ASSESSMENT OF COMMUNITY BASED WATER SUPPLY, CONSUMPTION, UTILIZATION AND PERCEIVED SUSTAINABILITY: A CASE OF RIRONI SELF-HELP WATER PROJECT, KIAMBU COUNTY KENYA

NG'AARI GODFREY NJUGI (B.SC)

H60/37761/2016

DEPARTMENT OF POPULATION, REPRODUCTIVE HEALTH AND COMMUNITY RESOURCE MANAGEMENT

A RESEARCH THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (COMMUNITY RESOURCE MANAGEMENT) OF KENYATTA UNIVERSITY SCHOOL OF PUBLIC HEALTH AND APPLIED HUMAN SCIENCES

MAY, 2020

DECLARATION

This research thesis is my original work and has not been presented for a degree in any other university.

Signature: _____ Date: 29/May/2020

Ng'aari Godfrey Njugi - H60/37761/2016

This research thesis has been submitted for review with our approval as university supervisors:

Signature: _____ Date: 29/May/2020

Lucy Ngige (PhD)

Department of Population, Reproductive Health and Community Resource Management

Kenyatta University

Signature: _____ Date: 29/May/2020

Lucy Kathuri - Ogola (PhD)

Department of Population, Reproductive Health and Community Resource Management

Kenyatta University

DEDICATION

This research thesis is dedicated to Jidraph Nyoro Kang’ethe (1919-2005) and the 1972 founder members of Rironi Self Help water project.

ACKNOWLEDGEMENT

My heartfelt gratitude goes to my supervisors, Dr. Lucy Ngige and Dr. Lucy Kathuri-Ogola for their mentorship, guidance and supervision. I acknowledge the Rironi Self-Help Water Project management 2018/2019 for the support accorded to me. I extend my appreciation to the participants of this study for their time, insights and candid response to the issues under the study. Special thanks to my research assistants for their unreserved commitment and dedication throughout the data collection process. Thank you and May God abundantly bless you all.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

CBWR	Community Based Water Resource
NACOSTI	National Commission for Science, Technology and Innovation
SHWP	Self-Help Water Project
SPSS	Statistical Package for the Social Sciences
UNICEF	United Nations Children Fund
WHO	World Health Organization

OPERATIONAL DEFINITION OF TERMS

Access to water–To obtain tap water from a Self-Help Water Project (SHWP) through water pipeline networks.

Active SHWP Members – Registered members who receive services from the SHWP.

Agricultural and Commercial water utilization- Water use to support income generating activities/investments by a SHWP member e.g. to support agricultural production and in multifamily housing buildings owned by a SHWP member.

Community Based Water Resource (CBWR) – Water sources and infrastructure owned and managed collectively by the community members through a self-help water project.

Community Based Water Resource (CBWR) Sustainability- The levels of sustainability of community based water resource was measured using 14 selected indicators including equity in access to water, water availability, water affordability, water conservation, community participation and Integrated Water Resource Management using a 5-point Likert scale. CBWR Sustainability scores were categorized into four levels (Low, Moderate, High and Very High) based on scores derived from the respondents' perception and rating of the CBWR sustainability indicators.

Household water consumption- The volume of water used (m^3) by the SHWP member household per month.

Improved water source–Water source that is free from contamination such as borehole water

Inactive SHWP members – Members whose status in the project has been suspended and therefore do not enjoy the services from the SHWP.

Self-Help Water Project (SHWP) – A water project formed through the initiative and use of community members' resources with minimal external support.

Sustainable community water resource management: - The collective responsibility of the community SHWP members to manage the water resources available in their locality in a way that their current needs are met and future water needs are planned for.

Water consumption level - Volume of monthly water use in cubic meters (1-10 m^3 Low user) (10-20m^3 - Moderate user) and (above 21 m^3 - High User)

Water supply – The water availed to active members though the water pipelines (piped water supply from the SHWP boreholes).

Water utilization – The different ways in which water is used by the SHWP Members e.g. domestic, agricultural and commercial uses.

