act separates policy formulation, regulation and services provision and defines clear roles for sector actors and a decentralised institutional framework. The Water Act provided for the creation of new institutions such as the Water Services Trust Fund (WSTF) in 2002 and the Water Services Regulatory Board (WASREB) in 2003 (World Water Council, 2012). The WSTF was set up to focus exclusively on informal settlements in an effort to fast-track access, by providing financial incentives for service providers to extend services to these areas and eliminate the heavy reliance on informal service providers, which charge considerably higher prices than the formal sector, with no guarantees of service quality (World Water Council, 2012).

In a report by the World Water Council (2012) water companies in Kenya are obligated to provide water and sanitation services to citizens in the areas under their jurisdiction. However, individuals and households are also responsible for ensuring their own access to water and sanitation. For sanitation in particular, there are certain aspects that can only be the responsibility of the individual or household such as the hygienic maintenance of a toilet or latrine and good hygiene behaviour. The government however, also has an obligation to ensure that individuals are able to fulfil their responsibilities by ensuring that services are affordable.

Furthermore the WASREB is responsible for promulgating minimum standards for water quality and ensuring service providers comply with these standards. It also seeks to empower consumers particularly those in un-served communities, to organise Water Action Groups (WAGs) with a view to making them a formal negotiating partner with the service provider, providing feedback on consumer concerns and commenting on tariff adjustments.

The Food and Water Watch and the Council of Canadians (2008) reported that the Lake Naivasha catchment has a rapidly increasing population and varying activities that are largely dependent on the water resource from the lake. This has created pressure on water resources from the lake for the diverse activities. Dwindling water resources translates to the inability to meet the water and sanitation needs of the population and hence the achievement of the Millennium Development Goal of halving the population of the people without sustainable access to safe drinking water and basic sanitation is curtailed (MDG Report 2009).

2.5 Challenges in Access to Water and Sanitation

Lack of access to safe water can be due to problems of water quality, with the primary health risk being pathogenic organisms. Also, in many areas, surface water is becoming increasingly polluted by discharges of untreated sewage, agricultural and industrial effluents (Bjorkland *et.al.* 2010). At least 60% of those who lack access to sanitation are from the poorest sections of society living on less than US $ 2 a day and the majority live in the poorest regions of the world. A lack of sanitation, including the collection, treatment and disposal or re-use of excreta and wastewater can have a severe negative impact on people's health and dignity and on the environment. A small number of people practising open defecation can threaten the quality of water resources which in turn infringes the right to water and the right to health. Sanitation for all is still such as distant goal because lack of sanitation is viewed as a symptom of poverty rather than as a barrier to development. Despite the fact that sanitation is one of the most cost-effective interventions for the improvement of health, particularly of children, it is largely overlooked by the health sector which prefers other interventions (COHRE *et al.* 2008).

In a report by the World Water Council (2012), lack of clarity of the role of government and other agents in delivering sanitation services contributes to poor delivery of services. The responsibility for sanitation resting with different departments and ministries often leads to fractured and uncoordinated policies and actions. In many developing countries, responsibilities are also not sufficiently clarified between different service providers, such as public or private utilities, and small to medium scale independent providers, leaving considerable proportions of residents without service provision or the hope of receiving services. Water is generally higher than sanitation on the political agenda of governments. Although the benefits of investing in sanitation alongside water are more pronounced than investing in water only, water sector requirements tend to be easier than the sanitation sector. The lack of commitment of resources may be explained by the fact that in many cultures, sanitation is a taboo subject, and is not popular with either politicians or planners. As a result, there is often not enough information on who does not have adequate access to sanitation and why, making planning and budgeting difficult (World Water Council, 2012).

The requirements for the financing of sanitation are often more complex than for water, and will include the purchase or construction of a latrine or toilet, storage, removal, or transport of the waste matter (a sewerage system or pit/septic tank emptying system), and treatment, disposal and/or reuse of waste matter. To ensure hygienic use of sanitation facilities, the costs to governments also include hygiene promotion, and awareness raising campaigns. The costs of sanitation to households include the cost of purchasing soap and water, for both hygiene and in some cases for flushing toilets. This range of services generally requires a number of service provider, which are often not coordinated, either in terms of securing the necessary financing (World Water Council, 2012).

Also, demand for sanitation is latent as compared to demand for other services because the impacts of poor sanitation fall on those voices that are not heard, that is, the vulnerable and marginalised individuals and groups. Further, the far-reaching benefits of sanitation are hard to perceive before they have been experienced, such that sanitation loses out to other services such as water or health care that may seem more pressing. In some settings defecation is a taboo subject that people are not willing to discuss openly thereby confounding the problem of access

to sanitation (COHRE *et.al.* 2008). There is a need for joint action by all actors to realise health benefits of improved sanitation starting from the individual households who have to change their behaviour and attitude to service providers who need to prioritise sanitation provision.

2.6 Case Studies of Successful Water and Sanitation Programmes

2.6.1 Successful Water project in the City of Dalian, China

In the year 1997, the Asian Development Bank (ADB) in conjunction with the UN-HABITAT carried out water supply and sanitation projects in developing countries with the aim of contributing towards the achievement of the MDGs. In the People's Republic of China (PRC), the City of Dalian with a population of about 2.6 million inhabitants saw a significant increase in water supply.

The water shortage was so severe that many areas had water service for only a few hours a day, and the pressure in the system sometimes was insufficient to provide water to higher elevations in the city for several days. In addition, frequent service disruptions had major implications for public health. Excessive extraction of groundwater was in some cases endangering the environment. The project provided new infrastructure to address the shortage as well as to meet the growing demand for water.

The project expanded the capacity of the city's supply system and domestic consumption increased from about 40 litres per capita per day to some 85 litres per capita per day. All customers had 24-hour supply, and the quality of water met national standards. Prior to the implementation of the project domestic consumption was extremely low and public taps were common with water only available at limited times. Following project implementation almost all urban households had in-house connections and average water consumption doubled. Furthermore, the water conservation and recycling programs implemented in association with the project facilitated the development of more than 50 parks and green areas in the city, thereby improving the city living environment.

The project affected health primarily through making more and safer water available. Many respondents indicated that washing was easier and that they were able to keep toilets, latrines,

and their houses in general cleaner than previously. Use of groundwater by industrial and residential consumers was reduced and extensive water conservation and recycling programmes were introduced. Since then the water supply conditions in Dalian greatly improved, which facilitated sustained rapid growth of the local economy. This in turn had positive impacts on incomes and living conditions in the city and surrounding areas.

The evaluation of the project confirmed that commitment by the local government is the most important factor contributing to the success of WSS projects and consumers will accept and understand the need for higher tariffs once they are certain that water supply services are improved and became adequate and reliable. (Asian Development Bank, 2002).

2.6.2 Water Supply in Austrian Households

Developed countries have adequate water supply to meet their citizens' water demand. In Austrian households, the average consumption (not including commerce, industry or large-scale users) amounts to about 135 litres per day per person. An average 4-person household needs about $200m^3$ of drinking water per year. Presently, 50% of the Austrian drinking water is extracted from groundwater and 50% from spring water. These resources are well protected by suitable requirements laid down in the Austrian Water Rights Act. More than 5,000 water supply enterprises supply the Austrian population and the holidaymakers with high-quality drinking water which complies with the stringent requirements laid down in the Drinking Water Ordinance. Of the total 8.1 million inhabitants approx. 7 million (87%) are supplied via a central drinking water network. Most water suppliers offer natural (untreated) drinking water or drinking water which has been disinfected for preventive reasons (State Ministry of Environment of Upper Austria, 2006).

According to the 2006 Drinking Water Report 96% of Austrian households supplied are satisfied or very satisfied with the performance of their drinking water suppliers. More than 1 million inhabitants (13%) take their drinking water from private wells or springs, meaning they have an individual home well which is partly used for drinking water. Home wells are not within public competence, but are the private responsibility of the well owners. Periodic inspections (water quality, structural condition of the well) are also highly recommendable for private wells,

especially when they are used for drinking water (State Ministry of Environment of Upper Austria, 2006).

2.7 Impact of Climate Change on Water Resources and Sanitation

Climate change can directly affect the hydrologic cycle, and through it, the quantity and quality of water resources. It can lower minimum flows in rivers, affecting water availability and quality for its flora and fauna and for drinking water intake, energy production (hydropower), thermal plant cooling and navigation (UN Water 2009). Anthropogenic climate change can also directly affect demand for water, when demand increases for certain seasons. Climatic change may alter the timing, magnitude and duration of precipitation events, which could pose problems for the sustainability of water supplies and the continuity of treatment (UN Water, 2009). The decisions and policies put in place today for mitigation against climate change (such as reducing green-house gas emissions, applying clean technologies and protecting forests) and adaptations (such as expansion of rain water storage and water conservation practices) can have profound consequences for water supply and demand both today and over the long term (UN Water, 2009). Estimates suggest that in developing countries, diarrhoeal disease incidence will increase by 5% per °C increase in temperature unless efforts are made to improve access to clean water (UNHCR, 2009).

Climate change is compounding existing situations of environmental unsustainability and is threatening gains in water supply in many countries through disruptions to water availability and increasing frequent extreme weather events. Rapid urbanisation is overwhelming water and sanitation systems in some cities and the continuing economic crisis is eroding developing countries' ability to maintain existing and invest in new water and sanitation services. The devastation caused by major emergencies of 2010, for instance the floods in Pakistan, along with the dozens of other smaller but serious emergencies around the world illustrate how steady gains in the water and sanitation sector can all be wiped out, especially in the context of the fragile economies of developing countries (UNICEF, 2010).

2.8 Ecosystems and Water Supply

Water management affects the health of ecosystems. Growing pressure on water resources affects ecosystems and threatens the ecosystem goods and services on which life and livelihoods depend. The natural environment provides food, essential natural resources and other life-supporting services and benefits for people, animals and plants. In addition to supporting the production of food and fibres, freshwater ecosystems regulate environmental flows, purify waste water and detoxify wastes, regulate climate, provide protection from storms, mitigate erosion and offer cultural benefits, including significant aesthetic, educational and spiritual services.(UN Water, 2009).

