CHALLENGES AND PROSPECTS FOR SUSTAINABLE WATER SUPPLY FOR KAJIADO TOWN, KAJIADO COUNTY

By

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A Research Project report submitted in partial fulfillment of the Requirements for the Award of the Degree of Master of Environmental Planning and Management in the School of Environmental Studies of Kenyatta University.

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DECLARATION

This research project is my original work and has not been presented for the award of a degree in any other university.

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DEDICATION

I dedicate this report to my loving wife Susan Mutuma, my daughter Nataly Mwendwa and my son Levin Mugambi for their incomprehensible support and fore bearing they endured with me to behold the successful end.

ABSTRACT

Kajiado town, the County headquarters for Kajiado County which is classified as semi-arid area, lacks adequate water supply systems. The town had a projected population of 16,003 in 2013 (KNBS, 2010) but no functional municipal water supply system. There is no permanent river near the town and the town has a formation with poor aquifer such that even bore holes have low water yields. Water is sold at an exorbitant price given that a twenty (20) litre jerry can cost on average Kshs 10 which translates to Kshs 500 per m^3 compared to Water Services Regulatory Board tariff of Kshs 35 per m^3.

The objectives of this study was to review the Policy, Legal and Institutional framework for water supply in Kenya, evaluate the existing water supply systems in the town, establish the water demand and opportunities for a sustainable water supply such as an integrated water supply plan for Kajiado Town.

There was an apparent lack of statutory way of prioritizing allocation of water resources as evidenced by diversion of water from Norturesh – Athi River – Kajiado pipeline for irrigation even when domestic demand has not been met. It was established that Olekejuado Water and Sewerage Company has a weak technical and resource capacity to meet the water demand for the town which is estimated to be 1387.76m^3/day in 2014 and is projected to be 1460.77m^3/day, 1959.96m^3/day and 2783.62m^3/day in 2016, 2026 and 2036.

Both national and county government need to put in place water policies and legislations to guide and accelerate water supply services. A reservoir can be constructed along Olekejuado River to harvest surface run off like the case of Maruba dam in Machakos County. Further exploration of ground water needs to be carried out and establish locations with potential for high yielding bore holes which can be developed to supplement harvesting surface run off.

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ACRONYMS AND ABBREVIATIONS

IRC	International Rescue Committee
WHO	World Health Organization
KEWASNET	Kenya Water and Sanitation Network
JMP	Joint Monitoring Programme
UN	United Nations
KNBS	Kenya National Bureau of Statistics
KM	Kilometer
WRMA	Water Resources Management Authority
WSRB	Water Services Regulatory Board
WSTF	Water Services Trust Fund
WAB	Water Appeal Board
OWNP	One WASH National programme
WASH	Water Sanitation and Hygiene
MoU	Memorandum of Understanding
WIF	WASH Implementation Framework
GoE	Government of Ethiopia
GTP	Growth and Transformation Plan
NEMA	National Environment Management Authority
EIA	Environmental Impact Assessment
NCEH	National Center for Environmental Health
NIC	Non Individual Connection
IC	Individual Connection
CIDP	County Integrated Development Plan

CHAPTER ONE
INTRODUCTION

1.1 Background to the Problem

Water is at the center of economic and social development; it is vital to maintain health, grow food, manage the environment, and create jobs. Yet in the year 2007, 1.2 billion people did not have access to safe water supply (IRC, 2007). Despite water's importance, over 783 million people in the world are still without access to improved water sources, and even more are without access to consistently safe drinking water (World Bank, 2013). Water, sanitation and hygiene related diseases such as diarrhea killed two million people and caused four Billion episodes of illness worldwide in 2011 (WHO, 2012). Previous analyses have shown that global spending to meet the Millennium Development Goals in Africa for drinking water is a quarter of what is required (WHO, 2012).Between 75 million and 250 million people in Africa will be living in areas of high water stress by 2030, with water scarcity in some arid and semi-arid places likely to displace between 24 million and 700 million people (Dominique Bureau and Eric Strobl, 2012).

Kenya is classified as a chronically water scarce country meaning that it is a country with less than $1000m^3$ of fresh water available per person per year (Ministry of Water and Irrigation, 2006). Kenya's limited fresh water amounts to only 647 m^3 per capita, which is decreasing rapidly due to population increase and climatic changes and is projected to be less than $245m^3$ per capita by 2025 (KEWASNET, 2012).

Drought and flooding are both common in Kenya and have been made worse in recent years due to the effects of climate change and urbanization. These natural disasters add to the challenge of sustainable Water access. According to JMP (2012), piped water to premises in urban areas in Kenya has been declining. It was 56% in year 1990, 50% in 2000 and 46% in 2010. Access to water is a key milestone in hygiene and health improvement. On 28 July 2010, the UN General Assembly recognized that safe and clean drinking water and sanitation are human rights, essential to the full enjoyment of life and all other human rights (JMP, 2012). Subsequently, at

its 15th session in September 2010, the UN Human Rights Council affirmed that the right to water and sanitation is derived from the right to an adequate standard of living and inextricably related to the right to the highest attainable standard of physical and mental health, as well as to the right to life and human dignity (JMP, 2012). Access to water is also one of the government's targets as per millennium development goal 7 targets 7(c). Further, Article 43(1) (d) of the Constitution (2010) recognizes the right to water. It provides that 'every person has the right to clean and safe water in adequate quantities'.

Water resources development and management are managed at two levels according to Kenya's Constitution 2010. At the national level, the Ministry of Environment, natural resources and Water is in charge of legal and policy framework for water resources development, while the County governments are responsible for water distribution and facility management. The Kenya water sector underwent far-reaching reforms through the national Water Policy Initiative of 1999 with the legal backing by Water Act of 2002 and further enhanced by Kenya constitution 2010.

Kajiado County which is classified as semi-arid area lacks adequate water supply systems. This can be derived from the fact that Kajiado town being the county headquarter with a projected population of 16,003 in 2013 (KNBS, 2010) has no functional municipal water supply system. During the construction of Kilimanjaro –Athi river pipeline, the town was given an off take but due to rising water demand upstream, the line does not convey any water to Kajiado town. Residents buy water of unknown quality from vendors thereby putting their health at risk.

1.2 Problem statement

Kajiado town, the County headquarters for Kajiado County which is classified as semi-arid area, lacks adequate water supply systems. The town had a projected population of 16,003 in 2013 (KNBS, 2010) but no functional municipal water supply system.

Kajiado town is supposed to be served by water from NolTuresh – Machakos – Kajiado water supply system managed by National Water and Pipeline Corporation. This system was commissioned in 1991 with a lifespan of twenty (20) years. Increased demand upstream in towns such as Loitoktok, Emali, Sultan Hamud and Kiima-Kiu, coupled with the aging system has contributed to failure of delivery of water to Kajiado, Machakos and Athi river towns. On the other hand, the vendors who own private bore holes and water tankers have not invested in distribution system thereby limiting conveyance and storage to jerry cans and containers. Water as a commodity is sold at an exorbitant price given that a twenty (20) litre jerry can cost on average kshs 10 which translates to Kshs 500 per m^3 compared to Water Services Regulatory Board tariff of Kshs 35 per m^3. The Central and County governments have not shown deliberate efforts and commitment to solve this challenge.

According to Design manual for water supply in Kenya (2005) and physical planning handbook (1981) an urban center with a population above 2000 residents should have a municipal water supply system. Kajiado town has a population of 16,003 (KNBS, 2010) which justifies the need for urgent intervention. There is therefore need for a strategy that will ensure that residents of Kajiado town have sustainable water supply as per the physical planning handbook (1981) and Design manual for water supply in Kenya (2005). This planning project seeks to address this strategy by analysing the actual water demand, sources and their distributions.

1.3 Research questions

a) What are the Policy, Legal and Institutional framework for water supply in Kenya which affects water supply in Kajiado Town?
b) What is the water supply system in Kajiado Town?
c) What is the water demand for Kajiado town?
d) What are the opportunities for sustainable water supply for the town?

1.4 Research Objective

a) Review of the Policy, Legal and institutional framework for water supply in Kenya that affect water supply in Kajiado Town.
b) Evaluation of the existing water supply system in Kajiado Town.
c) To establish the water demand for Kajiado town
d) To assess the opportunities for sustainable water supply system.
e) To prepare a water supply system for Kajiado Town.

1.5 Research Premises

a) Ole kejuado Water and Sewerage Company is characterized by financial and technical capacity weaknesses.
b) There are opportunities for development of a sustainable water supply system.

1.6 Justification of study

Kajiado town was selected for this study because it falls in arid and semi-arid areas where sources of water are limited or difficult to develop. Further most of the studies that have been carried out in Kajiado focused on wildlife, conservation and rangeland management with little focus on water supply. There are several non-governmental organizations intervening on up scaling water sanitation and hygiene services in the rural areas of Kajiado with no interventions in Kajiado town.

1.7 Significance of the study

The study is of significance to water planners for towns in Kenya especially in arid and semi-arid areas. It is also of interest to Water resources developers such as water service boards and Water Resources Management Authority. Its significance to the residents of Kajiado town cannot be underrated. If the recommendations will be implemented, the residents will have steady supply of water in their homes and businesses and save money since municipal water supply will be cheaper than the one supplied by vendors. It will also contribute to their health because they are assured of the quality of water. The study will benefit the county government and improve its rating among the residents since water service provision is one of their functions. The business

community will also benefit since water is essential for hygiene. The farmers in the peri-urban area will also benefit from this study should the recommendations be implemented.

1.8 Scope and Limitations of the study

The scope of the study is limited to sustainable portable water supply for Kajiado town. The possible sources of water that were evaluated were within a radius of 10km from Kajiado town. The study did not entail detailed hydraulic designs and calculations for water supply other than basic calculations to determine the volume of reservoir required, flow rates to satisfy the daily demand and determination of an economical pipe diameter for the raising main pipe. The study sought to establish the current and a projected future water demand against supply by Olekejuado Water and Sewerage Company, the participation of the residents in planning for water supply against their level of satisfaction and water access against the recommended daily allocation for an urban area.