ABSTRACT

The purpose of the study was to assess the influence of demography, water consumption level, water supply and water utilization on perception of CBWR sustainability at Rironi Self Help Water Project (SHWP) in Kiambu County, Kenya. The study objectives were: to determine the influence of demographic characteristics of project members on perception of CBWR sustainability, to establish the influence of water supply on perception of CBWR sustainability, to establish the influence of water consumption level on perception of CBWR sustainability and to assess the influence of water utilization on perception of CBWR sustainability. The study was guided by the general systems theory by Bertalanffy (1968). The study adopted a cross sectional survey research design. The research was carried out at Rironi, Limuru Central Ward in Kiambu County. Stratified random sampling was used to select nine geographical zones covered by the community based water project. From each zone, random sampling was used to select 297 respondents who participated in the study. The data was analyzed using the Statistical Package for the Social Sciences (SPSS) Version 24. Inferential statistics including Chi-Squares and Spearman Correlations were used to test relationships between variables. The findings revealed that the overall perception of CBWR sustainability was rated as moderate by 11%, high by 54%, and very high by 35% of the respondents. The results of the hypotheses tests showed that demographic characteristics had significant influence on the perception of CBWR sustainability as follows: gender (χ^2= =27.117, d.f= 2; p = 0.001), age, (χ^2 =31.532, d.f=8; p = 0.001), education, (χ^2 =12.135, d.f=4; p = 0.016), occupation (χ^2 =23.010, d.f=8; p = 0.003), household size (P=0.001, rs =0.240), duration of residence (χ^2 =22.256, d.f=6; p=0.001) and geographical zone (χ^2 =113.862, d.f=16; p = 0.001). The water supply and consumption variables that had a statistically significant influence on CBWR sustainability were: availability of secondary sources of water (χ^2 =27.428, d.f=4; p=0.001), water disruption in the dry months (χ^2 =30.705, d.f=8; p = 0.001), number days water was supplied (P=0.001, rs =0.250) and the volume of water consumed (χ^2 =10.919, d.f=4 p = 0.027). However, the mode of water utilization had no significant influence on perception of CBWR sustainability. It was concluded that respondents' demographic characteristics, amount of water supplied and amount of water consumed had statistically significant influence of the perception of CBWR sustainability. The study recommends the need to consider investment of water infrastructure in the SHWP, implement control measures to ensure that water supply is done equitably in the different geographical zones and reduce the variations in the number of days that water is supplied to members during the dry months. The SHWP should limit the expansion of the water supply coverage to a smaller geographical area. The SHWP members should adopt water conservation measures in order to ensure long term sustainability of community based water resources in the densely populated study region.

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

The United Nations World Water Assessment Programme (WWAP), (2016) estimated that approximately 663 million people worldwide lacked access to improved water sources, 319 Million of whom lived in sub-Saharan Africa. Further 1.8 billion people in the world lacked reliable water sources that are safe for human consumption. Notably, the sixth sustainable development goal seeks to promote access to clean water and sanitation to all the people in the world by the year 2030 (The 2030 Agender For Sustainable Development, 2015).

The urban population in Africa will triple by the year 2050. Currently the urban population in Africa is 340 million by 2050 it will be 1 billion**.** Clean and reliable water supplies will be essential for the rapidly growing African cities (World Bank Group, 2016). Kenya which is a water scarce country through its vision 2030 seeks to ensure that clean and safe water is accessible to all in both the rural and urban areas (Government of Kenya, 2008).The constitution of Kenya 2010 also recognizes the right to water. It states that 'every citizen has the right to clean and safe water in adequate quantities' (Government of Kenya, 2010). Further the Ministry of Water and Irrigation in Kenya seeks to promote sustainable water management in the country (Ministry of Water and Irrigation, 2016).

The majority of the Kenyans depend on community based water supply systems which include the SHWPs (Leclert, L., Nzioki, R. M., & Feuerstein, L., 2016). Kenya's culture of Self-help has been used in many development initiatives especially in the rural areas (Macharia, E. W., Mbassana, M., & Oduor, M. J., 2015).The origin of self-help groups is the traditional way of communal work and cooperative efforts in solving social issues and

undertaking activities of communal benefit. The Self-help groups in 1960s and 1970s were highly influenced by the many agriculture and dairy cooperatives. In the early stages the visionary individuals mobilized members of the community and established the SHWP to provide piped water to community members (Arvonen, V., Kibocha, S. N., Katko, T. S., & Pietilä, P. 2017).

There has been increased water demand resulting from high population growth and increased food production. The availability of water resources has also been affected by environmental pollution and climate change (Rathnayaka, K., Malano, H., & Arora, M., 2016). According to Spaling, Brouwer and Njoka (2014), the change in rainfall patterns and resulting increase in ground water withdrawals are threatening the sustainability of most Community based water resources in Kenya.