Lake Naivasha is an aquatic system and aquatic ecosystems produce significant economic benefits, including flood control, groundwater recharge, shoreline stabilisation and protection, nutrition cycling and retention, water purification, preservation of biodiversity and recreation and tourism (UN Water, 2009). The lake is an important reservoir of fresh water that sustains diverse habitats as well as the human activities around it. The papyrus swamp in the River Malewa delta is important for reducing the influx of sediments into the lake from the upper catchment particularly in times of flood. The papyrus around the lake and at the delta is also vital in taking up nutrients from terrestrial or riverine sources thereby minimizing eutrophication and algal blooms. Shoreline vegetation and papyrus also helps prevent erosion of the lake edge.

The Lake receives water from two perennial streams, River Malewa and River Gilgil and direct rainfall that occurs over the lake and surface runoff. Hydrologically the lake is also a seepage lake with significant input via groundwater. The outflow of the lake is thought to be via underground seepage mainly from the south-western part of the main drainage basin. Water extraction for human use and horticulture are some of the outputs from the lake (Food and Water Watch and the Council of Canadians, 2008).

2.9 Conceptual Framework

Local authorities and water companies need to prioritise their capital investment in water and sanitation projects so as to increase coverage of sanitation services and water supply. Improved management of water resources entails conservation and appropriate use of water resources to

ensure optimal use of this scarce resource. Improved access to water will result in improved sanitation in the households and hence reduced incidences of water related diseases. This will culminate in overall improvement of the health of the people. A population with better health are able to work optimally so that their productivity improves and also their standards of living.

The type of settlement most often than not influences the type of sanitation practice in households. Middle and high income areas are often characterised by well maintained and functioning water-borne sanitation systems due to improved access to water supply. Low income settlements are characterised by problems in water supply and sanitation due to inadequate access to water. Incidences of water-related diseases are more common in areas with inadequate water supply. Thus by improving coverage and supply of water, the health and hence standard of living will improve for the population. Water conservation is increasingly becoming a vital practice in face of changing climatic and weather patterns. Households need to conserve water and practice optimal use so as to efficiently use the minimal resources that are available.

The economic status of a household will determine the residential location of the household, the access to adequate water supply and the type of sanitation system that the household will use. The education level also influences the awareness of sanitation practice in the household. Households with members who have a higher level of education are able to bargain for and utilise improved sanitation facilities, and also ensure that water used within the household is comparable to standards set for potable water. The members are also aware of the risks associated with utilisation of contaminated water and will therefore make efforts to either treat or disinfect the water before use to avoid water-related diseases.

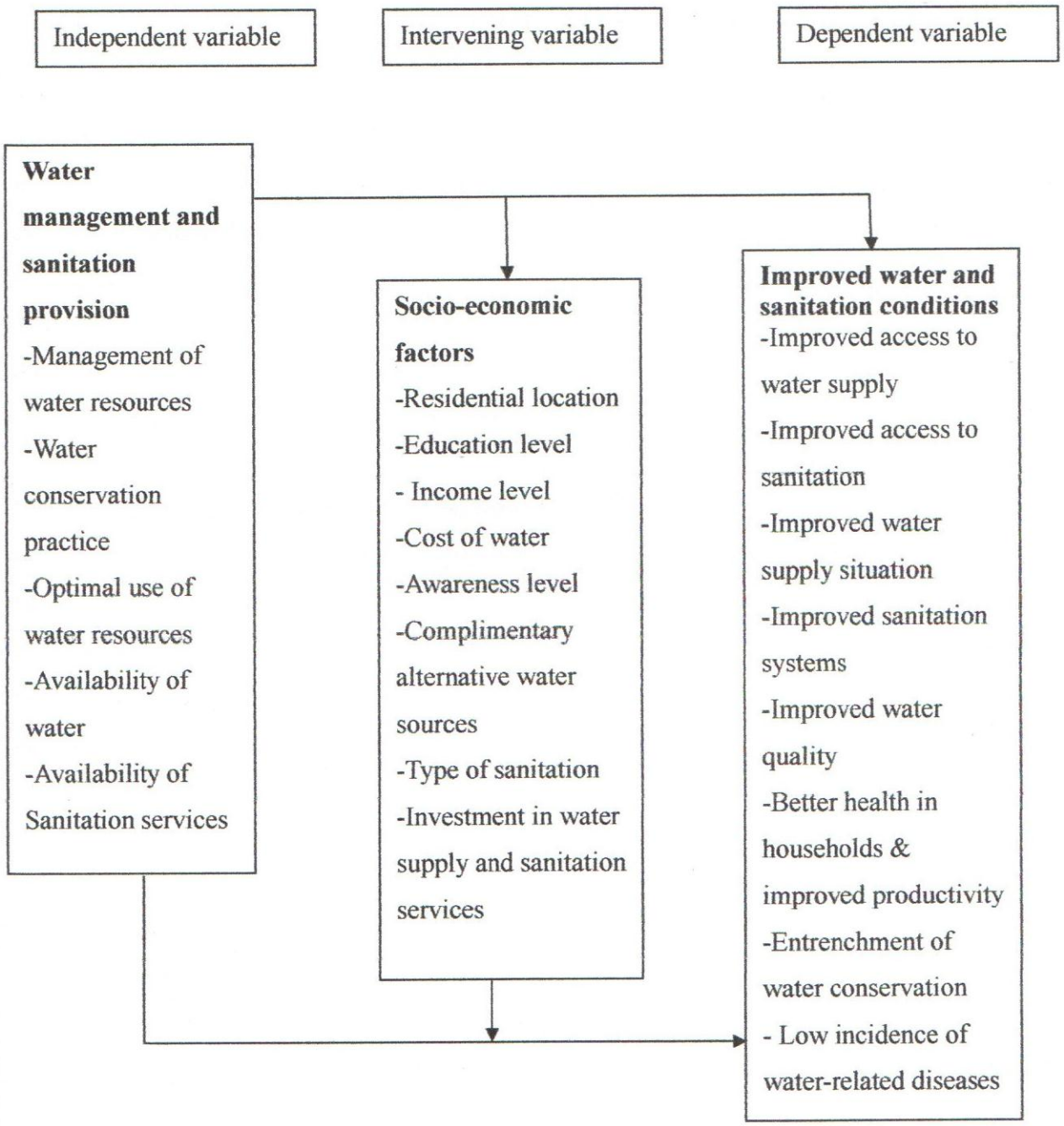

Figure 1: Conceptual Framework (Own Compilation)

CHAPTER THREE

METHODOLOGY

3.1 Study Area

The study was carried out in Naivasha Municipality. Naivasha has a shallow basin lake, situated 80km northwest of the Kenyan Rift Valley. It lies at an altitude of 1890m between the longitude 36° 20`E and latitude 0° 45`S and covers an area of approximately 100km^2. The population in Naivasha has rapidly grown from 7000 persons in 1969 to 376,243 in 2009 (Republic of Kenya, 2010). The lake watershed is mainly a semi-arid environment with a bi-modal rainfall distribution with long rains between April- June and short rains between October and November. The area receives an average of 600mm of rainfall annually.

Lake Naivasha is a fresh water lake in the Rift Valley and was declared a Ramsar site in 1995. Its watershed is mainly a semi-arid environment with scarce surface and underground water resources. The area around the lake has witnessed major land use transformation following colonisation of Kenya. At the beginning of the 1900s the land use in the watershed changed from pastoral economy to large scale white settler farming and since independence in 1963 the area has experienced rapid land subdivision (Mireri, 2005).

The land use changes since independence have led to rapid growth in population, human settlement, intensive commercial farming, tourism and geothermal production. These have put intense pressure on natural resources in the watershed, which threaten the sustainability of Lake Naivasha. Increased demand for scarce environmental resources such as water and biomass has led to the excessive abstraction of surface and ground water resources, depletion of forestry resources, pollution of water bodies and siltation of the lake (Mireri, 2005). The population has increased tremendously around the lake, resulting in a proliferation of unplanned settlements, which lack basic amenities such as water, sanitation and waste disposal programmes. The lack of water in these settlements forces residents to go to the lakeshore for domestic water, laundry and livestock watering (Becht *et al.*, 2006).

3.2 Soils and Topography

Soils in the catchment are developed from volcanic activity, and are of moderate to low fertility, deep clayish loam, greyish, brown to black in colour, often with drainage problems. The Eastern and Northern portion of the Lake shore has a combination of silty loam, sandy loam or clay loam that has developed in lacustrine deposits. The lakeshore soils are predominantly alkaline, sodic and lacking organic matter. The high ration of sandy soil and high rate of land degradation through human interferences makes the soil susceptible to surface erosion by water and wind.

The vegetation is heterogeneous from aquatic plants such as papyrus around the lake margins, submerged macrophytes to terrestrial vegetation comprising of grasslands, bush lands, woodlands and forests. Generally, savannah vegetation is predominant (Sparvs Agency Limited, 2008).

3.3 Socio-economic Profile

Traditionally the lake Naivasha basin largely occupied traditional pastures of the Maasai (Becht *et. al.* 2006). After colonisation, the basin became part of the so-called white highlands where only European settlers were allowed to own land. The higher parts were mainly used for wheat and cattle, the bottom of the Rift Valley for cattle and around Lake Naivasha sisal, Lucerne and vegetables were grown. After independence, indigenous people occupied the parts suitable for rain-fed agriculture. The land tenure in the bottom of the Rift Valley remained largely unchanged therefore much land around the lake is still owned by Kenyans of European origin. To the north of the Lake Lucerne is grown under irrigation, the land to the northwest between lake Naivasha and lake Nakuru is mainly used as cattle and game rangeland, while open rangelands are south of the Lake where the Maasai graze livestock during the dry seasons. Closer to the lake edge are many irrigated flower farms. The areas to the west and east of the lake which receive higher rainfall are occupied mainly by smallholders growing maize, vegetables and pyrethrum with some larger grain farms (Becht *et.al.* 2006).

Apart from the commercial and business activities taking place in the core-urban area, people living in the lake Naivasha catchment are involved in small scale mixed farming. Maize and beans are the main crops grown for subsistence use only, due to high crop failure as a result of

low erratic rainfall. Some households keep a few livestock (sheep, goats and cattle) that are occasionally liquidated to buy food and as a result the people accumulate very little assets (Sparvs Agency Ltd, 2008). People are also involved in commercial production of charcoal to make up for crop losses. Those living close to the lake are involved in fishing for both subsistence and commercial purposes. The most significant activity in Lake Naivasha, albeit for large scale farmers, is the extensive irrigated greenhouse floriculture and horticulture. Livestock ranching and private game sanctuaries and conservation areas also exist in the catchment.