1.9 Limitations of the Study

- Language barrier; administering the household questionnaires was challenging because questions were interpreted into local language for the respondents to understand.
- Inaccessibility; the researcher could not access some sites especially along Olekejuado river because there are no access roads to the interior.
- Inadequate technical information; there were limited studies on water supply for Kajido town and accessing relevant past reports was difficult.
- Financial limitations; the research required lots money carry out collection of data, procurement of publication such as reports from Water Resources Management Authority and production of maps and plans for the study area.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

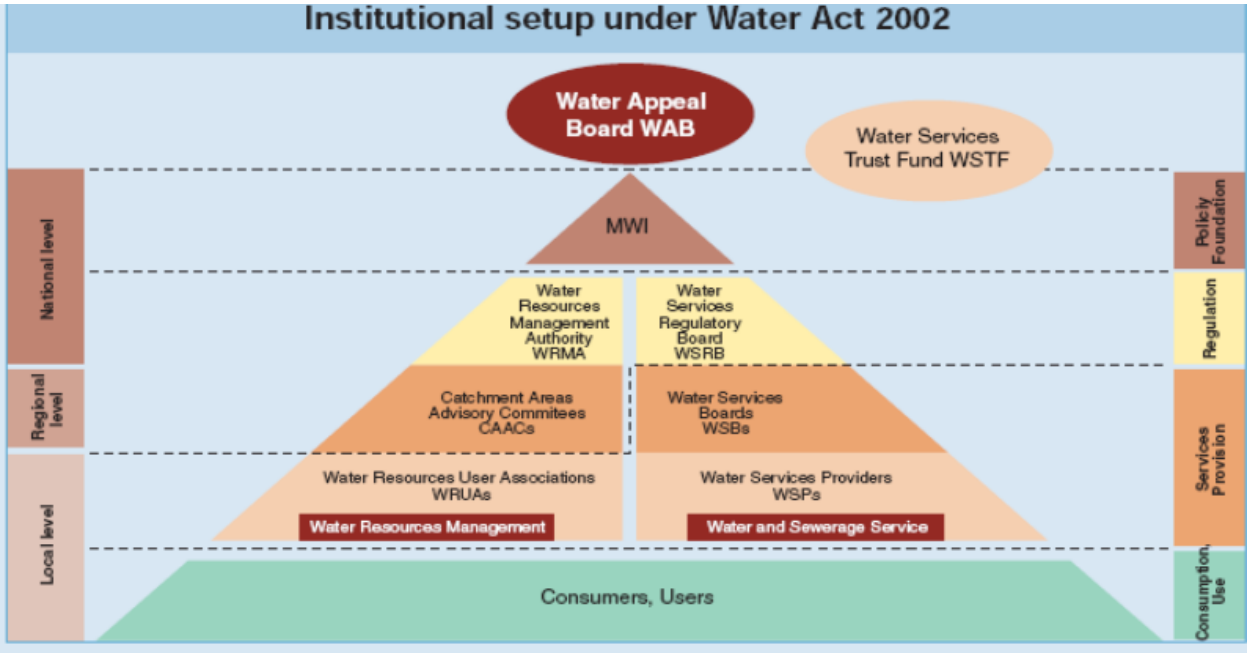
Globally, the challenge related to the management of water supply and distribution exists partly due to extensive industrialization, increased population density and a high rate of urbanization (Akpor, 2011).Critical to life in all its diversity, water is the lifeblood of society and a foundation of civilization (Oliver, 2005).Water is the strategic resource of the 21st century (Ibid). The management of water resources and supply is essential to the development and growth of cities (Michael, 2012). Sustainable resource use and the provision of quality services to a growing urban population underpins the success of future cities, enables them to act as poles of economic growth, and is at the core of social and economic development in an urbanizing world (Ibid).Over the last decade, privatization to a greater degree has been seen as one of the primary ways to infuse capital into the urban water sector and to overcome some of the inefficiencies of municipal management. It has been urged upon developing countries by international lending agencies as an essential component of water sector reform (McKenzie, 2009).It is at the national level that critical issues and needs must be analyzed and addressed, from policy and legislation downwards (WaterAid, 2011). This chapter articulates the legislative and institutional framework for water supply in Kenya and their influence on water supply for Kajiado town. It also briefly examines policies and institutional set in few other countries, discusses useful theories and conceptual framework for water supply and management.

2.2 Policy, Legal and Institutional Framework

A simple glance at the 'sector pyramid' diagram (Figure 2.1) reveals the complexity of the water sector in Kenya, with its numerous institutions, layers of geographical interventions and competencies, and the intersection between policy formulation, regulation, service provision and consumption of the resource (Rampa, 2011). The right to clean and safe water in adequate quantities for all people living in Kenya is provided in the Kenya's constitution (2010) in article 43(1) (d). Further, the fourth schedule of the Constitution (2010) part 1 section 22(*c*) spells out the function of the national government in relation to water as "water protection, securing

sufficient residual water, hydraulic engineering and the safety of dams". Part 2 of the schedule of the constitution section 11(b) list water and sanitation as one of the functions of the county government. This in effect means that the national government is responsible for water resources development while the county government will oversee the operations of water service providers including water and sanitation companies. According to Kajiado's County Integrated Development Plan (CIDP), emphasis is given to rain water harvesting and ground water abstraction.

Through the Water Act 2002, administrative centers such as Water Resources Management Authority (WRMA), Water Services Regulatory Board (WSRB), Water Services Trust Fund (WSTF) and Water Appeal Board (WAB) have been established to ensure harmony and form a bridge between the National planning effort and the water development and management agencies.



2.1: Institutional set up under Water Act 2002. Source: Rampa, 2011

The eight WSBs have the overall responsibility of planning for improvement in provision of water supply and sewerage services at regional level as well as of appointing and contracting the water services providers. This makes them the powerful center of a dense network of formal and informal relations and both a 'target of' and a 'means to' the scramble for water related resources (Rampa, 2011). County governments are in the process of formulating their own water supply

policies and legislation to guide them in planning, implementation and management of water supply services. There is a need to amend the water act 2002 in order to align it with the new constitution which dictates that water service is a function of the county governments.

2.3 Other countries Water supply experiences

2.3.1 Studies done in Malaysia

A study carried out in Malaysia showed that although there was a holistic coverage of the national water policy, there were apparent problems with regard to the jurisdiction, legislation and coordination initiatives that have resulted in the poor management of water resources (Ravichandran et al, 2012). The study postulated that, in addition to better coordination between water related agencies and more cohesive water legislations structure, it is fundamental to infuse the knowledge of 'water ethics' among water managers, institutions, the general public and into water policy formulation and implementation initiatives.

2.3.2 Water supply situation in Nigeria

According to Akpor (2011) in Nigeria, two institutions have been created to manage water resources: the federal Ministry of Water Resources and the River Basin Development Authority. Neither of the two institutions has been in a position or given a mandate to develop management plans, generate sufficient data for planning or have departments with the capacity for such management (Atkins in Akpor, 2011). The result of this is that, there is a lack of effective water resource management practices thus leading to confusion between development and management withsupply driven, top down approach that is failing (Ibid).

2.3.3 Ethiopia's One WASH National Program

The Federal government of Ethiopia formulated a national policy to guide Water, Sanitation and hygiene service delivery known as 'The One WASH National Program (OWNP)'. The Program operationalized the Memorandum of Understanding (MoU) and the WASH Implementation Framework (WIF) signed by the Ministries of Water and Energy, Health, Education and Finance and Economic Development in November 2012 and March 2013, respectively. The Program is

the Government of Ethiopia's (GoE) main instrument for achieving the goals set out in the Growth and Transformation Plan (GTP). In the GTP, targets for access to safe water supply are 98%, 100% for rural and urban areas, respectively by 2020 (Government of Ethiopia, 2013).

The policy states that "*The Program duration will be seven years, implemented in two phases; Phase I from July 2013 to June 2015 and Phase II from July 2015 to June 2020. There can be changes in important GoE policies, strategies and plans when the present GTP, UAP and MDGs end in 2015. Phasing will allow for these changes to be accommodated in the second phase of the Program. Before the end of Phase I, during the JTR in early 2015, a comprehensive review of the Program's progress and achievements during Phase I will take place and any adjustments/revisions required for Phase II will be identified.*

Phase I will be a marked by increasing harmonization and alignment among and between development partners and GoE, during which WASH organizations and procedures will be fully established and become operational at all levels. Also during Phase I, partners, including CSOs, will be expected to increasingly align their targets, plans and activities with the Program. New WASH programs/projects or new phases of existing WASH programs/projects will be expected to be aligned with the Program's principles, approaches and plans".

2.4 Water demand

Demand can be described in economic terms as willingness to pay for a particular service (World Bank, 1993). Demand expressed in this way is known as effective demand (Paul, 2001). Effective demand may be relatively high for the service people want (Ibid). The term 'service' not only refers to a particular level of service, but also how it is paid for, and how the project is implemented and managed (Sara, 1998). Achieving a consensus on what is understood by demand has been made difficult by the fact that engineers, economists and social scientists tend to have different points of view (Parry-Jones, 1999). Most of the engineers that were consulted and those interviewed by Bos in South Africa (Bos, 2001), equate demand for water with consumption. Demand is an informed expression of desire for a particular service, measured by the contribution people are willing and able to make to receive this service (Paul, 2001). In practice, a basic level of service is often fixed by national policy (Ibid). In Kenya, the minimum

water allocated to a person per day in an urban area is twenty liters per person per day (Ministry of water and irrigation, 2005).

Many factors, such as the climate, size of the city, standard of living, degree of industrialization, type of service (metered or unmetered), lawn sprinkling, air conditioning, cost, pressure, and quality of the water, influence the demand rate for water (Kent, 1999).Water demand projections should normally; be made for the "initial", the "future" and the "ultimate" year. The "initial" year is the year when the supply is expected to be taken into operation that may be assumed to be 0-5 years from the date of the commencement of the preliminary design. The "future" is 10 years and the "ultimate" year 20 years from the initial year. A water supply should normally be designed for the ultimate demand (Ministry of water and irrigation, 2005).

The size of a proposed water-supply project is usually based on an average annual per capita consumption rate. Therefore, forecasts of population for the design period are of the greatest importance and must be made with care to ensure that components for the project are of adequate size (Kent, 1999).The water demand projections should not include any provision for irrigation besides for very limited garden watering which is included in the per capita consumption rates (Ministry of water and irrigation, 2005).

2.5 Sources of water and Water quality

In selection of a source of supply, the various factors to be considered are adequacy and reliability, quality, cost, legality, and politics (Kent, 1999).In selecting a source of drinking water, there are a number of factors that must be considered (Ministry of water and irrigation, 2005): Quantity, quality, protection from contamination and feasibility. The major sources of a water supply are surface water and groundwater. In the past, surface sources have included only the commonly occurring natural fresh waters, such as lakes, rivers, and streams, but with rapid population expansion and increased per capita water use associated with a higher standard of living, consideration must be given to desalination and waste-water reclamation as well (Kent, 1999).

According to the Ministry of Water and Irrigation (2005), the e basic requirements for drinking water are that it should be Free from pathogenic (disease causing) organisms, containing no

compounds that have an adverse acute or long-term effect on human health, fairly clear (i.e. low turbidity little colour), not saline (salty), containing no compounds that cause an offensive taste or smell, not causing corrosion or encrustation of the water supply system and not staining clothes washed in it. A survey conducted on the in Lome city in Togo showed that people are aware of the causes and effects of poor water quality (Laurent, 2012).There is a well-established correlation between the coverage and quality of drinking water supply services, sanitation, health, and quality of life (Soares, 2002). Experience indicates that water-borne epidemics tend to disappear more quickly in places with good sanitation and where the quality of the drinking water supply is guaranteed (Ibid).

Adequacy of supply of water requires that the source be large enough to meet the entire water demand. Total dependence on a single source, however, is frequently undesirable, and in some cases, diversification is essential for reliability (Kent, 1999).

The function of selection criteria for a water supply service is to decide when particular areas should be provided with water services. The very serious consequences that arise from lack of water services in the urban areas makes the existence of urban population alone a sufficient criteria for providing water supply services (Ministry of water and irrigation, 2005).

2.6 Theoretical Framework

2.6.1 Information- gap decision theory

Information-gap decision theory is a non-probabilistic decision theory that seeks to optimize robustness to failure or opportuneness for windfall under severe uncertainty, in particular applying sensitivity analysis of the stability radius type to perturbations in the value of a given estimate of the parameter of interest(Wikipedia, 2013).Information-gap is a decision theory that seeks to assist in decision-making under uncertainty. It does this by using 3 models, each of which builds on the last. One begins with a model for the situation, where some parameter or parameters are unknown. One then takes an estimate for the parameter, which is assumed to be substantially wrong, and one analyzes how sensitive the outcomes under the model are to the error in this estimate (ibid).

2.6.2 System theory

The systems view was based on several fundamental ideas. First, all phenomena can be viewed as a web of relationships among elements, or a system. Second, all systems, whether electrical, biological, or social, have common patterns, behaviors, and properties that can be understood and used to develop greater insight into the behavior of complex phenomena and to move closer toward a unity of the sciences. System philosophy, methodology and application are complementary to this science (Wikipedia, 2013). In respect to planning aspects that utilizes engineering concepts, then Wikipedia (ibid) defines it as follows: 'Systems engineering is an interdisciplinary approach and means for enabling the realization and deployment of successful systems. It can be viewed as the application of engineering techniques to the engineering of systems, as well as the application of a systems approach to engineering efforts. Systems engineering integrates other disciplines and specialty groups into a team effort, forming a structured development process that proceeds from concept to production to operation and disposal. Systems engineering considers both the business and the technical needs of all customers, with the goal of providing a quality product that meets the user needs'.