Water supply may also be interrupted due to expansion of the supply systems to accommodate more members. A Study conducted by Mugera, Agwata and Anyango (2014) in Ruiru Sub County which is within the Nairobi metropolitan area points out the challenges in water supply attributed to Land use changes and high population growth. The study also noted that unregulated use of water was causing overexploitation and degradation of water sources threatening the sustainability of water production systems.

1.2 Problem Statement

The recurrent unpredictable and unreliable rainfall experienced in Kenya has continued to increase the dependence on piped water for domestic, agricultural and commercial use. The study area is within the Nairobi Metropolitan area which has experienced immigration leading to population increase, development of real estate projects and commercial

developments. The area is only served by one community based water project, which is the Rironi Self Help Water Project (SHWP) which supplies piped water to the members. The livelihood of most of the local people in the study area is dependent on the water supply from the SHWP.

As noted by Chepyegon and Kamiya (2018) the water sector is facing challenges such as climate change and population pressure. The water sector also faces the challenge of competing water use and unequal development of water infrastructure. Olela and Wanyonyi (2018) noted that the livelihood of the community members is enhanced by sustainable management of water resources. These factors made it ideal for the study to focus on assessing the SHWP members' perception on CBWR sustainability. The study was based on the premise of assessing how demography, water supply and water utilization influenced the SHWP Members' perception of CBWR sustainability.

1.3 Purpose of the Study

The purpose of the study was to assess the influence of demography, water supply, water consumption level and water utilization on perception of CBWR sustainability with focus on Rironi Self-Help water project in Kiambu County, Kenya.

1.4 Objectives of Study

1. To determine the influence of demographic characteristics of project members on perception of Community Based Water Resource sustainability.
2. To establish the influence of water supply to project members on perception of Community Based Water Resource sustainability.

3. To determine the influence of water consumption level by project members on perception of Community Based Water Resource sustainability.
4. To assess the influence of water utilization by project members on perception of Community Based Water Resource sustainability.

1.5 Null Hypotheses

The following null hypotheses were tested in the study:

1. Demographic characteristics of project members do not influence perception of Community Based Water Resource sustainability.
2. Water supply to project members do not influence perception of Community Based Water Resource sustainability.
3. Water consumption level by project members do not influence perception of Community Based Water Resource sustainability.
4. Mode of water utilization by project members do not influence perception of Community Based Water Resource sustainability.

1.6 Significance of the Study

The study findings will provide information on the influence of demography, water supply, water consumption level and water utilization on perception of Community Based Water Resource (CBWR) sustainability. Additionally the study findings will assist in the development of strategies and policies that will promote CBWR sustainability. The study will also make significant contribution to the existing literature in the field of community based water resources.

1.7 Scope of the Study

The study focused on assessing influence of demography, water supply, water consumption level and water utilization on the perception of CBWR sustainability with focus on Rironi self-help water project. The study was conducted at Limuru Central ward in Kiambu county in particular the nine geographical zones covered by the Rironi SHWP. The generalization of the research findings to other community self-help water projects should be done with caution since the demographic, social-economic and geographical factors vary from one community setting to the other.

1.8 Limitation of the Study

The study relied on the knowledge and self-reporting done by the community members and the SHWP Management. To address this limitation, information obtained was triangulated from different sources such as the SHWP founders and the management committee.

1.9 Theoretical Framework

The study was based on the General systems theory by Bertalanffy Ludwing (1968). General System's theory is an interdisciplinary theory by which a phenomenon is investigated in a holistic approach. The theory states that every system has objects, which are the variables in the system; there are internal relationships between the objects (variables) in the system. The system also operates in an environment. The four variables in the system include the input, throughput, output and feedback.

The Input refers to the information, energy or resources that enter the system. The sub components in the input include the anticipated outcomes which are viewed as the goals,

the demands in the system that require to be addressed, the resources to meet the demands, the desires and events that occur in the system and require action. The second variable is the throughput, which refers to the transformation the energy, information and the resources required to transform the input to output. The throughput consists of decision making process, communication, planning, and implementation and controlling of the inputs. The third variable is the output which refers to the final product that result from the interaction of the input and the throughput. It can include the production of resources, energy and information. The fourth variable is the feedback that re-enters the system as an input and has an impact on the subsequent output.