Naivasha is a tourist destination. There are two small National Parks (Hells Gate and Longonot) in the vicinity of the Lake. The scenery, the birds and wildlife, the proximity to Nairobi, the Hotels, homestays and campsites attract many visitors, both local and international (Becht *et.al.* 2006).There are however, challenges that are present in the municipality. Waste management remains a big challenge. Only a small section of the Naivasha Municipality is covered by conventional sewerage systems, the treatment of which works broke down many years ago. Therefore, the waste disposed from the sewerage system remains a potential source of water pollution. Further, the majority of the households use pit latrines to dispose human waste, while hotels and flower farms around Lake Naivasha use mainly septic tanks to dispose of human wastes with serious risk of environmental pollution.

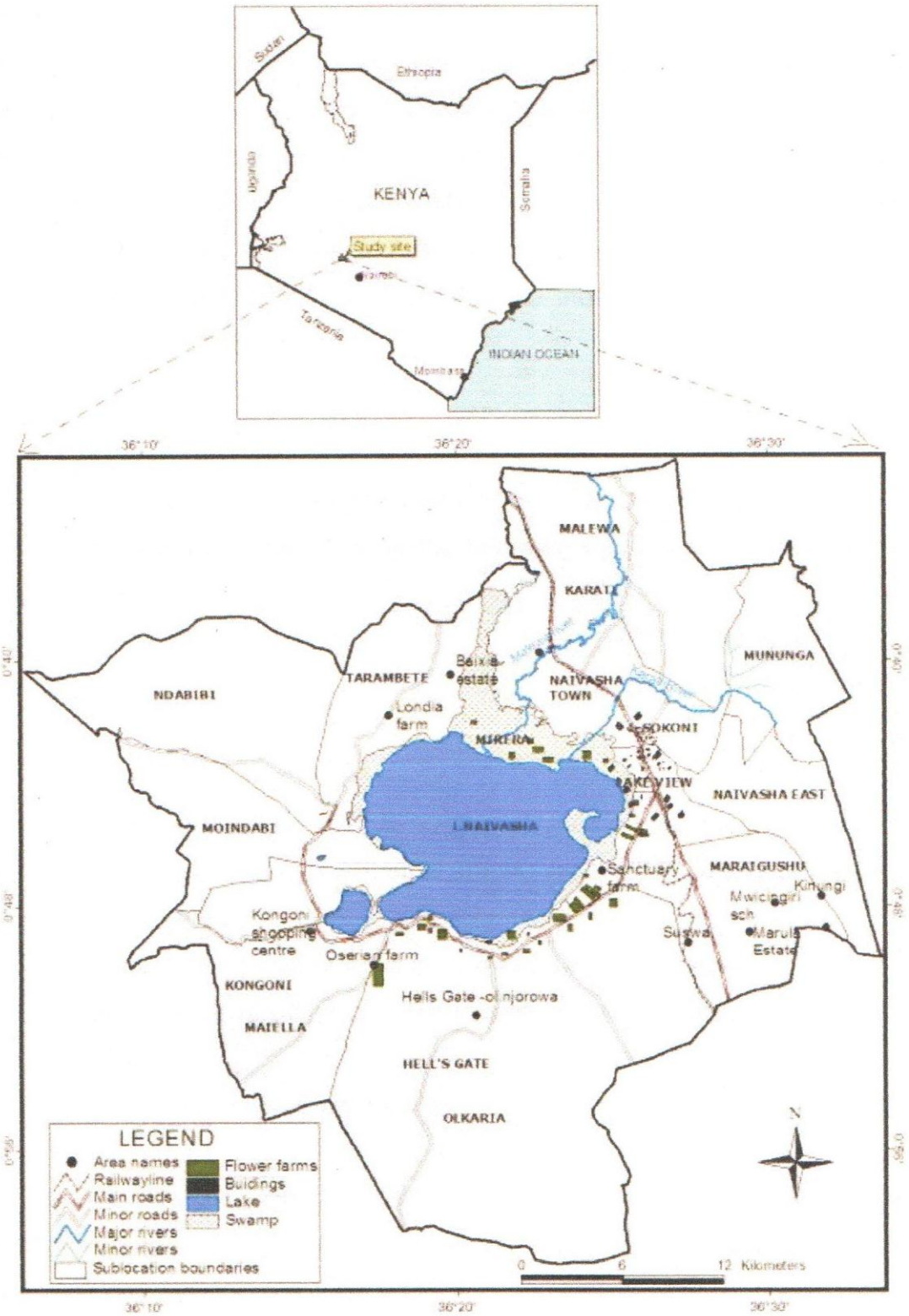

Figure 2: Map of Naivasha Municipality (Modified from Encarta, 2009)

3.4 Research Design

The study was a cross sectional survey targeting households living within the municipality. The survey utilised questionnaires, interviews and observations. The study utilised both primary and secondary data. The study captured information on the current situation of water supply and sanitation within Naivasha Municipality. This information included water supply situation within the municipality from the year 2007, the sanitation modes used by the population living in various types of settlements, water conservation methods and potential for improving the situation within the municipality.

3.5 Sampling Procedure

The target population were households living within the three income levels in the municipality. The sample size was obtained using the following formula as provided by (Mugenda and Mugenda, 1999).

$$n = \frac{Z^2pq}{d^2} \quad \text{.....Equation 1}$$

Where: n = desired sample size (if the target population is greater than 10,000). The study area Naivasha Municipality has a population of 376,243 and 56,538 households (2009 Population and Housing Census, 2010).

Z = standard normal deviation at the required confidence level

p = proportion in target population estimated to have characteristics being measured

q = 1-p

d = level of statistical significance set

Further, Mugenda and Mugenda (1999) suggest that if there is no estimate available of the proportion in the target population which is assumed to have the characteristics of interest, then 50% of the population is recommended.

If the proportion of target population with desired characteristic is 0.5(50%) the z-statistic is 1.96 and the desired accuracy (Level of Significance) at 0.05, then the sample size (n) is:

By substitution:

$$n = \frac{(1.96)^2 \times (0.50) \times (0.50)}{(0.05)^2} \quad \text{.....Equation 2}$$

$$n = 384$$

Stratified random sampling was used in this study. The households were stratified by level of income into low, middle and high income groups by mapping out the municipality into the three groups. A preliminary survey was undertaken to further assist in determining the sampling frame. This sample was then divided among the three classes of households. Simple random sampling was used to administer questionnaires among the three classes of households stratified by income levels of high, middle and low levels. Randomisation was achieved by assigning numbers to households and picking the 5th household to be interviewed. According to an economic survey done by the Kenya National Bureau of Statistics (2014) the National income bands was Kshs.0-23,672 for the low income, Kshs. 23,672-119,999 for the middle income and Kshs.120,000 and above belong to the high income. Further, from the preliminary studies, the population followed the pattern shown in table 1 below. There are more people in the middle and low income than there are in the high income when using the income bands. Therefore, the sampling frame followed this pattern of population distribution in identification of households to be interviewed.

Table 1: Sample size distribution in income levels

	Low income	Middle income	High income	Total
n	322	47	16	385
%	83.63%	12.21%	4.16%	100%

3.6 Data Collection

Primary and secondary data were collected in this study. Primary data was collected through the administration of questionnaires to households in the high, middle and low income areas within the municipality. The questionnaires contained both structured and open ended questions in order to capture optimum response from the respondents. The questionnaire sought to establish

the water supply situation within the households including sources of water, access to water, the reliability of the water supply, the quantity and quality and knowledge and practice of water conservation methods. The questionnaire also sought to establish the sanitation methods used by households and their satisfaction with the methods and establish the occurrence of water borne diseases within the three classes of households and how the households cope with this problem.

Also scheduled interviews were used to obtain information on information on water and sanitation from the Naivasha Water and Sewerage Company to establish the water budget for the municipality, the deficit and alternatives used to meet this deficit. The interviews also sought to establish the sanitation systems currently used within the municipality and the effectiveness in meeting the demand for sanitation services. Secondary data was collected from previous studies and publications on the water and sanitation situation within Naivasha municipality. Secondary data was also obtained from the water company's records on water supply trends over the years. This provided information on the quantity of water demand and supply within the municipality and also information on sanitation situation within the municipality. Observations were made on the physical condition of the sanitation systems in use and photographs were used to capture this situation. The photographs were also used to capture the hygiene of sanitation systems and hence show the sanitation situation within the municipality.

3.7 Data Analysis

The questionnaires collected were organised according to three classes of low, middle and high income and then coded. The information from the questionnaires was entered into the SPSS computer software for analysis. Results obtained were presented in form of frequency distribution tables, bar graphs, and pie charts. Correlation statistics were used to identify the relationship between different types of settlements and sanitation systems in use. Descriptive statistics were used to indicate the distribution of the sanitation systems for access by individual households. Analysis of variance was used to compare the means in households' access to water between the three income groups in the low, middle and high income residential areas.

Table 2: Summary Table for Statistical Data Analysis

Research question	Variables to measure	Statistical tools
What is the water supply situation in the study area	:Water accessibility :distance to source :reliability of water source :amount of water available per day per Capita	:Descriptive statistics :One-way ANOVA
What are factors that influence water access and choice of sanitation systems in the study area	:Reliability of source :Accessibility to water supply :Cost of water :Household income :Number of users of the sanitation system	:Descriptive statistics :Correlation
What are the sanitation systems used by residents within the municipality	:Type of sanitation system used :Satisfaction with sanitation systems :Type of sanitation in different residential location	:Descriptive statistics :One-way ANOVA
What are the solid waste collection methods used within the municipality	:Methods of solid waste collection used :Methods of solid waste disposal in use	:Descriptive statistics
Which water and sanitation related diseases occur in the study area the	:Prevalence of cholera, typhoid, dysentery, diarrhoea, skin and eye infections,	:Descriptive statistics: :Prevalence rates calculation
What water conservation methods are practised by the residents in the study area	:Water harvesting and conservation methods :Modes of water storage	:Descriptive statistics

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Demographic Characteristics

This study was carried out in the year 2012 and findings from the study indicated that the average household size was three people in the low income, four people in the middle income and three people in the high income areas. The average income earned by respondents in the low income was between Kshs.5,000- 10,000 and in the middle income was between Kshs. 20,000-30,000 and in the high income was between Kshs.40,000-50,000. From the study, 80% of respondents in the low income were married and 87% of respondents in the middle income were married. In the high income the 100% of the respondents in the study were married. 93.8% of the respondents in the low income bracket were female and 6.2% male while in the middle income the male respondents were 4.3% and female 95.7% and in the high income the female respondents were 100%.