2.6.3 Adopted theories

In this study both theories will be adopted and modified for use in planning for the sustainable water supply system. The information-gap decision theory will be adopted because there are many uncertainties in variables used in water supply-demand balance planning. Such variables includes: uncontrolled demand, controlled demand and losses. In such a situation it is better to plan for a robustness rather than optimality. A robust system is the one that performs adequately under wide range of uncertain futures such as either or a combination of water availability, population growth and operational costs.

On the other hand it is important to recognize that the water supply scheme is a system and involves many other disciplines in planning, implementation and operation. Without looking at water planning as a system sustainability will be compromised. Therefore both theories are applicable in this study.

2.7 Conceptual framework

This report has adopted a conceptual framework for water safety plan as proposed by NCEH Global Water, Sanitation, and Hygiene Team (Centers for Disease Control and Prevention, 2012) because it addresses the same concerns as a water supply improvement plan. Figure (2.2) shows the linkages among various aspects and steps in water supply system. To achieve the intended goal in water supply system planning, inputs, activities, outputs, outcomes and impacts must be identified and their linakge established. In the adopted conceptual framework, it can be seen what inputs are and that they influence the activities to be carried out. Activities in turn produce outputs which are measurable. The outputs contributed to outcomes and eventually in the long run they yield impacts. It is important to note that inputs and activities can be carried within a short period of time to produce outputs such as infrastructure. This time can be expressed in terms of months. But impacts are as a result of sustained service and take time to manifest and therefore measured in years.

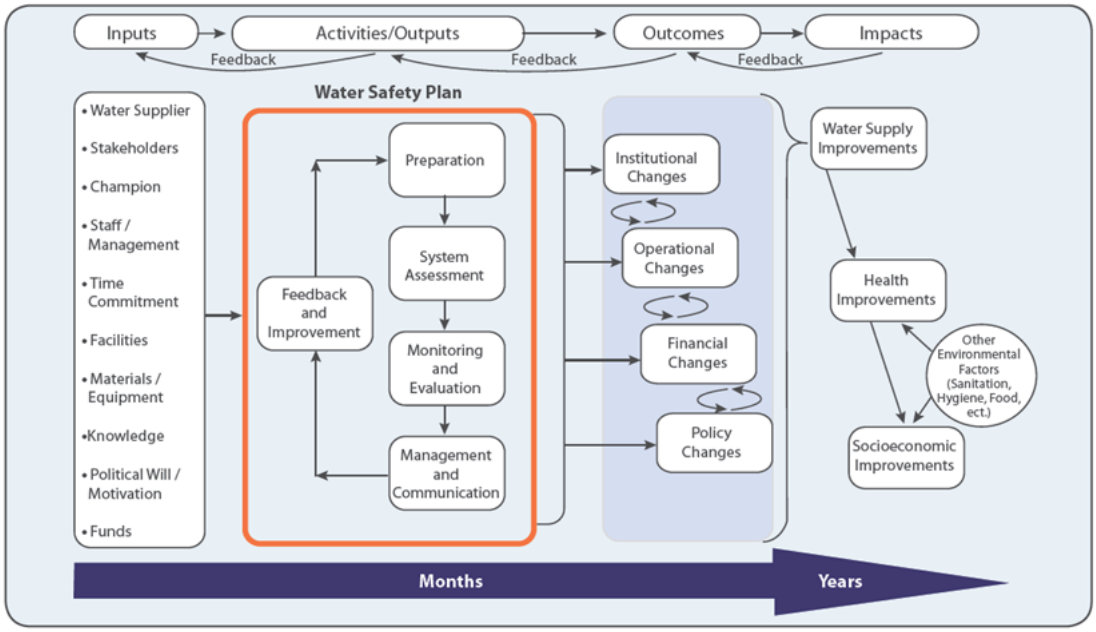


Figure 2.2: Conceptual framework; adopted from Centers for Disease Control and Prevention, (2012).

2.8 Sustainability of Water sources

For sustainable management of water resources politics, social-phenomena, environmental, economical, technical and institutional should be handled as a whole. Recent research indicates the need for integrated vulnerability assessment, water resources quality and quantity studies,

and decentralized technology decision-support frameworks to address the impact of climate change on local, regional and national water resources management and strategies involving stakeholders at all levels (Miklas, 2013). Sustainable management of water resources with due respect to ecological, economic and ethical sustainability requires a holistic and integrated approach involving engineering socio-economic and environmental aspects (Baris, 2007). In Kenya it is much easier to get finance for water sector hardware than for 'software' such as watershed management, research, policy making, monitoring, environmental and pollution control, training, and public awareness (Rampa, 2011).

CHAPTER THREE
AREA OF STUDY

3.1 The physical set up

This study was conducted in Kajiado town which is the headquarters for Kajiado County. The name "Kajiado" comes from the word "Orkejuado", means “The Long River” in Maasai language. The seasonal river named after the town runs west of the town. The original name for the town was “Olopurupurana” which means “a round elevation”.

The town is located approximately 80km south of Nairobi along the Athi River – Namanga road.

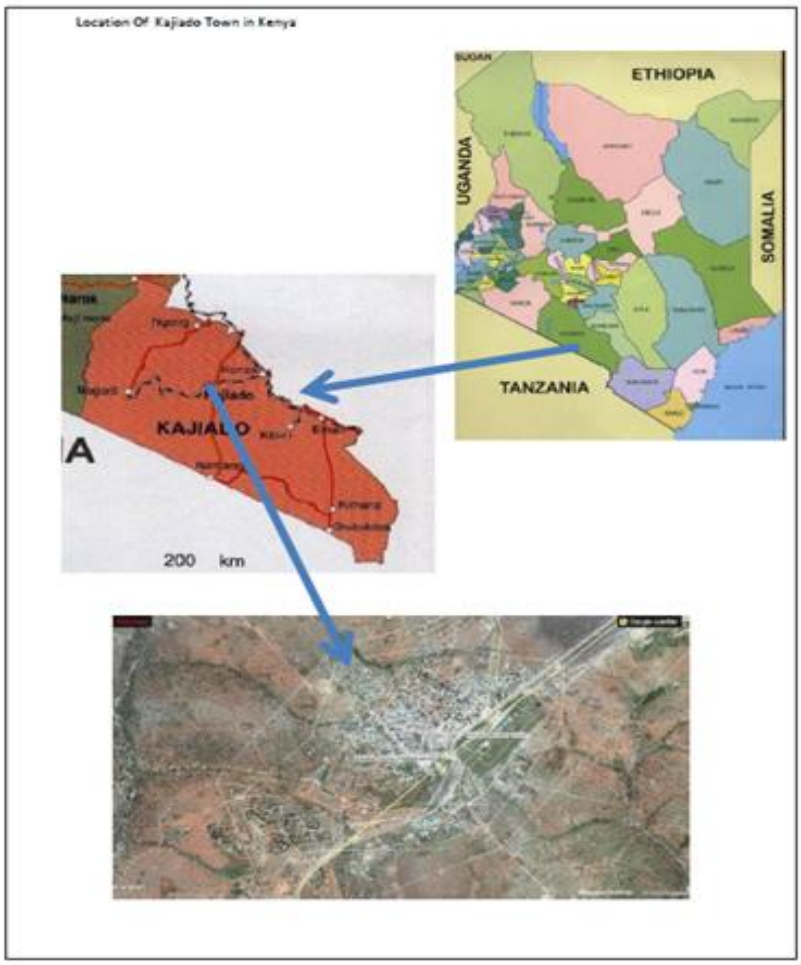


Figure 3.1: Location of Kajiado town in Kenya. Source: Wikimapia and Google

It is located at 1° 50' 24" S, 36° 47' 23" E at an altitude of 1707m above sea level and occupies approximately 16km^2. The area of study was Kajiado town and the peri-urban not exceeding 10km on any side. Figure 3.1 shows the physical location of Kajiado town in relation to the county layout. It falls under the greater Nairobi metropolitan area south of Nairobi city. Athi river- Namanga road passes through the town. Tata Chemicals have a soda ash depot on the east side of the town which is linked to Magadi-Konza railway line. The county administration offices are located on the outskirts of the town on North west direction

3.2 Topography and Geology

The landscape consists of plains and some volcanic hills and valleys. The area is dry with no permanent flowing rivers and is officially designated as semi-arid. The town is approximately 1707 m above mean sea level lying between kapiti plains and amboseli plains. Olekejuado river lie to the west of town flowing north-south direction and to the east are Oloyangalani hills. The namanga hills and ranges can be seen on the east side of the town and forms part of the catchment area for Olekejuado river. The town's general terrain falls in west direction.

The geology of Kajiado town is predominantly quaternary volcanics, plateaux and kapiti phonolites with deep, well-drained soils (GoK, 1966). Grey soils overlay black cotton soil in near Kajiado town (ibid). The deep basement Kapiti phonolite rock found in Kajiado town explains the reason for low water yields in Kajiado town because it is not fractured hence cannot form a good aquifer for ground water.

The climate is hot and dry. The annual rainfall varies between 500 and 1,250mm. Rainfall is bimodal, with "short rains" from October to December and "long rains" from March to May. The average annual temperature is 18.9°C.

3.3 Ecological set up

The area of study is an urban setting within an integrated ecological zone where livestock keeping, ranching, wildlife conservation and farming takes place. Livestock keeping dominates

as the town's agro-economic activity but cereal crops such as maize, beans, millet and vegetable gardening are grown mainly for subsistence.

Bush, woodland and grass land are the predominant vegetation outside the town which consists of savannah grass and whistling thorn bushes. The area of study is surrounded by group ranches which offers habitat for wild life in addition to livestock rearing.

3.4 Socio-economic set up

The area of study is an urban area along the Athi River – Namanga road. It is served by a number of educational institutions, a transport network and other service sectors who are consumers or proposed consumers of water.

Specifically primary schools were: Kajiado hill academy primary, Kajiado Adventist education and rehabilitation center, ACK Emmanuel academy, St. John primary school, Kajiado Township, Alhudamuslim, Highgate children's preparatory school, Saina primary school and Granda primary school. There were five secondary schools namely Kajiado hill girls, Almaktoum girls, Kajiado Central, AIC girls and Olekejuado high school.

Institutions to access proposed services included Kajiado district hospital, Magadi soda, Government offices, Banks, Corporate organizations, Churches and mosques and petrol stations.

Kajiado town is accessible by an all-weather road from either Athi River or Namanga border. The Magadi – Konza – Mombasa rail line passes though Kajiado. Public transport vehicles are readily available that connects Kajiado to other centers. Mobile telephone services are also available from the major operators such as Safaricom, Airtel and Orange telecom. Postal service of Kenya has a branch in Kajiado town and is complemented by other courier's service providers such as G4S and Naekana Sacco.

The town is already connected to the National electricity grid. It has a number of operational petroleum filling stations selling petrol, diesel, paraffin and liquefied petroleum gas. Thus, residents use paraffin besides wood fuel as a source of domestic energy. Solar energy installations are also used although a negligible extent.

The town is a one of the commercial center and a county headquarters for Kajiado County. There are varied businesses varying from retail, wholesale, offices, open air markets, market stalls, processing and packaging, hospitality to health services. Kajiado District hospital which has maternity, wards and out - patient wing is hosted in the town. There are also several privately operated dispensaries and clinics and chemists.

The town has no waste water and sewerage services infrastructure. Both business and residential estates make use of on-site septic tanks and pit latrines. The county government is in the process of planning the town and set aside land for sewer treatment as well as solid waste disposal site.