The system theory is an open system with the inputs and outputs, Bertalanffy Ludwing (1968) argued that if a system fails to adopt the feedback it will eventually fall apart and fail. A good system is that which is in a homeostasis by balancing with the environment. The homeostasis is determined by the feedback that provides the system with the information on how to change in order to maintain the homeostasis. The system has relationships that are either independent or dependent. Problems in the system are a manifestation of malfunction in the system.

1.10 The Conceptual Framework

This study was conceptualized using the aforementioned theory. The systems theory helped in the understanding the influence of the SHWP members' demographic characteristics, water supply, water consumption level, water utilization on perception of CBWR sustainability.

The theory helped in identifying the issues that face community based water resources in a holistic way and the coping mechanisms adopted to address the issues. The system theory emphasizes on the need to maintain a balance to achieve homeostasis. The homeostasis in this case is achieved by CBWR sustainability. The study sought to determine the influence of the independent variables on the dependent variable. The link between the independent and the dependent variable was the intervening variables. They included SHWP management, National Water policies and Land use policies.

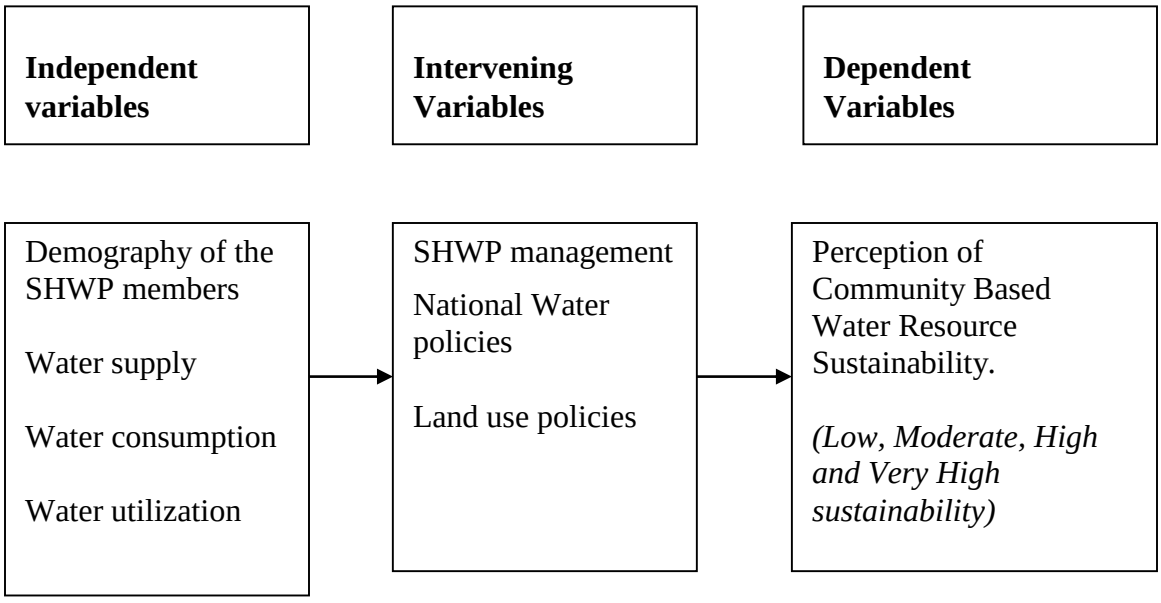


Figure 1: 1 Conceptual framework showing hypothesized relationships among variables

CHAPTER TWO: LITERATURE REVIEW

2.1 Brief history of Rironi Self-Help Water Project

In 1947, the colonial government drilled a borehole in Kiroe settlement, which is within the study area to provide water for the local residents and their livestock. The borehole was served by diesel powered pump to pump water to a reservoir where local residents could access the water. In 1964, after Kenya gained independence the newly formed County Council of Kiambu took charge of the water borehole. The county council built a water point in Rironi settlement and constructed a pipeline from Kiroe to Rironi to supply the residents of Rironi settlement with water.

The expansion of the project led to unreliable water supply due to the reliance on one borehole to supply both water points. Faced with this challenge, visionary residents of Rironi championed the idea of raising funds to drill more boreholes to supplement the existing borehole. The idea was welcomed by the residents and in 1971, a committee was formed to spearhead the initiative. It was around that time the water project began to operate as a SHWP. The objective was to drill more boreholes and have piped water connections to members (Rironi SHWP, 1973).