4.1 Water Supply Situation in Naivasha Municipality

4.1.1 Water access

According to the Naivasha Water and Sanitation Company, the rapid increase in population within the town had strained the water supply system. The water demand for Naivasha Municipality was 6400m^3 per day and the water company was able to supply only 2700m^3 per day. The water company was not able to achieve the demand for water and the deficit of 3700m^3 was met by alternatives including private boreholes mostly and rainwater harvesting. The boreholes were classified into two, those that contained high fluoride levels and those that contained lower levels of fluoride. Water and Sanitation for the Urban Poor (WSUP) is a non-profit partnership between the private sector, NGOs and research institutions (USAID & WSUP, 2011) which aims to bring lasting solutions to low-income areas by working in partnership with service providers including water utilities, local authorities and businesses, and the communities they serve.

Table 3: Showing Main Water Sources in Different Income Groups

	Low income (n=322)	Middle income (n= 47)	High income (n=16)
Water piped into respondents' house	9.5%	17.4%	25%
Water piped into respondents' yard	23.1%	50%	18.8%
Communal tap/water kiosk/town supply	28.8%	8.7%	0%
Purchase from mobile vendor	30.4%	19.6%	31.3%
Borehole	1.3%	0%	6.3%
Piped into yard and rainwater harvesting	0.3%	2.2%	0%
Shallow well	0.3%	2.2%	0%
Other sources	6.3%	0%	18.8%
Total	100%	100%	100%

The data collected indicated that 29.1% of respondents purchased water from mobile vendors for their daily household needs and 26.2% had water piped into the yard/plot while 25.1% used a communal tap/water kiosk. Only 11.1% of respondents had their water piped into the house as shown by figure 3. The main source of water for the respondents living in high income areas was mostly water purchased from vendors although they were the majority among those who used piped water, as shown by 31.3% and 25% and 31.3% respectively in table 2. The low income groups mostly sourced their water from mobile vendors (30.4%) and communal taps or water kiosks as shown by 28.8% of respondents. The main source of water for the middle income group was water piped into their yards as shown by 50% of the respondents in table 2.

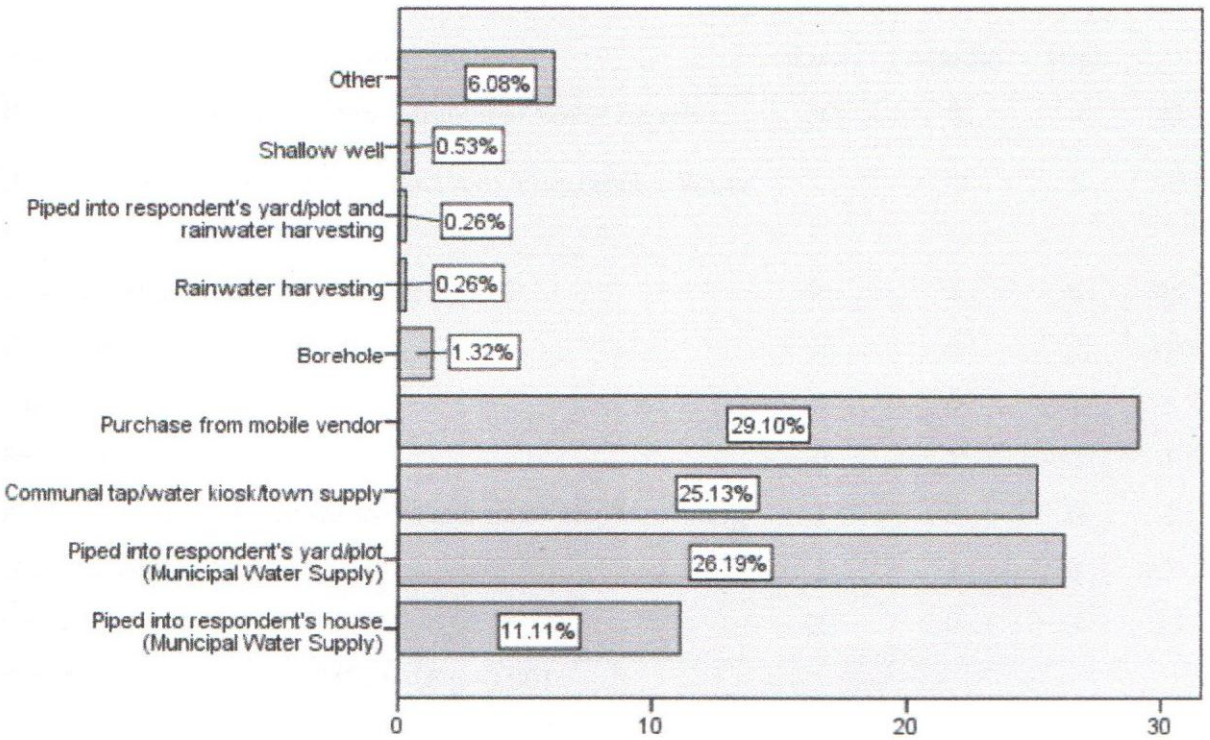

Figure 3: Main Sources of water for domestic use

Table 3 shows there was a significant difference in the main source of water for domestic uses in the three income levels within the municipality. The low income groups mostly purchased water from mobile vendors because they were unable to meet the cost of water connection to their houses and also their areas of residence were not served with the water piping from the water company. There being perennial water problems within the municipality, the reticulation of water systems did not cover all areas of the municipality and this accounted for inability to access piped water for some areas. The piped water however was found to be irregular in supply and the high income group also depended on mobile vendors although they were the majority among respondents who indicated that they mostly used piped water. Respondents in Lakeview indicated that their water supply was regular although they supplemented with drums to store water. The middle income respondents mostly used water that was piped into their yards.

Table 4: Cross tabulation of Main source of domestic water and level of income

Main source of domestic water	Level of income			Total
	Low	Middle	High	
Piped into respondent's house(Municipal Water Supply)	30	8	4	42
Piped into respondent's yard/plot(Municipal Water Supply)	73	23	3	99
Communal tap/water kiosk/town supply	91	4	0	95
Purchase from mobile vendor	96	9	5	110
Borehole	4	0	1	5
Rainwater harvesting	0	1	0	1
Piped into respondent's yard/plot and rainwater harvesting	1	0	0	1
Shallow well	1	1	0	2
Other	20	0	3	23

Pearson chi-square=49.618[a] df=16 p=0.001

In Naivasha, WSUP works in the low income peri-urban settlement of Mirera- Karagita that is situated 6km from Naivasha Town. In Naivasha, boreholes are the main source of water and most of the underground water is characterised by high levels of fluoride which causes dental and skeletal fluorosis. WSUP runs the Mirera-Karagita Water and Environmental Sanitation Programme which aims to reach 100,000 people in the Naivasha area with improved water and sanitation services, together with better hygiene. The project runs a model where the water services provider, water company and community run decentralised water treatment plants under an operating agreement, while private and community boreholes provide the water. Fluoride filters, using locally produced bone char, are used to treat the high level of fluoride in the drinking water sold to kiosks in the programme area. The project also provides untreated water for washing and cooking at a lower price.

In an interview with WRMA, initially the water supply to Naivasha town was surface water from the Aberdares. However, due to abstractions upstream, this source could not be relied on and therefore water supply was changed to boreholes which had a more reliable supply. However, there was groundwater flowing from Kinangop and this was used to serve estates such as

Lakeview which was a high income residential area. Residents in Lakeview area indicated that water was reliable and of good quality.

The study found out that purchasing water daily from mobile vendors or water kiosks was costly to the respondents in the middle and low income areas as they ended up spending a considerable amount of their income to buying water. However due to the irregular supply of water, the study found that even respondents in high income areas could sometimes buy water from mobile vendors. In peri-urban areas of Accra, although most water is sold primarily through standpipes, 20 percent of that water is resold by cart operators. Likewise, standpipes in Khartoum sell most of their water (80 percent) to cart operators, who then resell it to households. Similarly, in Ouagadougou, more than 80 percent of water sold at standpipes is bought by carters and not by individuals. In Luanda, Angola, most of the water delivered in peri-urban areas, where the majority of the population lives, is brought in by trucks that sell water obtained either from the piped water system or directly from the river. The water trucks then sell the water to an estimated 10,000 non-mobile water vendors, primarily households that have built water storage tanks. These households in turn sell the water to the rest of the population. In peri-urban areas of Luanda, 70 percent of the dwellers purchased their water from water vendors (Keener, *et.al.*, 2010).

Wholesale vendors may own a borehole or may buy water in bulk either from private borehole owners or from utility companies. These vendors own or rent tanker trucks with large capacity which allow them to then sell bulk quantities of water to small scale vendors. Distributing vendors go to the consumer, usually door-to-door and make up the majority of the small water enterprises. In low income countries, a vast number of households depend on small water enterprises (vendors) who are viewed as an interim solution before utilities are built or completed. Vendors are most active in areas with multiple barriers to piped systems or where the utility supplied water was unsanitary or inconvenient. Barriers to constructing piped systems included terrain that was difficult to access with piping, high costs of utilities, squatter settlements that are not officially recognized, rural areas where housing is extremely spread out and peri-urban areas that spring up too quickly for utilities to keep pace (Opryszko *et. al.* 2009).