The main water supply for the town is private bore holes. The water and sewerage company pumps water from a bore hole in Isinya to their reservoir in Kajiado town from where water tankers draw and sell to the residents. There is a seasonal river called Olkejuado which has potential for harvesting run off.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

Methodology is more than a guideline for solving a problem with specific components such as tasks, methods, phases, techniques and tools. It encompasses procedures followed to collect, analyze and interpret data in any study. This chapter therefore describes the methods and/or procedures which were employed in the study in order to achieve study objectives. This chapter therefore deals with research design and methodology that were adopted in the study. It focuses on research design, nature and sources of data, research instruments and methods of data analysis.

4.2 Research design

The study adopted a participatory approach in which residents and a range of stakeholders were involved in the whole process. It used generalized survey design with triangulation to ensure multiple sources of evidence for validity and reliability of the study. The study methodologies employed in data collection were both qualitative and quantitative as described in this chapter. It incorporated the essentials of action research design which follow a characteristic cycle whereby initially an exploratory stance is adopted, where an understanding of a problem is developed and plans are made for some form of interventionary strategy such as the portable water supply for Kajiado Town. Thereafter, the intervention is carried out during which pertinent observations are made. The new interventional strategies are carried out, and the cyclic process continues until an implementable solution for the problem is achieved (Bradbury et al, 2003).

4.3 Nature and source of data

The nature of the data collected during fieldwork is presented in table (4.1)

Table 4.1 nature of data against each objective

No	Objective	Nature of data
1	To review Policy, Legal and institutional framework for water supply in Kajiado Town.	• Identification of existing policies and legislative frameworks for water supply • Weaknesses and strengths of policies and legislative frameworks related to water supply • The level of involvement of residents in formulation of policies and regulatory framework for water supply.
2	To evaluate existing water supply system in Kajiado Town	• Identification of sources of water for the town. • The scope and extent of coverage of water supply infrastructure. • Adequacy and reliability of the water supply system • Water consumption rates and cost.
3	To assess the opportunities for a sustainable water supply system in Kajiado town	• Hydrological and climatic data for the town. • Geological data • Topographical • Energy sources

This implies that both quantitative and qualitative data on water access, quality and quantity were collected. The sources of data were both secondary and primary.

4.4 Secondary data

This data was obtained from various published and unpublished journals, documents and data water supply and its challenges. The secondary data was obtained from the ministry of

Environment, natural resources and water, Tanathi water service board and Water Resource Management Authority.

4.5 Primary data

Primary data refers to the type of data that is collected by the researcher. For this research project data was collected as it was not available from secondary sources. In this study, primary data was collected using household and business questionnaires, observations, interview schedules administered on key informants and taking photographs.

4.6 Sampling method

The town has a total population of 16003 who are engaged in different trades and callings. Among the adults, the residents include traders and business community, civil and private sector employees, hawkers, transporters and farmers.

The study area was divided into transect routes, a sample size for each transect was determined in proportion to number of Households and businesses in it, simple random sampling techniques was used to administer the questionnaires. The household and business numbers were used to determine the number of surveys in each transect or row according to the method of Fisher et al (1998). The sample size was determined using the formula recommended by Nassiuma (2000) as follows:

$$n = \frac{NC_V^2}{(C_V^2 + (N-1)\, e^2)}$$

Where n= sample size

N=population

Cv=Coefficient of variation (take 0.5)

e= Tolerance of desired level of confidence, take 0.05% at 95% confidence level

In this study, the population (N) was 16003. According to Nassiuma (2000) formula, a sample size (n) of 99 was appropriate. However, a sample size of 109 comprising of 65 household and 34 business questionnaires was collected.

4.7 Research Instruments

This study employed Household and Business questionnaires, interview schedule, observational guide and phonographs as research instruments.

4.7.1 Questionnaire

Appendix (1) and (2) shows sample questionnaires that were used to collect household and business data respectively. Both were administered to collect quantitative and qualitative data. These tools were employed to collect data that secondary data sources could not provide.

4.7.2 Interview Schedule

Appendix (3) shows a sample key informant interview schedule that was used to guide the researcher on the kind of information sought from the interviewee. Interview schedules were used to collect qualitative data since the responses were descriptive in nature (see plates 4.1, 4.2, 4.3).

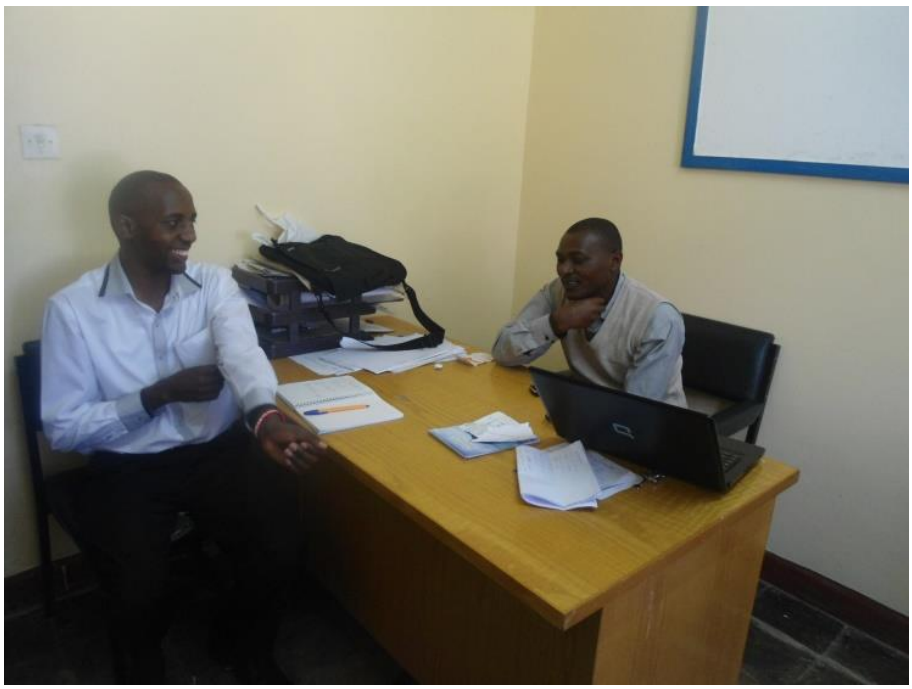


Plate 4.1: Administration of interview schedule on the Kajiado Central sub County Water Officer

4.7.3 Observation guide

Appendix (4) shows a sample observation guide. It was used to guide the researcher on land marks, visual aspects that required to be captured and things to observe during transect walks. Both qualitative and quantitative data was collected using observation guide too.

4.7.4 Photographs

These tools were employed to capture the real life situation on the research site. They were used to capture various aspects on ground. This data was used in triangulation to support the findings from the other tools.

4.8 Collected Data

The following approaches were employed:

a) Document /secondary data review. This included review of the County Integrated Development Plan document, review of previous water supply projects initiatives, water records from Water Resources Management Authority which provided useful information.

b) The Household and business survey questionnaire. Questionnaires were administered to 65 Households and 34 businesses.
c) Interview schedules were administered on key informants who included the Coordinator for Welthungerhilfe, Ag Manager, Red Cross – Kajiado branch, District Development Officer, Ole Kejuado water and Sewerage Company and several officers in the Ministry of Environment, water and natural resources in County Government of Kajiado.
d) Observation guide was used to collect both quantitative and qualitative data during the transect walks.
e) Use of photography was also employed to capture images from the study area which were used to further reinforce the findings of the other tools.

4.9 Methods of data analysis and presentation

Data was generated from the household and business survey, entered into Statistical Package for Social Science (SPSS) database, cleaned/ cross-checked to ensure accuracy of the information obtained from the field then compared and validated. The qualitative data was analysed by consolidating emerging themes from Key Informant Interviews and review of secondary information. Analysis tables such as frequencies tables, cross tabulations, multiple response tables, and means tables were generated. Pie charts and graphs are used to facilitate ease of interpretation. Data from the households ‘and business survey is complemented by data drawn from secondary sources.

4.10 Limitations

Study encountered some limitations language such as language barrier due to interpretation of the questionnaires from English to local language. This was overcome by training the enumerators and checking the adequacy of the communication during pre-testing.

Some potential interviewee were reluctant from being interviewed and agreed after being assured that the information they were going to give was purposely for academic purpose and confidentiality is guaranteed. It was difficult to get official information such as budget allocation for water services, but the County Integrated Development Plan gave some insights.

It was also difficult to access some site for observation, but the challenge was overcome by using online resources such as Google Earth and Wikimapia. There were limited studies on water supply for Kajido town and accessing relevant past reports was difficult.

CHAPTER FIVE
DATA ANALYSIS AND DISCUSSION

5.1 Introduction

This chapter will evaluate the existing policy, legal and institutional framework for water supply in Kenya and how they affect water supply in Kajiado town. It will also deal with the examination of the existing water supply system in Kajiado, establish the water demand for the town and the opportunities for sustainable water supply for the town. Data that was collected using various tools is analyzed and discussed in this chapter.

5.2 Existing Policies, Legal and institutional framework for water supply in Kenya

The national water policy 2012 is at draft stage and not yet a substantive. This was identified as one of the major weakness in the water sector. The would be successor of Water Act 2002, the Water Act 2012 is also in draft form and has not yet gone through the stages of a bill in parliament to become law.

There is a need to amend or overhaul the water act 2002 in order to align it to the constitution which devolved the function water service provision to the counties. It is important that a new law be formulated to define the mandate and scope of water service boards. Whereas Water Act 2002 anticipated that the water service boards were to develop water resources within their water basins and leave issues of water management to water companies, these functions have since been transferred to the counties. The County Government of Kajiado has neither water policy nor Water Act to guide it in planning, implementation and management of water resources. The fate and future operation of Water Resources Management Authority is also not clear and in case a county government enacts laws that overlap its functions.

There is an apparent lack of statutory way of prioritizing allocation of water resources. For instance the Norturesh-Athi river-Kajiado water pipeline is used for irrigation along the way when a section of the population it was meant to with domestic water has never been served. A national criteria needs to be set and define which water needs must be satisfied before others. This will reduce the number of water related conflicts especially in arid and semi-arid areas. An observation among the Maasai community on the outskirts of Kajiado town confirmed this gap.

The pastoral community gives priority in water resource allocation to animals, domestic and other uses in that order. The agencies involved in water management have weak financial and technical capacity to enforce policies and regulations.

Although sanitation is outside the scope of this research, it is worth noting that the Ethiopian model of 'one WASH one program' is good and can be considered in the policy and legislative reviews of the existing framework.

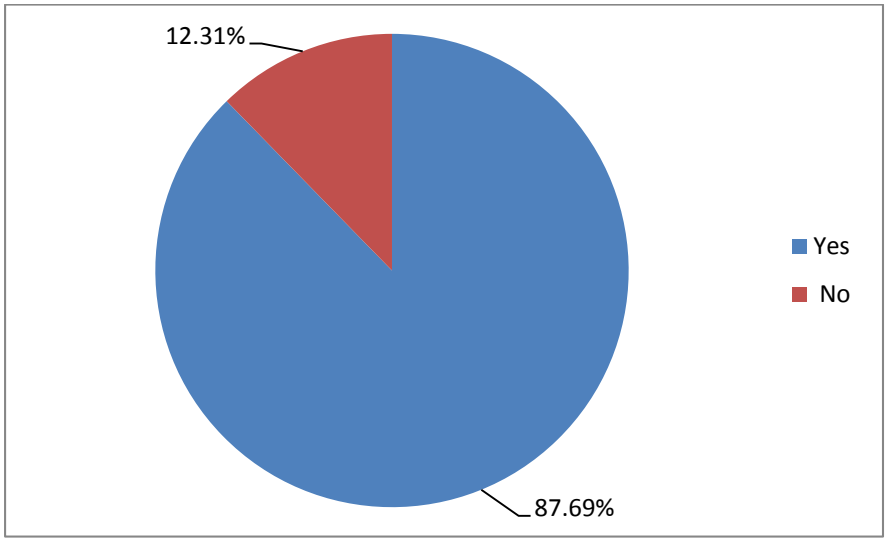


Figure 5.1: Knowledge of the existence of a public water and sanitation company among residents of Kajiado

This research found out that s a mere 12.31% of the residents interviewed was aware of the existence of a water and sewerage company in town (see figure 5.1). When asked to rate the services of Olekejuado Water and Sewerage Company, 98.46% of the households and 100% of business community's respondents interviewed rated it as 'poor' with a paltry households at 1.54% rating is fair (see fig 5.2 and 5.3). The findings shows an institutional failure which could have been precipitated by weak regulatory framework.