2.2 Demographic issues in Community based water resources

In the past decades, Community Based Water Projects comprised of a homogenous population and it was easy to manage the small numbers. According to Sally, Gaskin, Folifac and Kometa (2014), the population in many areas has changed from homogenous to heterogeneous as a result of urbanization, bringing about conflicting and different interests. Sally et al. (2014) noted that due to population increase the community water

projects membership increases significantly bringing about complexities. New members to the water projects may lack the sense of ownership in the project since they have not invested much in the project. According to Awortwi (2013), security of tenure increases the participation of the indigenous people in water resource management. The migrants and renters are in most cases not committed to long term community initiatives. This can be attributed to the little investment made in the resources and low level of ownership as noted by (Sally et al.,2014).

Factors such as geography, climate, and levels of economic and technological development contribute to the water accessibility disparities with some areas having ample supply of water while others face extremely high levels of water scarcity (FAO, 2015). According to Obeta and Nwankwo (2015), community based water supply is dependent on available water supply infrastructure, geographical features of the area, management and social cultural environment . Topography becomes a challenge in water supply when water is supplied to a large geographical area.

Cobbinah (2015) noted that community involvement in the management of natural resources such as water contributes to greater support if both social and economic benefits are derived leading to positive impact of the resource on the livelihood of the community members. According to Awortwi (2013), large households are more likely to participate in management of community water resources because large households have higher needs that are addressed by the initiatives.

Gender inequity in the community based water projects is often manifested in many ways for instance the committee members in water projects constitute of low number of women. The gender roles and occupation influences the community members' frequency of

attendance to the project meetings, cash contribution to the project and the influence they have over the decisions made (Marks, S. J., Komives, K., & Davis, J. , 2014). According to Behailu, B. M., Suominen, A., & Katko, T. S. (2015), some of the inhibiting factors to the accomplishment of full access to water in the communities and in the households is the low levels of involvement of the women in water resource management at the community level. Incorporating both men and women in community initiatives ensures that there is balanced community development (Ajayi & Otuya, 2016).

The depth of local knowledge on the issues of water resource management is influenced by the level of community involvement in the management of the water resources (Yadav, B. D., Bigsby, H. R., & MacDonald, I., 2016). Participation of the community members correlates with sustainability of development projects. Project actors have diverse interests, power and perspective. The participatory environment should take into account the power relation among the actors. Power is an aspect that could influence sustainability. The inclusion of women in committees has been influenced from a global level for instance world back polices recommends that 30% of local project committee members should be women. There is high correlation between inclusion of special groups in decision making and sustainability status. This is because all the users of the services are considered in decision making (Kilonzo & George, 2017)**.**

2.3 Water supply for community based water projects

Water supply if often viewed as the responsibility of the government however communities are realizing the important role that they play in the water sector. The low levels of water and sanitation in the developing countries was given due attention in the United Nation conference held in Vancouver in the year 1976. The decade between 1981 and 1991 was

set as a decade that would see the full access to water by residents of the developing countries, this was instrumental in raising awareness on the role of the community in water resource management (Behailu et al., 2015). Kenya has over 350 community run water projects but majority are inactive due to issues of poor management and lack of proper maintenance (Ongw'en, K. L., Kyalo, D. N., Mulwa, A. S., & Matula, D. , 2014).

In many rural areas in Africa it is expected that ground water supplies will remain as the main sources of improved water to the community (Bonsor, H., MacDonald, A., Casey, V., Carter, R., & Wilson, P. , 2018). According to Nyanchaga (2016), the technology used in water supply is influenced by the available capital, topography of the area, water quantity and quality requirements. Chepyego and Kamiya, (2018) observed that most rural areas have dispersed settlements thus the cost of installing and maintaining water pipe systems is high. The high cost of Operational and maintenance and delays in payments are some of the challenges limiting water supply coverage.

Community water Projects that are able to continuously supply water assures the households benefit from the projects in a long term basis (Kiveu, 2016). Water supply that is not continuous affects the household water consumption. The non-continuous water supply contributes to inequity in water supply due to reduction in water pressure at the high points or ends of the supply system during the non-peak hours (Ilaya-Ayza, A. E., Benítez, J., Izquierdo, J., & Pérez-García, R. , 2017). According to Heymans, Eberhard, Ehrhardt and Riley (2016), It is important to have continuous water supply to enable the all households to have access to adequate water. Standard household surveys in most cases do no ask the respondents the amount of hours in a week or a day they receive the water

supplied thus failing to gather data on the actual water reliability at the household which is one of the indicators of sustainable water resource management (Heymans et al., 2016).