From this study, 62% of the respondents used improved sources of water (Figure 3). Improved sources of water are sources that provide safe drinking water including household connection, public standpipe, boreholes, protected dug well, protected spring and rainwater (WHO, 2000) . In Kenya about 53 percent of the water provided by small-scale providers comes from "improved sources" (UNDP, 2011). The study therefore showed that many people in Naivasha used water from improved sources. Further, overally only 57% of households in Kenya use water from sources considered safe (GoK, 2007). However, Kenya's vision of ensuring water and sanitation are available and accessible to all by 2030 still faces challenges of achievement and this means that by extension, Kenya might not attain the MDG target of halving the proportion of the population without access to safe drinking water and basic sanitation due to challenges of urbanization and rapid population growth. The inadequate access to safe drinking water may result in the worsening of hygiene standards and proliferation of diseases due to water storage and use of alternative water sources. Furthermore, the low and middle income groups will continue spending more than the required amounts of their household income in the purchase of water for domestic use. The ability of mobile vendors, such as pushcarts and tanker trucks, to obtain water from a variety of sources allows them to supply water in times of shortage. This, however, also introduces an information gap regarding the quality of water sold, as end users have little means of verifying the safety of the water they purchase. Inferior quality pipes used by illegal connections break easily, and initially safe water can thus be contaminated by garbage, other toxic residuals, and impure external water flows (UNDP, 2011).

4.1.2 Alternative water sources

From the household survey carried out the alternative sources of water supply used by residents was mostly from rainwater harvesting (45%) as shown by figure 4. This rainwater harvested was bought from people who owned storage tanks such that they stored the water and sold to residents as an alternative for drinking water or during the dry season when water supply was diminished then this was an alternative. Although some households were living in plots that had underground water tanks that they depended on for water supply, when this water got finished they resorted to buying from mobile vendors until the following rainy season when the water would be collected and stored for their use.

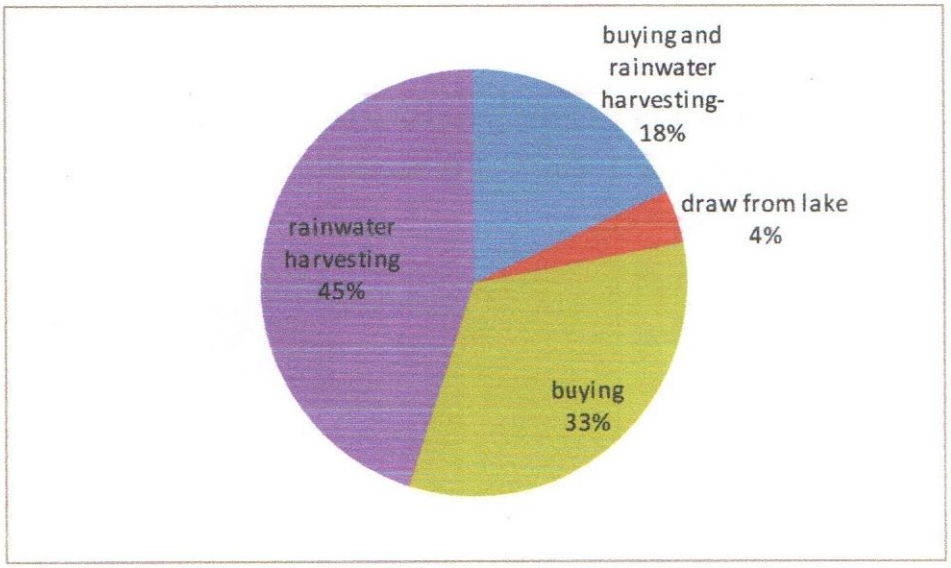

Figure 4: Alternative sources of water for domestic use

4.1.3 Water quality

According to the Naivasha Water and Sanitation Company the municipality mostly uses the water from boreholes that have low fluoride from the northern part of the town towards Nakuru. However, the residents living in areas established by flower farms are supplied by water from boreholes that have high fluoride levels of 9mg/l much higher than the 0.5-1.5mg/l recommended by the WHO, and the water is salty. High fluoride levels in water cause dental fluorosis and it was observed that some of the residents' teeth had brown markings as an indication of the high fluoride levels in the water. In order to cope with the limited water supply and fluoride in the water, some respondents opted to buy water for drinking from shops selling bottled water. But this was expensive and some opted to look for individuals who had rainwater storage tanks to purchase potable water.

Table 5 shows the perception of water quality of the main source of domestic water in the three levels of income. Respondents in the low income perceived their main source of water which was from mobile vendors' to be of good quality (71.9%). The middle income group who depended on water piped into the yard or plot perceived their main water source to be of good quality as shown by 80.4% of respondents. The high income respondents also depended on mobile vendors as their main water source since the water piped into their houses was irregular in supply.

Table 5: Perception of water quality

Level of income	Main source of water	Perception	%
Low	Purchase from vendor	Very good	3
		Good	71.9
		Fair	25.6
		Bad	1.9
		Very bad	0.3
		Total	100
Middle	Piped into	Very good	2.2
	Respondents yard	Good	80.4
		Fair	17.4
		Total	100
High	Purchase from mobile	Good	68.8
	vendor	Fair	31.3
		Total	100

Water from mobile vendors was perceived to be of good quality as shown by 68.8% of respondents saying the water was good. This means that the residents may not treat the water before use, because their perceptions did not reflect the true condition of the water which most often than not was contaminated. Water treatment options should consider that the residents perceive the water to be of good quality and may therefore not value treatment before use. These results indicated the possibility of a well-developed water market in Naivasha despite the handling practices of the vendors. Owing to the perennial water problem in the town, it was possible that trust relationships between specific vendors and residents had been established and thus creating royalty and perceived quality in commodity delivery. The implications were that the people continuously used contaminated water and therefore would continue suffering from water related diseases.

The results are an indication that water supply was a major problem in Naivasha as most people bought from mobile vendors who ferried water in drums and sell to the residents. The residents also complained that the vendors used their mouth to pull the water from the drum using a pipe and thus leading to possible contamination of the water. The quality of the water was thus not assured since the vendors did not disclose the source of water that they sold to residents. Rainwater was less contaminated if used within the compound of the water tank storage but if the water was collected then transported to be sold to users outside the premises then the water quality was compromised. Plate 1 showing a mobile vendor with drums on a donkey cart. Water supply within the CBD is also a challenge since the vendors also supplied water to various premises within the town centre.

Plate 1: Water vendor with drums on donkey cart

The quality of water from mobile vendors was compromised because of the handling, contamination mostly occurs during handling. The water vendors purchased water from borehole water stored in overhead tanks as shown by plate 2 then the water was transported by drums and jerry cans to the end users. The vendors did not clean the water vessels before any refill and this was the point of contamination of water before it reached the users. Rainwater harvesting was cleaner and this was attributed to less handling of the water if the water was used within the

premises of the rainwater collection tank. However depending on air quality it could contain some chemicals.

In a study conducted by Donde et.al,. (2013) in Naivasha, it was found out that the contamination of water in samples increased after water was collected and stored from safe sources because of contamination through hands, unwashed containers and dippers. Therefore based on this, where basic sanitation was lacking, there was more likelihood of indicator bacteria from faeces being introduced into stored water. Using uncovered water containers was also likely to increase water contamination between source and point-of –use as hands were dipped into vessels to scoop a cupful of water. There were also a number of health concerns associated with water supplied to consumers by water vendors. These included inadequate treatment or poor transport using inappropriate containers, which could result in contamination.

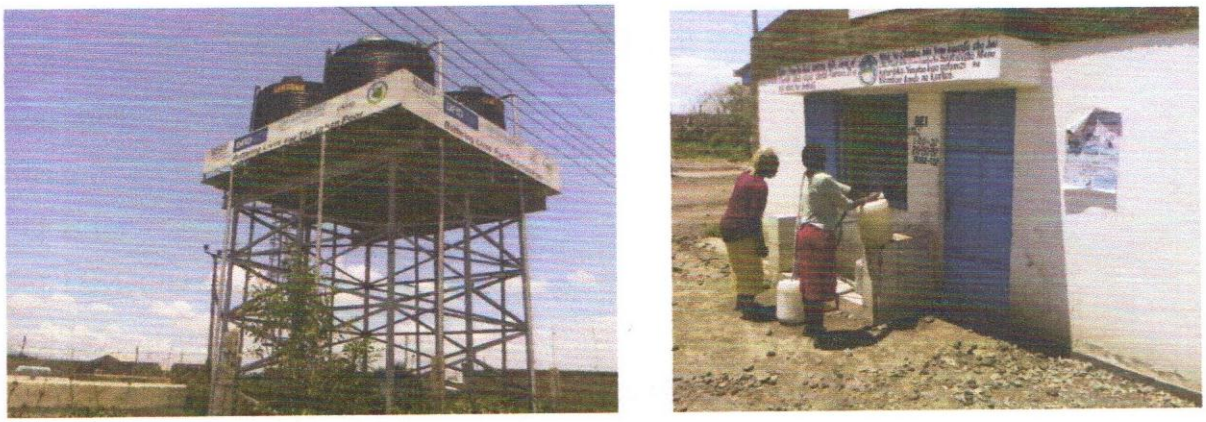

Plate 2: Water stored in overhead tanks for distribution

The water problems experienced was mostly salty water that was represented by 31.8% of the respondents. During the survey the households said that the water was salty and not suitable for drinking. They resorted to alternatives such as buying bottled water for drinking and rainwater harvesting. For the residents who did not have harvested rain water they bought from households that had stored rainwater in their tanks.

4.1.4 Per Capita water use

Table 6 presents results on the daily water usage in Naivasha and how it differed among the income brackets. These results showed that the average daily usage was 21, 22 and 23 litres per person daily for the low, middle and high income brackets respectively. The results indicated that there was no significant difference between the amounts of water used per person per day in the three income levels (p= 0.829). Though there was huge intra income variation in water usage, the results indicated that water is truly a basic commodity which, if accessible, income doesn't greatly influence consumption.

This could imply that water use in households was mostly significant depending on the number of household members and the amount of household activities that require water use per day. More washing and cooking within a household would require more water overall in a household.

Table 6: Comparison between water quantities used per day (litres)

	Low Income (N-227)	Middle Income (N-33)	High income (N-9)
Minimum	2.5	3.57	2.86
Maximum	57.14	59.05	60.95
Mean	20.906	21.51	22.93
Std. Error	0.683	2.003	6.18
Std. Deviation	10.284	11.506	18.54

F=0.187 p=0.829

According to the WHO/UNICEF Joint Monitoring Programme (2000) reasonable access to water is described as a person accessing an average of 20 litres per day. The study shows that the respondents' were able to access water as per the required quantities. However, the number of household members and the cost of accessing the water brought the challenge of a household's ability to fully meet the water requirements of each member considering the income levels of the three groups.