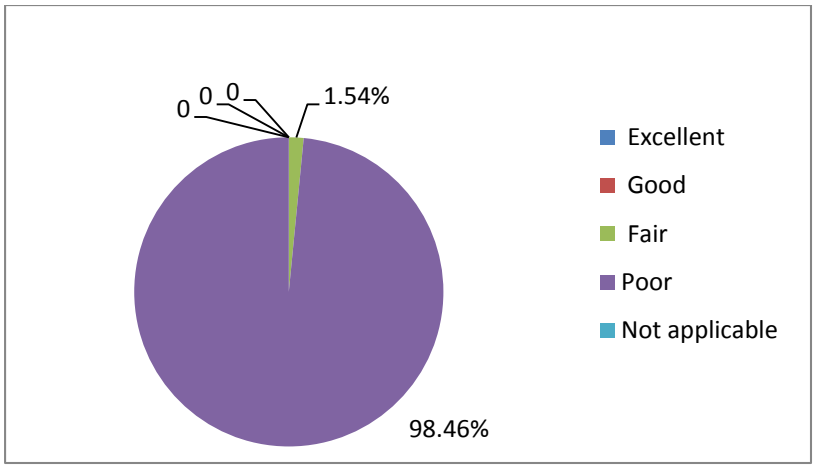


Figure 5.2: How people rate Olekejuado Water and Sewerage Company

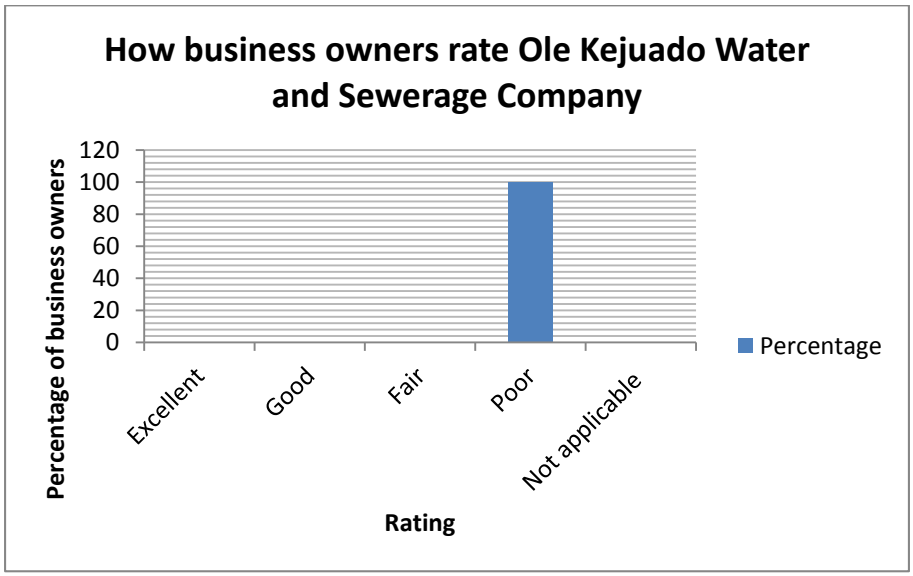


Figure 5.3: How business owners rate Olekejuado Water and Sewerage company

5.3 Water supply system in Kajiado Town

A water supply service in Kajiado town is mainly done by private business people. Ole Kejuado water and Sewerage company is dormant and non-functional at the moment. 100% of the business gets their water from private bore holes during dry season. In wet season 58.82% of the businesses get their water from private bore holes while 41.18% gets their water from rain water harvesting (see fig 5.4). None of the households interviewed indicated they got municipal water supply (Figure 5.5).

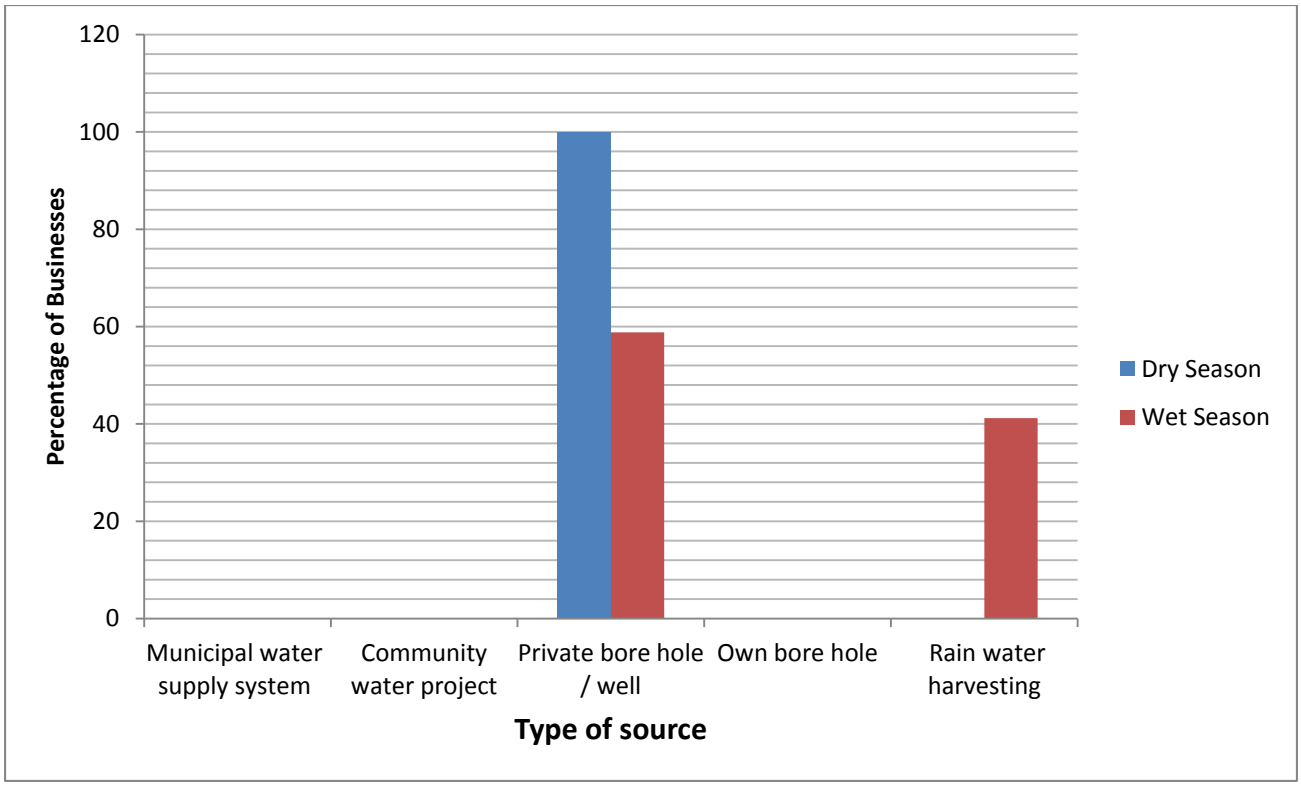


Figure 5.4: Sources of water for businesses

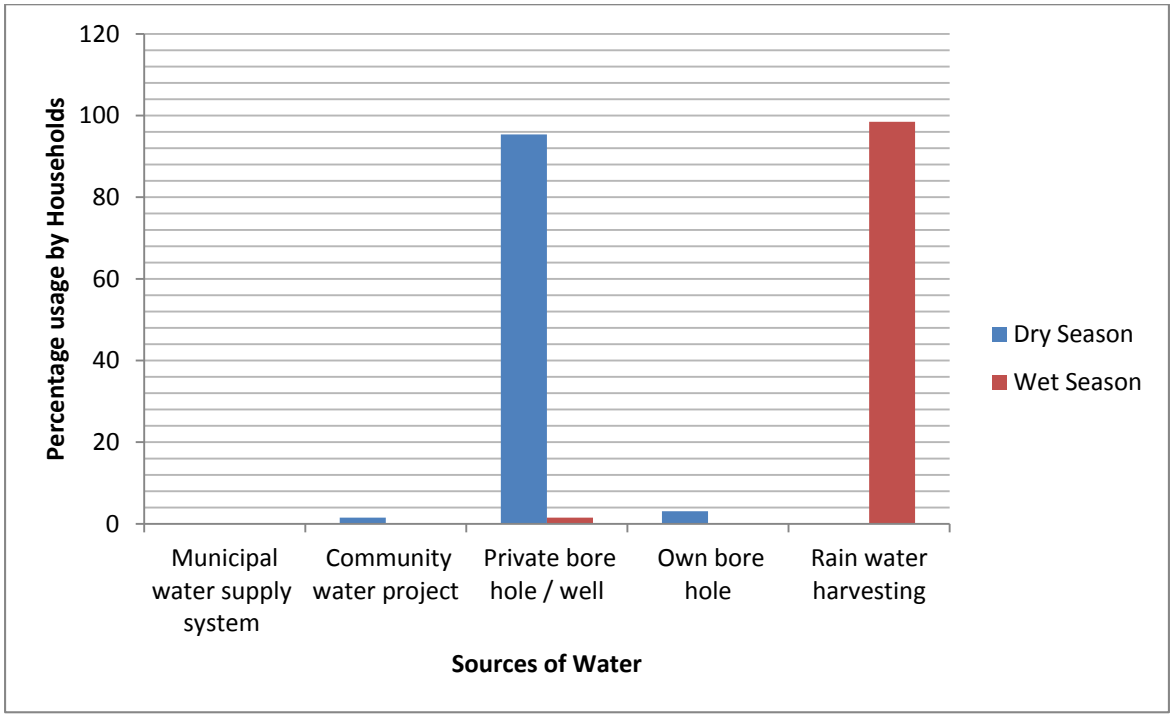


Figure 5.5: Sources of water for Households

A survey of the households (see figure 5.6) showed that 1.54%, 95.39% and 3.08% gets water from community water projects, private bore holes and own bore hole respectively during dry season. During wet season 1.54% and 98.46% of households get their water from private bore holes and rain water harvesting respectively.

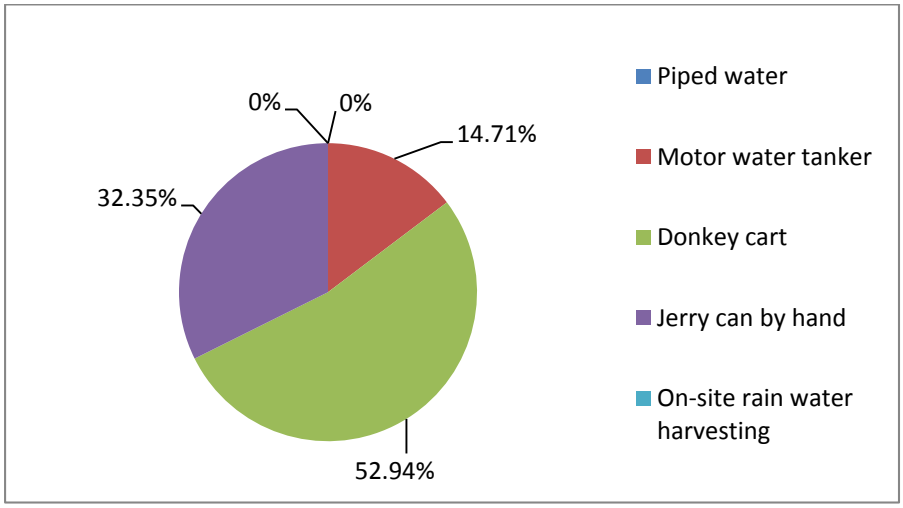


Figure 5.6: Mode of water delivery to business premises

It was also established that 14.71%, 32.35% and 52.94% of business gets water delivered by use of motor water tankers, jerry can by hand and donkey cart respectively (see figure 5.6). the implication of these mode of water delivery is the potential for contamination of water and the cost.