According to Behailu, Katko, & Hukka (2017), one of the greatest threats to most rural water supply systems is the inability of the community members to meet the operational and maintenance cost. Other concerns are the reliability of the water resources in terms of quality and quantity of water. When there is low water yield most water sources dry up and the community members do not receive adequate water. It is important for community members to have water storage tanks for water harvesting during the rainy season. The water could be used in the dry months when the yield from the boreholes is low (Obeta & Nwankwo, 2015). According to Nyanchaga (2016), water harvesting is proposed as the best way of solving endemic water problems. Through water harvesting challenges such as water scarcity and depletion of water resources can be mitigated (Ondigo, D. A., Kavoo, A. M., & Kebwaro, J., 2018).

2.4 Factors Influencing Water Consumption levels

Water demand has been increasing at 1 % globally as a result of population growth, economic development and changing water consumption patterns. The demand is highest in the developing countries. As at 2018 3.6 billion people in the world lived in areas experiencing water scarcity in at least one month in a year, this number is projected to increase to 4.8 -5.7 billion by 2050 (United Nations World Water Assessment Programme & UN-Water, 2018). The projected urban population in Kenya by 2030 is approximately 38 Million which will be 67% of the total population. The increased population is expected to exert pressure on available water resources (Ondigo et al., 2018).

Water consumption is influenced by many factors, for instance seasons, water availability, water supply rationing, tariff structure of pricing ,the characteristics of household (Fan, Liu, Wang, Geissen, & Ritsema, 2013). Water quality influences water consumption by the households. There are independent bodies that monitor and evaluate the quality of water provided to the consumers for instance the Ministry of water and sanitation, Kenya bureau of standards and National Environmental Management Authority (Water Services Regulatory Board, 2013).

If the consumers are not able to store enough water to serve them when the water supply is low then their water demand is not met. Most middle and high income water users commonly hire water tankers to supplement their piped water supply (Purshouse, H., Evans, B., Roxburgh, N., Javorszky, M., & Sleigh, A., 2015). According to Nyanchaga (2016), the factors that affect water consumption demand can be categorized into demographic, economic and social drivers. The demographic drivers include population growth, migration, urbanization, gender and age distribution. Social drivers include the individual perception and attitudes regarding water resources and changing lifestyles.

Metered water consumption was first introduced in Kenya by the pre-colonial government to control water wastage and to generate the required revenue for operational and maintenance. To protect the vulnerable groups such as the rural areas the tariff system is used. This is whereby the low volume users pay less per cubic meter of water as compared to the high volume consumers (Nyanchaga, 2016)

There exist literature gaps on the influence of water consumption level on the perception of sustainable community based water resource. To address these gaps, the study analyzed

the association between water consumption rate and the perception of community based water resource sustainability. This was done by investigating the influence of water disconnection, monthly volume of water use and monthly water expenditure on the perception of community based water resource sustainability.

2.5 Water utilization for domestic and livelihood

Domestic water demand is high due to the progressive increase in population. The level of domestic water utilization may be addressed by efficient use, however the high rate of population growth becomes a challenge (El Khanji & Hudson, 2016). Approximately 85% of water supplied to a household is used for cooking, drinking, washing and shower (Chepyego & Kamiya, 2018). The struggle to have water for domestic use lays a lot of burden on women and girls who have to walk for long distances and spend a lot of time fetching water (World Water Assessment Programme, 2015).

Globally it is estimated that agriculture will remain as the highest area of water utilization at 70% followed by industrial water utilization at 20% and domestic utilization at 10% (Huby & Stevenson, 2013). Natural resources are important to rural livelihoods as they are linked to economic development of the rural areas (Tantoh & Simatele, 2017). Efficient rural Water supply is linked to improved rural livelihood because agriculture remains the primary economic activity in the rural areas (Obeta & Nwankwo, 2015). Investing in the water sector has positive impact on the emerging economies thus there is a need to shift towards effective water management and conservation of the water related ecosystems (United Nations World Water Assessment Programme, 2015).