4.1.5 Cost of water

The results showed that the low income spent 12% of their income on water, the middle income spent 15.7% of their income on water while the high income spent 2.7% of their income on water. The people in the higher income group were able to meet their households' needs because

of their ability to pay for water but those in the low and middle income had to find ways of meeting the households needs either by using water minimally or finding alternative ways of conserving the water they got by re-using and by delaying some activities so that they were only done at intervals during the week such as washing clothes and the water re-used for cleaning the floors and toilets.

Table 7: Comparison of cost of water per month against monthly income

	Low income (N-148)	Middle Income(N-14)	High income(N-6)
Mean	1592.74	4713.57	1358.33
% of Income	12	15.7	2.7
Monthly income(KShs.)	5,000 – 20,000	20,001-40,000	40,001 – above 50,000

From table 7 the expenditure on water was higher than the recommended range for low and middle income households given that the household had to buy food and pay for shelter among other basic needs. On average, households in Kenya spend 11% of their income on water (UNDP, 2011). This means that many people who cannot afford water to fully cater for their households' needs are forced to cut down on water usage so as to meet other needs and this compromises the hygiene of the households. This may lead to spread of water borne and water-washed diseases due to low hygiene. Also, the sanitation situation of households is compromised due to the inadequate amounts of water required to keep sanitation systems clean. However, for the high income group, their percentage household expenditure on water was within the acceptable range and therefore this group may not be affected much. According to Water Governance Project Partners (2009), households should not spend more than 5% of their income on water. In turn the statistics indicate that households would most likely cut on their expenditure on water by purchasing lesser quantity than their daily demand, purchasing water from cheaper sources or engaging in water harvesting. However, the bottom line is a reduction in overall household welfare due to the high cost of water. In Indonesia, a regulation adopted in 2006 prescribes that domestic expenses for the fulfillment of the standard of basic needs for drinking water should not exceed 4% of the income of the user or household (deemed to earn the provincial minimum wage), (Smets, H. 2009). In industrialized countries, households with an

income equal to the median disposable income generally spend around 1.1% of their income for their water and sanitation bill. Poor households in these industrialized countries spend on average approximately 2.6% of their income. In order to help vulnerable people, public authorities often take measures aiming to reduce water bills to less than 3%.

In transition countries and developing countries, the affordability index is generally higher depending whether the country seeks to reduce subsidies for water. Median households often have to spend 2.5% of their income for water, i.e. over twice what is practiced in industrialized countries. Consequently the affordability index of poor households is about three times larger (7.5%) because of the low income of very poor households (Smets, H. 2009).

4.2 The sanitation systems used by residents in the Municipality

4.2.1 Sanitation situation

The Naivasha Water and Sanitation Company operates a sewer system within the central business district, and still only a part of the CBD is serviced by the sewer system. Businesses within the CBD that don't have access to the sewer system use septic tanks for their sanitary requirements. Naivasha Municipality has had problems with water supply for a long time, and the absence of an established sewerage system can be attributed to the perennial water problems, because a functional sewerage system needs efficient water supply to sustain its operations. The people of Naivasha have therefore resorted to using pit latrines which consume little water in their maintenance as opposed to the water closets or pour flush systems that need a reliable source of water. Most landlords who construct rental houses in their plots use pit latrines for the sanitary needs of the tenants.

Table 8: Sanitation systems used by residents

Type of sanitation	Low income (Frequency/Percentage)	Middle income (Frequency/Percentage)	High income (Frequency/Percentage)
Simple pit latrine	171 (54.1%)	5 (10.6%)	1 (6.3%)
Ventilated improved pit latrine	101 (32%)	11 (23.4%)	2 (12.5%)
Pour flush latrine with septic tank	34 (10.8%)	6 (12.8%)	3 (18.8%)
WC with septic tank	34 (10.8%)	6 (12.8%)	3 (18.8%)
Total	316 (100%)	47 (100%)	16 (100%)

The survey indicated that households in the low income areas mostly used simple pit latrines as shown by 54% of respondents, while those living in the middle and high income areas used water closets connected to the sewer line with 42% and 37.5% respectively as shown by table 8. It was also noted that in the high income areas, there was a substantial amount of households using septic tanks (25%), and this was attributed to the fact that with perennial water problems in the municipality, the use of septic tanks was a better option since the system was managed within the plot and once full, the septic tank would be exhausted and this system was better managed at a micro scale.

During the survey it was noted that the households did not have a choice of the sanitation system they used in the rental house. Once a person moved into a rental house they only utilised what was available in the plot as revealed by 99% of respondents, for their sanitary needs and the number of users notwithstanding, the households had to cope with the conditions they found in the plot. From the study 23% of respondents from the high and middle income could be classified as using optimal sanitation. The challenge still lies in meeting the MDG of halving the proportion of population without sustainable access to basic sanitation. As compared to the water situation, sanitation seems to be lagging behind in Naivasha. More funds need to be channelled to improve the sanitation situation and public private partnerships need to be strengthened so that

the many actors in this sector are harmonised for the realisation of improved sanitation in Naivasha.

According to the WHO and UNICEF in the 2010 report on progress on drinking water and sanitation, improved sanitation facilities are considered to be facilities including pour flush system to sewer system, septic tank and pit latrine, ventilated improved pit latrine, pit latrine with slab and composting toilet. According to the Ministry of Health (June 2013) 72% of excreta disposal facilities in Kenya are simple pit latrines. The situation in Naivasha was therefore a true reflection of the status of faecal disposal countrywide. Most households in the low income areas used pit latrines and there was a likelihood of ground water pollution due to the high amount of faecal matter seeping into the ground from the pit latrines. This was an environmental issue of concern since contamination of groundwater may be caused by poorly designed, operated or maintained sanitation facilities such as pit latrines located in areas with high water tables (USAID, 2009). Pit latrines that are not kept clean are a source of diseases when flies from pit latrines land on food that is ingested thus causing faecal-oral diseases.

4.2.2 Hygiene condition of toilets

Results on table 9 shows indicators that were used to assess the hygiene of toilets in the three income areas. The results showed that a high percentage of pit latrines observed in the low income areas had a wet surface floor (49.50%) and flies (57.80%). These toilets also had an unpleasant faecal smell. Despite the presence of the vent pipe, some pit latrines still had a smell, and this was attributed to the poor hygiene practices given that the number of users of the pit latrines was high and the average number of users was 12 households

Table 9: Comparison of indicators on toilet hygiene in the three income groups

Indicator	Low income	Middle income	High income
Presence of wet toilet floor	49.5%	17%	0
Flies presence	57.8%	21.3%	0
Smell present	59.3%	17%	0
ventilation provided	69.1%	89.4%	86.7%
Presence of clean walls	64.2%	89.4%	100%

According to WHO and UNICEF 2010, only facilities that are not shared or not public are considered to be improved. These results indicated that the hygiene in pit latrines in low income areas was low as compared to the middle and high income areas that had little or no flies with dry toilet floors. From the toilets observed, there were house flies present and also moth flies. Moth flies breed in drains, sewers, septic tanks and soil that has been contaminated with sewage. Therefore the presence of the moth flies in the toilets indicated poor hygiene in the pit latrines. Houseflies typically lay eggs on animal faeces or garbage. When feeding, houseflies regurgitate their stomach contents onto food to liquefy it before ingesting it. They also contaminate food and surfaces by defecating on them. Therefore the presence of flies was a potential for spreading bacteria and disease causing organisms.

During the survey the respondents indicated that they were not satisfied with the conditions of the toilet because they were dirty and were shared by many people but they had no choice of improving the overall conditions of the toilet since this responsibility generally fell on the landlord. Their only contribution was to clean the toilets and in some plots this was done when the women wash clothes then the dirty water was used to clean the toilets. Some pit latrines had poor hygiene as shown by faecal matter on the squat hole. The walls were worn out and contained moth flies which found a good breeding place given the conditions of the toilet.

Table 10: Comparison in percentage of toilets sharing among family members in the three income groups

	Low income	Middle income	High income
Shared	95.3%	40.4%	12.5%
Private	4.7%	59.6%	87.5%
Total	100%	100%	100%

Table 10 above shows how the toilets are shared by users in the high, middle and low income areas. The study showed that people mostly in the low income shared toilets as compared to the middle and high income areas. However, the challenge of shared toilets is cleanliness. Toilets with many users tend not to be hygienically maintained and end up with flies and odour. According to Kwasi (March 2004) high sharing of toilets creates unsanitary and unkempt

conditions which provide conducive environments for vectors and pathogenic organisms associated with infections and also increases the possibility of transmitting pathogens from one infected household to others.

Table 11: Comparison on number of households sharing toilet

Number of Households using the toilet/latrine	Low income (N-251)	Middle income (N-18)	High income (N-2)
Mean	12.4 (60 people)	10.8 (50 people)	4.5 (20 people)
Std. Error	0.68	2.81	1.5
Std. Deviation	10.8	11.9	2.1

F=0.688 df=2 p=0.503

From table 11 there was no significant difference between the sharing of toilets in the three income (p= 0.503). All households therefore shared toilet facilities and the number of households per toilet determined the cleanliness and hygiene of the toilet. From the survey, the average number of households sharing toilets in the low income were found to be 12 households. With an average of 5members per household, this gave a total of 60 people. Also from the above table the survey showed that only households in the high income areas were able to meet the standards provided by the WHO for sharing of toilets with an average of four households (20 people) sharing a toilet. The number of households sharing toilets was quite high in the middle and low income areas given that the maximum number of persons sharing a pit latrine should be 20 users (UNICEF and WHO, 2008). According to the UNICEF and WHO (2008), where one toilet is shared by four or five families, it is generally better kept, cleaner and regularly used.

4.3 Factors that influence water access and choice of sanitation systems

From the survey, it was noted that the factors influencing water access and choice of sanitation included area of residence, level of education, number of household members, the type of toilet used by the household and the main source of domestic water.