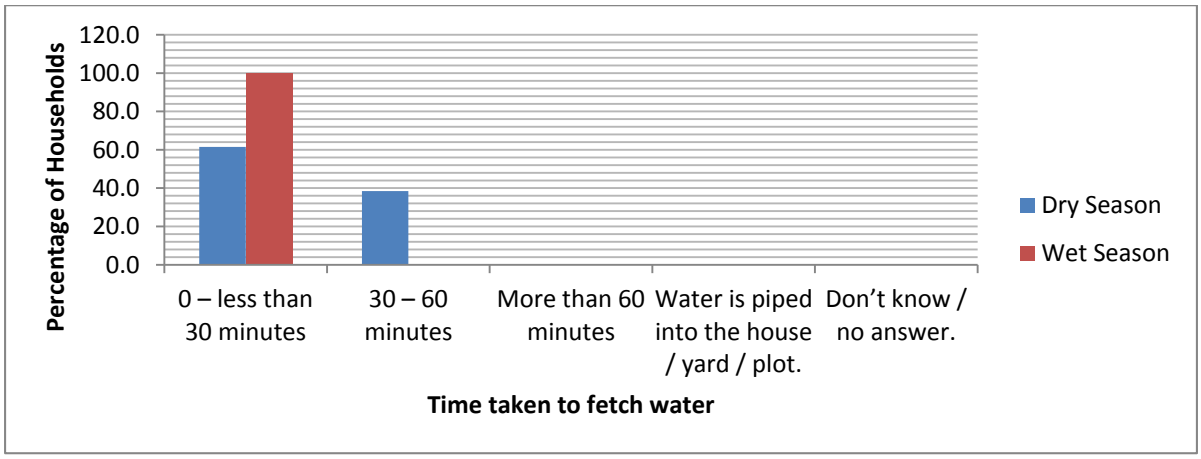


Figure 5.7: Time taken to fetch water by household members

None of the respondents indicated that they have water piped in their house or yard. Further, 39.5% of the households took between 30 and 60 minutes to fetch water while 61.5% take 30 or fewer minutes to fetch water (fig 5.7). This means a significant percentage of the population of the town spend significant part of their time to fetch water rather than engaging in socio-economic activities that can improve their living standards.

5.4 Water demand for Kajiado town

The size of a proposed water-supply project is usually based on an average annual per capita consumption rate. Therefore, forecasts of population for the design period are of the greatest importance and must be made with care to ensure that components for the project are of adequate size (Kent, 1999).The water demand projections should not include any provision for irrigation besides for very limited garden watering which is included in the per capita consumption rates (Ministry of water and irrigation, 2005).

The criterion as provided for in the Design Manual for Water supply in Kenya (Ibid) is adopted for this report.

The water demand has been calculated based on **2.6%** annual population growth rate for the town and is as tabulated in table (5.1).

Table 5.1: Rates adopted for estimating water demand for Kajiado. Source: GoK (2005)

Sr No.	Aspect of water use	Rates
	Medium class residents	150L/H/Day
	Low class with individual connects (I.C)	75L/H/Day
	Low class without individual connections (N.I.C)	20 L/H/Day
	Schools with water closets	25L/H/Day
	District Hospital	5000 L/Day
	Dispensaries & Clinics	1000 L/Day
	1 Livestock Unit	50L/Unit/Day
	Business/commercial centers	1.5% of the supply
	Industry	20,000 L/Day

The following assumptions were made:

- 30% of the residents live in medium class housing and 70% are in low class.
- There is one livestock unit for every ten people in town.
- The District hospital will add 40 beds by 2026 and 100 beds by 2036
- The water demand for dispensaries and clinics will increase geometrically by doubling every ten years.
- Demands for water by industries will double every 20 years.
- That there will be 15% loss of water in the system also known as unaccounted for water.
- 20% of the total water demand will be supplied from ground water.

Table (5.2) shows the types of connections to be planned for during design of water supply system, while table (5.3) shows the town's population, classification and type of supply for each class.

Table 5.2: Water allocation plan during project design. Source: GoK (2005)

Service Type/Period	**Initial Year %**	**Future Year %**	**Ultimate Year %**
Individual Connections (I C)	5	10	20
Non Individual Connections (N I C)	95	90	80

Table 5.3: Classification of population and type of supply planned. Source : GoK (2005)

Service Type/Period	**Present (2014)**	**Initial Year (2016)**	**Future Year (2026)**	**Ultimate Year (2036)**
Total Population	16,003	16846	21776	28148
Medium class Population	4801	5054	6533	8445
Low class population	11202	11792	15243	19703
Individual Connections (I C)	560	590	1524	3941
Non Individual Connections (N I C)	10642	11202	13719	15762

Table 5.4: Water Demand (m^3/day)

CONSUMERS	**DEMAND IN DESIGN PERIODS**			
	PRESENT (2014)	**INITIAL (2016)**	**FUTURE (2026)**	**ULTIMATE (2036)**
Medium class connections	720.15	758.1	979.95	1351.2
Low class Individual connections	42	42.25	114.3	295.575
Low class Non Individual Connections	212.84	224.04	274.38	315.24
Primary Schools (Population in 2014 = 2492)	62.3	65.6	84.775	109.6
Secondary Schools (Population in 2014 = 1585)	39.625	41.725	53.925	69.7
District Hospital	5	5.1	13.1	25.1
Dispensaries and Clinics (Current 7No)	7	8.4	16.8	33.6
Livestock (Current units = 1600)	80	84.25	108.9	140.75
Industries	20	22	33	44
Water for businesses	17.83	18.77	25.19	35.77
System Loss	181.01	190.54	255.65	363.08
Total Water demand per day(m^3)	1387.76	1460.77	1959.96	2783.62

The current, initial, future and ultimate water demand was established to be 1387.76m^3, 1460.77m^3, 1959.96m^3 and 2783.62m^3 per day respectively (See table 5.4). The value of ultimate water demand was used for the project planning as required by the Water supply service in Kenya design manual (2005).

5.5 Evaluation of the opportunities for sustainable water supply systems

5.5.1 Current situation

According to the deputy sub-county water officer for Kajiado central, there is hope for water supply for the town with proper planning and budgeting. The information regarding the boreholes drilled in Kajiado town indicates that the formation is not suitable for bore holes. Bore holes are drilled to average depth of 200m and yields range between 2 and 3 m^3 of water per hour which is very low. There are no springs or permanent rivers close to Kajiado town.

However, a high yielding bore hole ($50m^3$/hr.) has been drilled at Oloyangalani six kilometers northwest of Kajiado town which indicates that with proper prospecting of ground water and adequate budget the county government can explore the option of high yielding boreholes outside the town. The challenge with bore holes is salinity and pumping costs.

On the outskirts of the town there exist seasonal rivers which have the potential for rain water (run off) harvesting which can be impounded into economically viable reservoirs, treated and distributed (See Figure 5.8). Particularly Ole Kejuado River has a vast catchment area especially from from Eluai, Olkeju and Dalalekutok hills on the North west of Kajiado town (see plate 5.1, 5.2 and 5.3).

Plate 5.1: Photo of Olekejuado River taken from the bridge along Kajiado – Namanga road.

Plate 5.2: Photo of Olekejuado River taken from the bridge along Kajiado – Namanga road.

Plate 5.3: Photo of Olekejuado River taken from the bottom of bridge along Kajiado – Namanga road.

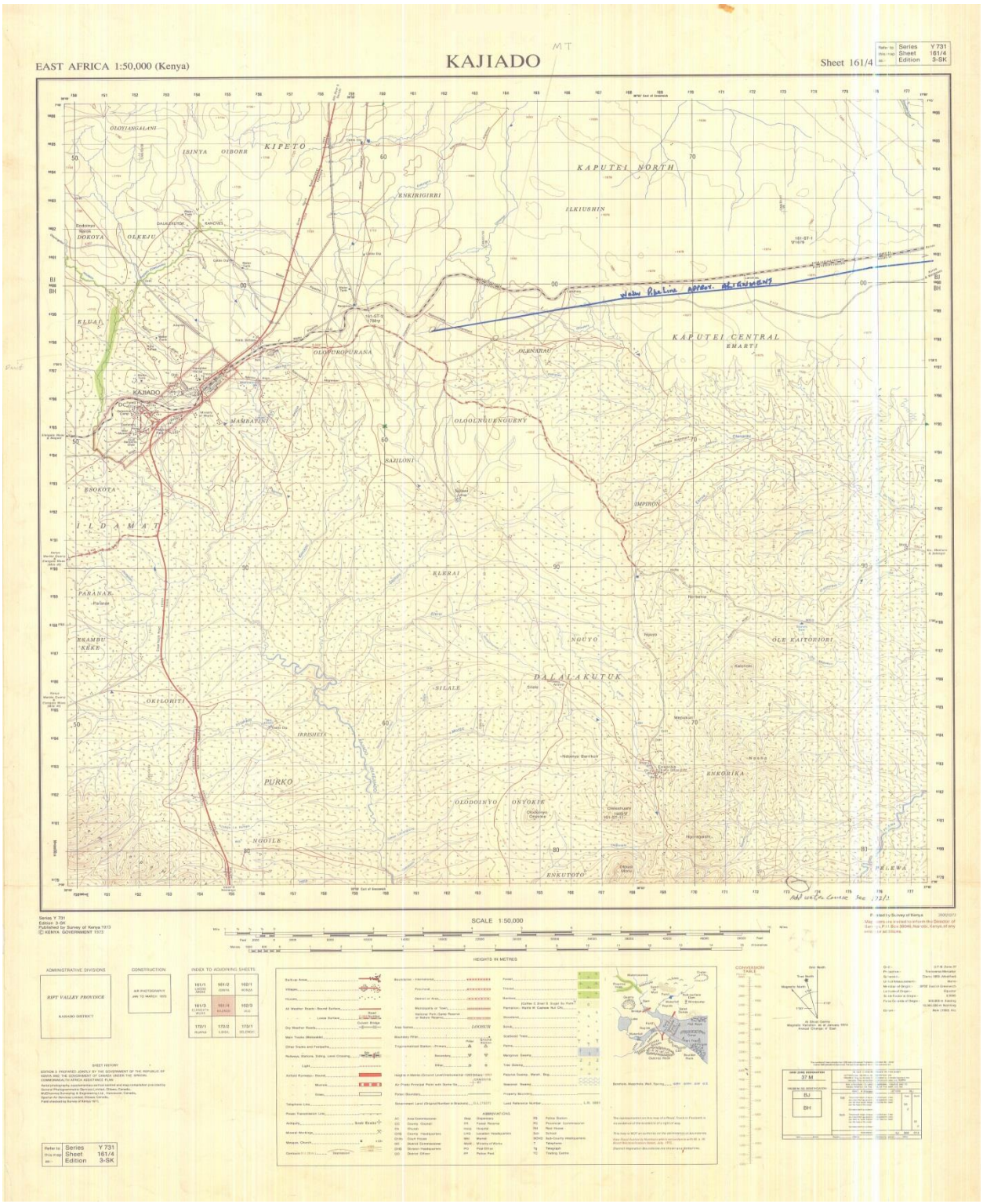


Figure 5.8: A topographical map of Kajiado town and its environs. Source: Survey of Kenya

5.5.2 Opportunities for sustainable water supply system

The identification of sustainable water supply options has to take into account people's priorities, requiring the skills of a social scientist (Paul, 2001). Further (Ibid) puts it as quoted in figure (5.9) in relation to the role of water supply planning engineer. All stakeholders must be involved in the project planning and implementation. Table (5.5) shows stakeholders that have been identified as per the County Integrated Development Plan.