Table 12: Correlation between factors influencing water access and choice of sanitation system

		residence	education	number of people in house	Water used per person per day	type of toilet/latrine	main source water
residence	Pearson Correlation	1	-.028	.090	-.108	-.024	.077
	Sig. (2-tailed)		.586	.083	.081	.642	.143
education	Pearson Correlation	-.028	1	-.133**	.066	.342**	-.024
	Sig. (2-tailed)	.586		.009	.281	.000	.641
number of people in house	Pearson Correlation	.090	-.133**	1	-.387**	.028	-.106*
	Sig. (2-tailed)	.083	.009		.000	.584	.041
Water used per person per day	Pearson Correlation	-.108	.066	-.387**	1	.091	-.108
	Sig. (2-tailed)	.081	.281	.000		.142	.079
Type of toilet/latrine	Pearson Correlation	-.024	.342**	.028	.091	1	-.066
	Sig. (2-tailed)	.642	.000	.584	.142		.204
main source domestic water	Pearson Correlation	.077	-.024	-.106*	-.108	-.066	1
	Sig. (2-tailed)	.143	.641	.041	.079	.204	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

From Table 12 there was a positive correlation between the level of education and the type of toilet that the household uses. The study indicated that the low income group mostly had secondary education while those in the middle and high income had tertiary education. This therefore indicated a strong relationship between the level of education and the type of sanitation system used because the higher the level of education the higher the income and thus the ability to access improved sanitation. In a study done by Fening (2008) on the impact of socio-economic status and sanitation levels on the prevalence of diarrhoeal diseases in the Akim Oda area of Ghana, it was established that diarrhoeal transmission is affected by low standard of hygiene and low social class among individuals as a major causative factor in the epidemic. The survey revealed that residents from Old-town and Aduasa belong to low social class and was reflected in their high illiteracy, unemployment rates and associated poor sanitation. As such, they had the highest prevalence of diarrhoeal diseases. Contrarily, residents from Quarters residential area were found to belong to high social class, which was reflected in their high literacy, employment rates and good sanitation. As such, they had no case of diarrhoea (Fening, 2008).

There was a negative correlation between the water used per person per day and the number of people in the household. The more the number of people in the household the less the water was available for their use. This was caused by the high cost of water that was especially felt by the low income households who ended up paying more for water than the middle and high income groups. The implications of this was that the hygiene standards of the low income households were compromised and household members were prone to water washed diseases including eye infections and scabies.

4.4 The prevalence of diseases related to water and sanitation

Prevalence is the proportion of people in a population who have a particular disease at a specified point in time, or over a specified period of time (Roe, March 2000). From the survey, it was revealed that the prevalence of diseases related to water and sanitation including cholera, typhoid and diarrhoea was low.

Table 13: Comparison of prevalence of water and sanitation related diseases in last 6 months

Disease	Prevalence rate per 100 persons Low income	Prevalence rate per 100 persons Middle income	Prevalence rate per 100 persons High income
Cholera	0.5	0	0
Typhoid	8.85	0.78	0.26
Diarrhoea	14.06	0.78	0.26
Repeated eye infections	10.68	1.56	0
Scabies	0.78	0	0

The prevalence rate for typhoid in the last 6 months in the low, middle and high income areas was 8.85, 0.78 and 0.26 per 100 persons respectively. These results indicate that typhoid is more prevalent than cholera in Naivasha municipality and affects all income groups but with the low income group bearing the brunt of the disease. Therefore interventions targeting the low income group would achieve greater results since this is the group that is more vulnerable.

Diarrhoea was the most prevalent disease as per the study results affecting more people than all the diseases across the income groups. Though this was attributable to water, it was also possible that other factors than water such as contaminated food caused diarrhoea. However like in the case of the above two diseases, the low income group was the most vulnerable.

The prevalence of repeated eye infections was 10.68 per 100 persons in the low income and 1.56 per 100 persons in the middle income areas. The prevalence of eye infections indicated poor hygiene which could arise from insufficient amounts of water for personal hygiene. This was especially so in the low income households which had to minimise per capita use because of the high cost of water. The results indicated that there were no cases of repeated eye infections in the last 6 months in the high income group. Further the prevalence of scabies in the last 6 months was less than 1 per 100 persons among the low income group. The results indicated that there were no cases of scabies in the middle and high income areas in the last six months. Water related illnesses are related to water shortage and contamination and diseases that are related to

vectors whose part of their life cycle are in water habitats. Water related diseases are caused by micro-organisms, parasites, toxins and chemical contamination of water (Stanwell- Smith, 2003). Results indicated that the most prevalent disease was diarrhoea which occurred in the low income group. Diarrhoea is majorly caused by poor hand hygiene as well as water contamination. Earlier results indicated that the people living in the low income group sourced their water mostly from mobile vendors. Approximately 80 percent of hospital attendance in Kenya is due to preventable diseases and about 50 percent of these illnesses are water, sanitation and hygiene related. Coverage of adequate sanitation has dropped from 49 percent to 43 percent in recent years. 16 million (50 percent) Kenyans do not have adequate sanitation. (Njuguna and Muruka, 2011).

The containers and drums and jerrycans that transported this water were not kept clean and their hygiene was not maintained. This was an indication of the causes of a higher prevalence rate of diarrhoea among the low income group as compared to the middle and high income groups. It was also noted that majority of low income residents used pit latrines for their sanitation and these toilets were not kept clean. Therefore the presence of flies could cause the spread of faecal oral diseases. The absence of adequate amounts of water also compromises the hygiene of users of the toilet especially hand washing which may not be adhered to after every visit to the toilet.

4.5 Water conservation methods in use by residents in Naivasha Municipality

Table 14: Water storage and conservation methods

	Low income		Middle income		High income	
Storage/Conservation method	Frequency	%	Frequency	%	Frequency	%
storage in containers/jerrycans	232	94.7	39	97.5	8	88.9
re-use of water	5	2.0	-	-	-	-
none	8	3.3	1	2.5	1	11.1

Due to the perennial water problems within the municipality, the survey revealed that the households were storing their water for use and this was replenished once used up. Water was stored in 100 and 200 litre containers and 20-litre jerry cans for future use. The practice of water storage was done across the three income levels and this was due to the irregular supply in areas

that had piped water. For the plots that had water tanks, rainwater was harvested and stored. This water was used for drinking mostly and cooking while for washing clothes and bathing, water from mobile vendors was used. The households also indicated that they were minimising on their daily water use in household chores. Some households reported that they only washed clothes a few days in a week so as to minimise their water use. With a daily usage of about 20 litres and 38% of daily income being spent on water, the residents of Naivasha appeared very keen on water conservation and waste water reuse. The water that had been used to wash clothes was used to wash toilets so that the use of clean water on the toilets was minimised.

4.6 Solid waste collection methods used within the municipality

Table 15: Solid waste disposal methods

	Low income		Middle income		High income	
Solid waste disposal	Frequency	%	Frequency	%	Frequency	%
Municipal waste collection (MWC)	90	28.4	32	68.1	9	56.3
Private collectors	39	12.3	2	4.3	0	0
Open dumping	116	36.6	3	6.4	1	6.3
Waste pit	32	10.1	4	8.5	0	0
Burning	4	1.3	1	2.1	1	6.3

The majority of households within the municipality had their solid waste collected by the municipality as indicated in Table 15. However, this was closely followed by open dumping as the means of waste disposal. There was a lot of open dumping observed within the residential areas especially in some middle and low income residential areas. Rubbish heaps act as breeding grounds for pests and this was a health risk for households living in these areas. Open dumping also contaminates the soil when some components of bottles or cans leak into the ground. This causes soil pollution and makes the environment unsightly.

From table 15 the waste disposal method used in the low income areas was open dumping as indicated by 36.6% of respondents who practice open dumping. In the middle and high income areas, the main waste disposal method used was municipal waste collection.

Plate 3: Open dumping observed

From the survey it was also noted that 92% of households did not sort the waste before disposal. Only 8% of households sorted their waste by separating bio degradable waste and non-biodegradable waste. The biodegradable waste was applied to vegetable gardens or put into a composting pit which would be emptied into the garden when full. The non-biodegradable waste was mostly burnt. There were a lot of plastic papers observed mostly strewn around the residential areas. These plastics are an environmental hazard as they act as breeding ground for pests especially when they carry moisture. Open dumps are normally burnt to reduce the volume. The burning wastes especially plastic bags is hazardous to health as the smoke contains dioxins, carbon monoxide, nitrous oxide and carbon monoxide which cause respiratory complaints, eye and ear irritations, coughing, dizziness, and headaches in the short term and cancer and heart disease in the long term. Children using open dumps as playgrounds get into contact with burning wastes and occasionally get burnt.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study established that access to water supply and sanitation in Naivasha municipality was a big challenge. The study revealed that only 63% of the residents were able to access improved water sources. However, the average water usage per person did not differ much between the low, middle and high income areas. On the amount of income used on water expenditure per household, the study showed that people in the middle and low income areas spent more than the recommended percentages of their income on water.

In Naivasha only 23 % of respondents used optimum sanitation. The sanitation system used by the low income group was mostly pit latrines and the middle and high income groups used water closets connected to the sewer line. However, there was a substantial use of septic tank by the high income group due to the perennial water shortages. The toilets especially in the low income had poor hygiene and this could be attributed to the high number of users per toilet.

From the study, the factors that influenced water access and choice of sanitation systems included area of residence, level of education, number of household members, type of toilet used and the main source of domestic water available for the household to use. For example a higher level of education of household members meant a higher income and hence access to improved sanitation. The higher the number of household members meant that the household used more water overally as compared to households with a lower number of members.

The water and sanitation related diseases that occurred included cholera, typhoid, diarrhoea, repeated eye infections and scabies but the most prevalent disease was diarrhoea and could be attributed to poor hygiene and water contamination.

Water storage and conservation was practised in Naivasha where due to the irregular supply people were compelled to store water in 100 litre and 200 litre containers and 20 litre jerrycans for future use. Water storage was practised in households across the three income groups. Waste

water re-use was an important aspect especially in the low income areas so as to reduce on the amount of freshwater used by the household.

The methods used for solid waste collection and disposal in Naivasha were municipal collection, open dumping and burning. The waste was not sorted before disposal and this resulted in heaps of garbage that were attracting flies and animals foraging on the wastes helped spread diseases.. This was a source of pollution since hazardous waste could be dumped and seep into the ground. The burning of wastes also polluted the environment since it was not selective burning.

5.2.1 Recommendations

Current water sources should be optimised and alternative sources developed and sustained so that disparities in expenditure on water can be mitigated. Rainwater harvesting should be encouraged so that water is treated and stored for future use.

More funding needs to be channelled towards sanitation improvement so that it does not lag behind water supply. All actors in the public and private sector should initiate more projects on sanitation so that the benefits of improved water supply can be anchored with improved sanitation for the residents.

Residents should be supported and encouraged to form community organisations that endeavour to clean the environment. Waste paper recycling should be encouraged as an economic activity where organised groups collect, treat and recycle polythene paper and turn them to materials with various uses. The Municipality should instil in people the practice of sorting out wastes before disposal to ease the management of different waste streams.

5.2.2 Recommendations for Further Studies

More study work should be done on the effect of pit latrines on the quality of underground water both from shallow wells and boreholes and the effect of the water on human health.

Also, more studies should be done on the quality of water sold by mobile vendors which was a major source of water that is depended on by the people across the three income groups.

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APPENDICES

APPENDIX 1

Survey questionnaire for Households in high, middle and low income settlements (June 2012)

Introduction

Hello, my name is _____. I am a researcher/student from Egerton University which is conducting research on various human and economic activities and how these have affected the physical environment and human health within the Lake Naivasha area. I am interested in the water and sanitation conditions at home and the effect they have on people's health. The interview will take about 30 minutes and you will be asked questions about your home environment, your work environment and your health. The information you provide is totally confidential and will only be used for research purposes. At no time will the information be disclosed to anyone. Your participation is voluntary and you can withdraw from the survey after having agreed to participate. You are also entitled to refuse to answer any question in the questionnaire that may seem to touch on issue you consider private and confidential to your person. If you have any questions about this survey, you may ask me or contact Dr. W. Moturi, Department of Environmental Science, Egerton University, P. O. Box 536, EGERTON, KENYA.

Respondent name and signature (optional)_____

Interviewer _____

Date _____ Place of Interview _____

Time of Interview _____

	PART 1: DEMOGRAPHIC DATA	CODE
1.	Name of Enumerator:	
2.	Code of Household/Individual:	
3.	Area of residence: Sub-loc _____ Location _____ Division _____	
4.	(Age) of respondent (Optional) :	
5.	Sex: Male: [1] Female [2]	
6.	Marital status Married [1] Divorced [3] Single [2] Widowed [4]	
7.	Total number of people living in household	
8.	Total number of children in family	
9.	Total number of children aged 5yrs and below	
10.	What is your level of education? No formal education [1] Lower primary [2] Upper primary [3] Secondary [4] Tertiary [5]	
11.	What is the level of education of your spouse? No formal education [1] Lower primary [2] Upper primary [3] Secondary [4] Tertiary [5] Don't know [6]	
12.	What is your occupation? Self employed [1] Government employee [2] Flower farm worker [3] Other private sector employees [4] (Specify employer)_____ Others (Specify)_____	
13.	How long have you worked in the present employment (livelihood)?	
14.	On average, what is the family's income per month? Below 5000 [1] 20001 – 30000 [5] 5000 – 10,000 [2] 30001 – 40000 [6] 10001 – 15000 [3] 40001 – 50000 [7] 15001 – 20000 [4] above 50,000 [8]	

15.	How long have you lived in Naivasha town?	
16.	Is the house you are living in Rented? [1] Owned [3] Care-taking [4] Other? Specify_____	
17.	If rented, how much rent do you pay per month? KSh_____	
18.	Type of house Permanent (brick wall & iron/tile roof) [1] Semi-permanent (iron roof & mud wall/cement floor) [2] Non-permanent (timber/mud/wall/iron roof/earthen floor) [3] Other (Specify)_____	
19.	What is your source of energy for heating?(Allow for multiple responses) a) Wood fuel [1] b) Electricity [2] c) Charcoal [3] d) Kerosene [4] e) Gas [5] f) Other specify [6]	
20.	What is your source of lighting?(allow for multiple responses) a) Kerosene [1] b) Electricity [2] c) Solar [3] d) Other specify _____	
	PART II: WATER AND SANITATION	
21.	What is the main source of your domestic water? Piped into respondents' house (Municipal water supply) [1] Piped into respondents' yard/plot (Municipal water supply) [2] Communal tap/water kiosk/town supply [3] Purchase from mobile vendor [4] Other (Specify)_____	
22.	What factors determine your choice of source of water? _____	

23.	What is your alternative source of water supply?(Allow multiple responses) Buying [1] Rainwater harvesting [2] Draw from lake [3] Other (specify) _____	
24.	How do you perceive the quality of your main source of water? Very good [1] Good [2] Fair [3] Bad [4] Very bad[5]	
25.	What is the total cost of water used in your household per month? KSh	
26.	How many litres of water does your household use per day for the following (1 jerry can = 20litres) Kitchen (Cooking, washing utensils) Washing clothes (per week) Flushing toilet Bathing Irrigation of crops Other (specify)	_____ _____ _____ _____ _____
27.	Is this water supply adequate for your needs? Yes [1] No [2]	
28.	List the problems you experience with regard to water supply in this area? _____	
29.	List the ways/mechanisms you employ to cope with these problems? _____	
30.	What water conservation methods do you practice in your household? _____	
31.	What type of toilet/latrine does your household use? Simple pit latrine [1] Ventilated improved pit latrine(VIP) [2] Pour flush latrine with septic tank [3] WC with septic tank [4] WC connected to sewer [5] Others (specify) _____	
32.	Why do you use this type of sanitation system?	
33.	Is the toilet/latrine shared or private? Shared [1] Private [2]	
34.	If shared how many households use the toilet/latrine?	
35.	If you use a pit latrine, what happens when the latrine gets full? _____	
36.	Does the toilet satisfy your sanitation requirement? Yes [1] No [2]	
37.	If answer to Q.36 is No, what are the reasons?	
38.	(a)How many times per week is the toilet/latrine cleaned?(Observe) Every day [1] 4-6 times [2] 2-3 times[3] Once [4] None [5]	

Item	Yes/No	Enumerator's

				remarks
		Dry toilet surface/floor		
		Flies		
		Smell		
		Clean walls		
		Ventilation		
		Other (specify)		
39.	Where is the waste water from the kitchen drained? _____			
40.	Where is the waste water from the bathroom drained? _____			
41.	How do you manage your solid waste? (Multiple answers allowed) Municipal waste collection [1] Private waste collectors [2] Open dumping [3] Waste pit [4] Burning [5] Burying [6] Along the road/vacant space [7] Composting [8] Others (specify) _____			
42.	If your waste is collected (Q41) how much do you pay for waste collection? KSh			
43.	Do you sort the waste before collection? Yes [1] No [2]			
44.	Are you satisfied with the waste management system in your residential area? Yes [1] No [2]			
45.	If no in Q44 list the reasons? _____ _____			
46.	List the diseases have the adult members in your household suffered from in the last six months? (multiple answers allowed)			
		Disease	**Yes /No**	**Frequency**
		Cholera		
		Typhoid		
		Diarrhea		
		Repeated eye infections		
		Scabies		
47.	In your opinion, what could have caused the diseases in Q46 above? _____ _____			

APPENDIX 2

QUESTIONNAIRE TO THE MUNICIPAL COUNCIL OF NAIVASHA (JUNE 2012)

QUESTIONNAIRE

ON

Water Supply trends and Sanitation Situation in Naivasha Municipality

Municipal Council of Naivasha

1. What is the water demand for Naivasha municipality? _____
2. What is currently being supplied to meet the water demand?_____
3. What is the deficit in water supply?_____
4. How is the deficit met?_____
5. What is the water quality being supplied within the municipality? _____
   _____
6. What are the water pollutants likely to be generated from waste water from the various activities within the town? _____
   _____
7. What are the methods used for disposal of human waste within the municipality?
   _____
8. Is the chosen method efficient in waste treatment?
   _____
9. What is the capacity of the sewage treatment system and does it meet the demands of the population?
   _____
10. Are all areas of the municipality covered by the sewage system? (a) Yes (b) No
11. If not, what alternatives do people use?_____
    _____
12. Are these alternatives effective in waste management? (i) Yes (b) No
13. If No, what are the challenges of using the alternative _____
    _____
14. What methods of dealing with storm water does the municipal council use? _____
    _____

APPENDIX 3

QUESTIONNAIRE TO THE NAIVASHA WATER AND SANITATION COMPANY (JUNE 2012)

Naivasha Water and Sewerage Company

1. What is the water demand for Naivasha municipality? _____
2. What is currently being supplied to meet the water demand? _____
3. What is the deficit in water supply? _____
4. How is the deficit met? _____
5. What is the water quality being supplied within the municipality? _____
6. What pollutants have been found in the water being supplied? _____
7. Has the source of these water pollutants been established? _____

_____

8. What water conservation methods are currently being used to help ease the demand for water within the municipality?

_____

8. How is waste water disposed of?

_____

_____

9. What are the methods used for disposal of human waste within the municipality?

_____

10. Is the chosen method efficient in waste treatment?

_____

11. What is the capacity of the sewage treatment system and does it meet the demands of the population?

_____

12. Are all areas of the municipality covered by the sewage system? (a) Yes (b) No

13. If not, what alternatives do people use? _____

_____

14. Are these alternatives effective in waste management? (i) Yes (b) No

15. If No, what are the challenges of using the alternative _____

_____

APPENDIX 4

TABLE 1: FIELD OBSERVATION SCHEDULE

Item	Yes/No	Enumerator's remarks (Clean, Fair, Dirty)
Dry toilet surface/floor		
Flies		
Smell		
Clean walls		
Ventilation		
Other (specify)		

Table 2: Cross tabulation of Main source of domestic water and level of income

		Level of income			Total
		Low	Middle	High	
What is the main source of your domestic water	Piped into respondent's house(Municipal Water Supply)	30	8	4	42
	Piped into respondent's yard/plot(Municipal Water Supply)	73	23	3	99
	Communal tap/water kiosk/town supply	91	4	0	95
	Purchase from mobile vendor	96	9	5	110
	Borehole	4	0	1	5
	Rainwater harvesting	0	1	0	1
	Piped into respondent's yard/plot and rainwater harvesting	1	0	0	1
	Shallow well	1	1	0	2
	Other	20	0	3	23
Total		316	46	16	378

Pearson chi-square=49.618[a] df=16 p=0.001