In technical terms, project engineers are likely to be involved in a number of tasks, associated with the following:

- *identifying options that meet perceptions and priorities;*
- *developing feasible technical options with potential users;*
- *designing infrastructure to meet future demands;*
- *providing detailed information about the costs of options;*
- *demand assessment;*
- *negotiating technical design and levels of service;*
- *providing advice, information and training on future upgrading and extension; and*
- *assisting with the development of the scheme's management system.*

Figure 5.9: The role of a water supply project engineer. Source: Paul (2001)

Table 5.5: Identified stakeholder and their roles in water provision in Kajiado County.

Stakeholder	Role
County Government	Ensure proper waste disposal, management and distribution of clean water to the community within the area of operation
Development Partners	Funding community water projects.
NEMA	Regulate the usage of natural resources by conducting of EIA;
NGOs, Civil Society and Donors	Implementation of water projects, communities capacity building.
Private Sector	Collaborate with government to provide water to the residents; provide water infrastructure equipment's; contracted to install water equipment.
Tanathi Water Services Board	Offer technical advice, regulate and licence water providers, plan investments and Implementation
WARMA	Regulate water resources, gives permit on water abstraction.

Source: Kajiado County Integrated Development Plan (2013)

In the case of Kajiado town, it is assumed that 20% (556.724m^3/day) of the town's water demand will be met from ground water sources such as bore holes. The 80% (2226.896m^3/day) water demand will be supplied from surface and rain water harvesting. A feasible source of surface water would be Norturesh springs on the slopes of Mt. Kilimanjaro. However, this source was considered and a water supply project designed and constructed but failed to serve the intended people because of politics and interests by residents and farmers in some parts of Oloitoktok Sub County. Given the challenges that have plagued abstraction, transmission, operation and maintenance of the Norturesh pipeline, it can be concluded that the source is not suitable for consideration in relation to Kajiado Town. The most feasible source of water for the town is rain water harvesting.

A review of topographical maps of Kajiado central sub County showed that Olkejuado River has a good catchment area (see Figure 5.8) and can be used to harvest surface run off. This kind of rain water harvesting from a seasonal river has been successfully done in Machakos County (Maruba dam near Machakos town). Kajiado town and Machakos town have similar climatical

conditions and therefore the case of Maruba dam can be replicated in Kajiado where surface run off is impounded in a reservoir, treated and distributed for domestic use.

This study adopted water supply from a reservoir along Olkejuado River as a major source of water to cater for 80% of the demand. Surface water can also be used to blend ground water to make it potable instead of using expensive treatment systems such as desalination units and reverse osmosis systems. The preceding section will deal with determination of major infrastructural components of river abstraction systems.

The size of the catchment area is determined according to the criteria given in Practice Manual for Water Supply Services in Kenya (Ministry of water and irrigation, 2005). The catchment area should be big enough to ensure replenishment of the reservoir even in moderate dry years. Yet the catchment area should not be too big as otherwise the spillway and freeboard (dam-height) will become too large, hence too expensive in relation to the dam wall. As a first indication towards the minimum size of catchment area; the storage required should be equal to 5% of the mean annual rainfall on the catchment area. The 5% represents the runoff factor, which includes a safety for dry years as the normal runoff factor for an average year is usually about 20% for Kenya.

5.5.3 Project design Period

From the Ministry of Water and Irrigation's revised services practice Manual (2005 revised edition), the water project design periods will be as below:

- Present Year 2014 (Year of Project design and implementation).
- Initial year 2016 (Year project is fully operational for first time).
- Future year 2026 (Year marking 10 years of project operation and routine maintenance).
- Ultimate year 2036 (20 years of project operation and maintenance – the period at which project augmentation and replacement of some components are so primary for the project to operate at optimum level).

Infrastructure design and planning will be determined by the following aspects:

- Design Demand = 2783.62 m^3/day,
- Surface water harvesting will meet 80% (2226.896m^3/day) of the demand
- Economical velocity **0.8m/sec.** applied in the project design.

5.5.4 Reservoir capacity

A reservoir capacity to last at least one year without rainfall is recommended. The town is in a semi-arid area with bimodal rainfall pattern. The effects of climate change have been integrated in determination of the capacity of the reservoir. The assumption here is that even if one season fails to rain, the reservoir will still have sufficient water for the town.

In this case the capacity is calculated as follows:

Withdrawal volume	2226.896m^3/day x 365	=	812817.04m^3
Residual water	(10% of demand)	=	81281.704m^3
Seepage loss	(5% of volume)	=	40640.852m^3
Evaporation loss	(30% of volume)	=	243845.112m^3
Required volume		**=**	**1178584.708m^3**

5.5.5 Determination of the size of delivery pipe

From the Design demand of **2226.896m^3/Day**, determining discharge, **Q**, (m^3/sec.), gives;

Q = A.V where **A** is cross sectional area of raw water main and **V** is the economical velocity of the flow through the delivery main.

Thus **Q** = $\frac{\textbf{2226.896m}^3}{\textbf{3600 x 12}}$ =0.0515m^3/sec. = 185.4m^3 /hr.

But **Q=A*V**

0.0515=A*0.8

A=0.0515/0.8

$A=\Pi d^2/4$ where **d** is the nominal diameter of the rising main;

$\Pi d^2/4=0.064375$

$d^2=0.081964$

d= **0.2863m**

= 286.3mm diameter pipe;

Consider the nearest conventional size for design (i.e. 300 mm nominal diameter of pipe for the design)

Thus delivery main pipe Diameter = 300 mm for G.I pipes and 318 mm for PVC pipes

Calculate Actual velocity=V_a

$V_a = Q/A$

$Q=0.0515m^3/sec.$

$A= \Pi d^2/4$

$= 0.070686\ m^2$

$V_a = 0.729$ m/sec;

Thus the actual velocity is **0.73m/sec.**

5.5.6 Pumping and Storage

According to Water supply in Kenya design manual (2005), a balancing tank which is also used for distribution should have a capacity equal to or greater than half of daily water demand. In this case a tank with a capacity of 1392 m^3 is sufficient. The tank shall be constructed at the highest point in town so that water flows by gravity to all parts of the town.

Since the town is connected to the national electricity grid, mains electricity can be used to pump water from the reservoir to the distribution tank. Alternatively, solar energy can be utilized to power pumps and water reticulation in town.

5.6 An integrated water supply plan for Kajiado Town

The water supply system will consist of reservoir along river Olkejuado, treatment plant, pumping system, pipe networks, and distribution tank and bore holes at Oloyangalani and Isinya (See distribution plans on appendix 6). Figure (5.10) and (5.11) are further elaborated in appendix (6). The water from the bore holes will be blended with the treated water from the reservoir and distributed to town.

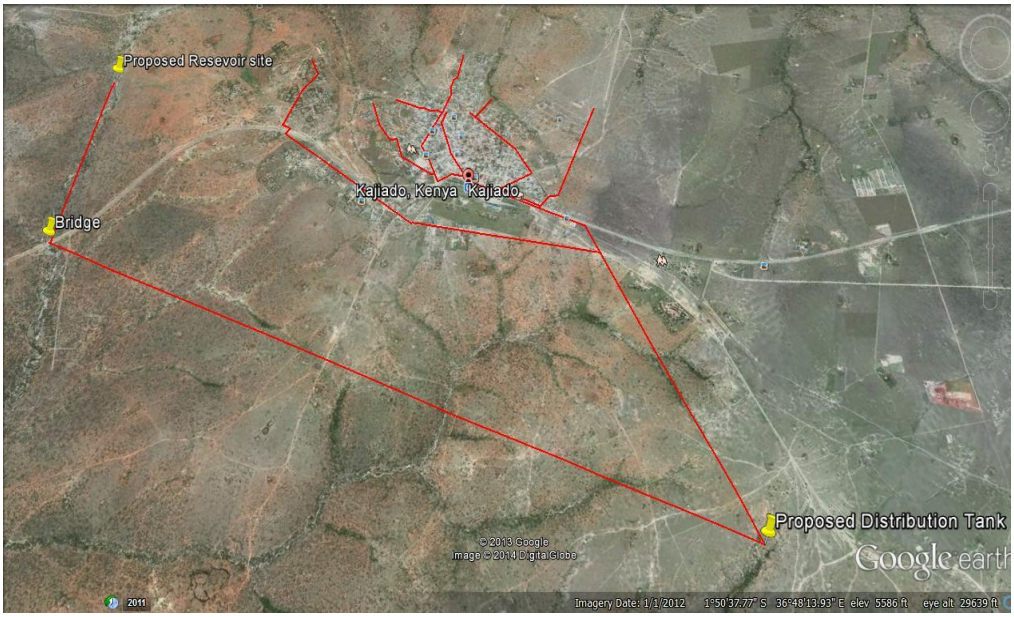


Figure 5.10: Map of Kajiado town showing the proposed water distribution system. Modified from Google maps

Figure 5.11: Map of Kajiado town showing the proposed water distribution system. Modified from Google maps.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of the Findings

A review of the existing policy, legal and institutional framework revealed that the County Government of Kajiado has neither water policy nor water act to guide it in planning, implementation and management of water resources. It was also not clear on the fate of Water Resources Management Authority and its future operations in case a county government enacts laws that overlap its functions. It was observed that there is lack of statutory way of prioritizing allocation of water resources in Kenya.

Water supply services in Kajiado town were mainly done by private business people who have developed their own bore holes. The town had no surface water sources and ground water sources were also found to be inadequate due to low yields and salinity. Ole Kejuado water and Sewerage Company was dormant and non-functional and had not invested in public water supply infrastructure in the town. The Norturesh water supply project was riddled with lots of management challenges that it was not a viable source of water for the town.

It was established that with proper ground water prospecting especially in Oloyangalani and Isinya, it is possible to get high yielding bore holes. There is also potential to harvest surface run off during rainy season by construction of impounding reservoirs along Ole Kejuado River. The water supply system can be powered by solar energy to reduce on the operating cost and make it sustainable.

The daily water demand for the town for the year 2014, 2016, 2026 and 2036 was established to be 1387.76m^3, 1460.77 m^3, 1959.96 m^3, 2783.62 m^3 respectively. Water supply system is based on the ultimate water demand (2783.62m^3 /day).

6.2 Conclusion

The Norturesh Water supply project which was to serve Kajiado town alongside Machakos and Athi River is no longer a viable source of water for the town. But with adequate budget as shown

in planning matrix table (6.1) and distribution plan in appendix 6, it is possible to implement a sustainable water supply system for Kajiado town by harvesting surface run off from conserved catchment area along Olekejuado River, treat and distribute.

6.3 Recommendation

- Both the Central and County Government to draft harmonized water policy, laws and institutional framework in tandem with the new constitution.
- Water policies for both tiers of the government to give water resource allocation priority to minimize conflicts related to water sources.
- The county government to build the financial and technical capacity of Olekejuado Water and Sewerage Company to make it effective in service delivery.
- The county government to set aside adequate budget to construct a reservoir along Olekejuado River with a capacity of 1178584.708m^3 , treatment works and distribution system to supply 80% of the water for the town.
- The county government to set aside adequate funds to carry out hydrogeological survey for the area with good potential for ground water and drill wells and supply system to supply 20% of the water demand.
- The county government in partnership with the local community to develop a shared catchment area protection and conservation plan.

6.4 Further areas of study

This study could not exhaust all areas of sustainable water supply services for urban areas in arid and semi-arid areas of Kenya. The following are the recommended areas of further studies.

- Effects of climate change on urban water supply services.
- Potential for waste water recycling and re-use.
- Private sector investment in water supply services.

Table 6.1: Planning matrix for Water Supply for Kajiado Town

OBJECTIVE	ISSUES	STRATEGY	ACTIVITIES	TIME FRAME (Years)			BUDGET	ACTORS (STAKEHOLDERS)
				ST <2	MT 3-10	LT >11		

1. **Review of the Policy, Legal and institutional framework for water supply in Kenya that affect water supply in Kajiado Town.**	• Lack of national and County Water policies. • Gaps in the existing Water Act. • lack of statutory way of prioritizing allocation of water resources	• National Government to fast track the validation and adoption of draft national water policy. • County government to draft, validate and adopt county water policy. • National Assembly and County Assembly to enact Water laws.	• Fast track the validation and adoption of the draft national water policy. • County government to draft, validate and adopt county water policy. • Enactment of Water laws	Y	Y	Y	20M	• Kenya National Assembly • County assembly of Kajiado • Ministry of Environment, Natural resources and Water (National and County level) • Water Resources Management Authority • Tanathi Water service Board • Citizens • NGOs • Water Service Regulatory Authority

	• Lack of technical and Financial capacity	• Institutional technical capacity building	• Training of staff • Hire of additional staff	Y	Y	Y	50M	• Conty Government of Kajiado • Tanathi Water Service Board
2. Evaluation of the existing water supply system in Kajiado Town.	• Low water infrastructure coverage • Aged infrastructure	Develop water supply infrastructure to cover the entire town	• Engineering design of the supply system	Y			40M	• County Government of Kajiado • Olekejuado Water and Sewerage Company. • Private investors
3. To establish the water demand for Kajiado town	Lack of authentic data on water demand for the town	Carry out a detailed assessment of water uses and trends for the town	Carry out a survey to establish the actual and type of uses of water for the town	Y			2M	• County Government of Kajiado • Olekejuado Water and Sewerage Company

4. To assess the opportunities for sustainable water supply system.	• Lack of permanent source of surface water • Low potential for ground water • High cost of operation for water works • Catchment area protection and conservation	• Identify and develop new sustainable water sources • Minimize operating cost for Water Company. • Involvement of all stakeholders in conservation efforts and programmes.	• Carry out demographic survey • Carry out Water resource assessment and feasibility studies. • Water catchment area protection and conservations such as tree planting, soil erosion control and controlled grazing	Y	Y	Y	50M	• Conty Government of Kajiado • Tanathi Water Service Board • National Environmental Management Authority (NEMA) • Ministry of Environment, natural resources and water
5. To prepare a water supply system for Kajiado Town.	• Lack of a municipal water supply system	• Determination of water demand • Evaluate	• Engineering design of the systems • Construction	Y		Y		• County Government of Kajiado • Olekejuado Water

		various sources and develop the most feasible • Plan and construct distribution system • Set up monitoring and maintenance schedule • Employ revenue collection system	and commissioning of water supply systems. • Collect revenue and maintain the water supply system		Y		600M	and Sewerage Company. • Private investors

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Appendix 1: Household questionnaire

Declaration:

I am a Postgraduate Students at Kenyatta University pursuing a Masters Degree in Environmental Planning and Management. Am carrying out a research on the challenges and prospects of sustainable water supply for Kajiado Town.Amkindly requesting for your time to answer some questions. The information provided in the following questionnaire will be used for academic purpose and confidentiality of the participant guaranteed.

Location Address: _____

Size of Household: _____

Respondents responsibility in the Household [Father, Mother, Son, Daughter]_____

KH1. Indicate the amount of water used by your Household in a day.

Volume in Liters	Dry Season	Wet Season
❒1. <200		
❒2. 200 - 400		
❒3. 401 - 600		
❒4. 601- 800		
❒5. >800		

KH2. What is the source of water for your household?

Source	Dry Season	Wet Season

❒1. Municipal water supply system		
❒2. Community water project		
❒3. Private bore hole / well		
❒4. Own bore hole		
❒5. Rain water harvesting		

KH3. How long does it take you to walk from the house/yard/plot to the water source and back?

Source	Dry Season	Wet Season
❒1. 0 – less than 30 minutes		
❒2. 30 – 60 minutes		
❒3. More than 60 minutes		
❒4. Water is piped into the house / yard / plot.		
❒5. Don't know / no answer.		

KH4. How do you pay for water?

- ❒ 1. Per 20 Liter Jeri can
- ❒ 2. Per month
- ❒ 3. Both

KH5. Is the water source for your HHuse the same as for livestock?

- ❒ 1. Yes
- ❒ 2. No
- ❒ 3. N/A

KH6. How much do you pay for water in a month?

Cost (Kshs)	Dry Season	Wet Season
❒1. < 1000		
❒2. 1001 – 2000		
❒3. 2001 – 3000		
❒4. 3001 – 4000		
❒5. > 4000		
❒Not applicable(Don't pay)		

KH7. How do you rate this water charge?

- ❒ 1. Affordable
- ❒ 2. Unaffordable
- ❒ 3. N/A

KH8. Do you consider the water you have as of good quality for drinking by your Household?

- ❒ 1. Yes
- ❒ 2. No
- ❒ 3. N/A

KH9. Are you aware of the existence of a public water and sanitation company in this town?

- ❒ 1.Yes
- ❒ 2. No

KH10. How would you rate the services provided by Ole Kejuado Water and Sewerage Company?

Rating	Tick appropriately
❒1. Excellent	

❒2. Good	
❒3. Fair	
❒4. Poor	
❒5. Not applicable	

KH11. Have you participated in the activities of water supply planning?

- ❒ 1. Yes
- ❒ 2. No

KH12. Have you paid a bribe for any service related to drinking water in the last one-year?

- ❒ 1. Yes
- ❒ 2. No

KH13. For what purpose have you most recently paid a bribe?

- ❒ 1. To get a connection/ to access water supply
- ❒ 2. To finish repair work
- ❒ 3. Other

KH14. How much did you pay? _____

KH15. Are the water sources which are not acceptable to the Community?

- ❒ 1. Yes
- ❒ 2. No

KH16. If yes for KB10, mention them.

- ❒ 1. _____
- ❒ 2_____
- ❒ 3. _____

Appendix 2: Business Questionnaire

Declaration:

I am a Postgraduate Students at Kenyatta University pursuing a Masters Degree in Environmental Planning and Management. Am carrying out a research on the challenges and prospects of sustainable water supply for KajiadoTown.Amkindly requesting for your time to answer some questions. The information provided in the following questionnaire will be used for academic purpose and confidentiality of the participant will be observed.

Location Address: _____

Nature of business: _____

KB1. Indicate the amount of water used by your business in a day.

Volume	Dry Season	Wet Season
❒1. <200		
❒2. 200 - 400		
❒3. 401 - 600		
❒4. 601- 800		
❒5. 801 – 1000		
❒6. >1000		

KB2. What is the source of water for your business?

Source	Dry Season	Wet Season
❒1. Municipal water supply system		

❒2. Community water project		
❒3. Private bore hole / well		
❒4. Own bore hole		
❒5. Rain water harvesting		

KB3. What is the mode of water delivery to your premises?

Mode	Tick appropriately
❒1. Piped water	
❒2. Motor water tanker	
❒3. Donkey cart	
❒4. Jerry can by hand	
❒5. On-site rain water harvesting	

KB4. If (KB3) is piped how reliable is the water source?

Reliability	Dry Season	Wet Season
❒1. 24 hour flow		
❒2. 12 hour flow		
❒3. 6 hour flow		
❒4. Less than 6 hours flow		

❒5. No flow at all		

KB5. How much do you pay for water in a month?

Cost (Kshs)	Dry Season	Wet Season
❒1. < 1000		
❒2. 1001 – 2000		
❒3. 2001 – 3000		
❒4. 3001 – 4000		
❒5. 4001 – 5000		
❒6. 5001 - 6000		
❒7. 6001 – 7000		
❒8. >7000		
❒Not applicable(Don't pay)		

KB6. How would you rate the services provided by Ole Kejuado Water and Sewerage Company?

Rating	Tick appropriately
❒1. Excellent	
❒2. Good	
❒3. Fair	
❒4. Poor	

❒5. Not applicable	

KB6. Have you participated in the activities of water supply planning?

- ❒ 1. Yes
- ❒ 2. No

KB7. Have you paid a bribe for any service related to drinking water in the last one-year?

- ❒ 1. Yes
- ❒ 2. No

KB8. For what purpose have you most recently paid a bribe?

- ❒ 1. To get a connection/ to access water supply
- ❒ 2. To finish repair work
- ❒ 3. Other

KB9. How much did you pay? _____

KB10. Are the water sources which are not acceptable to the Community?

- ❒ 1. Yes
- ❒ 2. No

KB11. If yes for KB10, mention them.

- ❒ 1. _____
- ❒ 2_____
- ❒ 3. _____

Appendix 3: Key Informant interview guide

Demand

i. What is the current (updated) population of the town?
ii. What is the population growth rate for the town?
iii. Which socio-economic activities are likely to influence population growth?
iv. What are the major uses of water? (statistics needed)
    - Domestic
    - Institutions
    - Irrigation
    - Livestock

Viability and Feasibilty

i. What are the existing water sources?
    - Ground water, surface water resources, rainwater harvesting - Mapping/Infrastructure
    - How much do they supply?
    - What is the Deficit?
    - What are the causes of severe water shortage in the area? Time Lines
ii. Explore potential water sources e.g. dams, pans, roof water harvesting, boreholes, shallow wells, natural water springs, e.t.c.
iii. Are there any cultural beliefs that could also influence the selection and use of the water source e.g. certain springs should not be touched because of ancestral beliefs?
iv. Quality, quantity and distance to the water supply.
v. Are the water sources acceptable to the Community?

Sustainability

i. What is the capacity of the water company?

ii. What is its organizational structure?

iii. Any other existing water projects privately managed or managed by the GOK.

iv. What are the Government plans and other development agencies plans in the area in reference to water policy and Water Act 2002?

v. Environmental impact caused by various interventions – depletion and pollution of water sources.

vi. Trends – focused on rainfall patterns for a period of 30 years.

vii. What are some of the ways of conserving/replenishing water sources?

viii. Cost estimates of various options of supplying water e.g. borehole, piped water, technical shallow wells etc.

ix. Establish the current and potential production of existing water sources.

x. Reports for all existing water sources (Ministry of water, WRMA, NEMA, NGOs & CBOs).

xi. What are the sustainability plans for the existing and proposed water supply projects?

Appendix 4: Observation Guide

1. Number of water sources
2. Types of water sources
3. Number of water infrastructure projects in place
4. Number of shallow wells, boreholes, small rain water harvesting systems (roof catchment), number of large water harvesting systems (rock catchment, water pans, earth dams, sand dams/ sub-surface dams)
5. Number of protected and unprotected springs
6. Number of river abstraction supply systems
7. Number of water treatment systems
8. Number of local level institutions actively involved in Water service provision.

9. Number of private sector entities actively involved in Water related activities (construction, maintenance, water quality testing)
10. Challenges in Water supply initiatives

Appendix 5: Key informant interviewees

1. County water director.
2. Head of Department from line ministries: Water, County Development Officer, NGOs and CBO involved water sanitation interventions in the area.
3. Primary schools' heads.
4. Water Management Committees and Water users associations
5. Chiefs and other key community leaders.

Appendix 6: Spatial plan of the proposed water supply system for Kajiado Town

Appendix 7: Minutes of the proposal presentation