2.6 CBWR sustainability

Community based management of water resources promotes efficiency and social transformation. In addition, local knowledge is important in protection and conservation of natural resources. Community based natural resource management is based on the assumption that the local people are in the best position to respond to their environment, the local interests are represented, they are aware of the complexities in the resource management, they are in a better position to mobilize the resources needed and they are more accountable to the decisions made (Tantoh & Simatele, 2017).

Community management of natural resources gained popularity mainly in the 1980s to 1990 mainly due to previous high levels of exclusion of the community members in the management and conservation of natural resources. Community members management of the natural resources is based on the fact that the locals have the knowledge and greater interests in ensuring that the management of natural resources is done in a sustainable manner unlike external gents/institutions (Jain & Kumar, 2014).

Target 6.1 of the Sustainable Development Goal (SDG) 6 seeks to have equitable access to safe water at affordable cost by all the people. The target is monitored by establishing the percentage of people using safe water, equity in water supply and water availability. Access to safe water is a determinant of household wellbeing, child health and survival and economic productivity. Equitable water access implies elimination of inequality on water access by the different subgroups. Water that is managed sustainably should be affordable and accessible. Water accessibility reduces the time spent on water collection (United Nations, 2015).

According to UN-Water (2016), it is important to have recycling and reuse of water to reduce the rate of freshwater withdrawals. Water use efficiency is also key to sustainable withdraw and supply of fresh water. Sustainable withdraw of water is essential for maintaining healthy ecosystems. Water use monitoring ensures that there is no water loss for instance through pipeline leakage.

Target 6.5 of SDG 6 focuses on promoting sustainable water management through Integrated Water Resource Management. This entails coordinated development and management of water and related resources to maximize social economic benefits. The different users and uses of water are taken into consideration in the process. The main elements of Integrated Water Resource Management include strategic planning, financing and participation (United Nations, 2015)**.** Stakeholders have a high level of promoting project sustainability by ensuring that there is adequate financing of the water projects ,adapting the use of modern technology and by being involved in monitoring and evaluation (Ndurya, 2016).

The agenda 21 recognizes the importance of participation in natural resource management, the rights of indigenous people ,empowerment, capacity building of the local people and integrated decision making as some of the key principles that support sustainable development (de Beer, 2013). Proper community organization in the management of the water resource is essential to the sustainability (Ibrahim, 2017). Through participation the community members are empowered in decision making, thus they have a say in their development initiatives (Ibrahim, 2016).

This study used the indicators identified above to assess the perception of CBWR sustainability.

2.7 Summary of the Literature Review and Gaps

Studies done by Awortwi, (2013), Sally et al., (2014), Marks, et al. (2014) , FAO,(2015), Obeta & Nwankwo, (2015), Cobbinah, (2015), Behailu et al., (2015) , Ajayi & Otuya, (2016) and Yadav et al., (2016) have analyzed the role of community demographic issues on community based water management. However there exists literature gaps on the influence of Demographic characteristics of Community based water project members on their perception of CBWR sustainability. To address this gap this study analyzed the influence of SHWP members' gender, age, education, occupation, and duration of residence, zone and household members on their perception of CBWR sustainability.

In this study literature from UNICEF & WHO, (2015), Ongw'en, et al, (2014)., Bonsor, et al, (2018), Nyanchaga, (2016) , Chepyego & Kamiya, (2018) , Kiveu, (2016)., Ilaya-Ayza, et al, (2017), Heymans, et al, (2016), Heymans et al., (2016), Obeta & Nwankwo, (2015) and Nyanchaga, (2016) on water supply was reviewed. The studies discussed the water supply situation, determinants of water supply and the importance of the water supply to the community. The researcher could not find studies that could explain the influence of water supply on the perception of CBWR sustainability. This study addressed that gap by investigating the influence of number of days water is supplied, water supply disruption in the dry months, secondary source of water, duration served by the SHWP and households using the water supplied on perception of CBWR sustainability.

Literature from United Nations World Water Assessment Programme & UN-Water, (2018), Fan, Liu, et al, (2013), Purshouse, et al, (2015), Nyanchaga, (2016) and Water Services Regulatory Board, (2013) have identified the factors that affect water consumption and the water consumption situation. However there exists literature gaps in

regard to the relationship between water consumption rate and perception of CBWR sustainability. To address this gaps the study analyzed the influence of water consumption on perception of CBWR sustainability.

El Khanji & Hudson (2016), Chepyego and Kamiya (2018), World Water Assessment Programme (2015), Huby and Stevenson (2013). Tantoh and Simatele (2017) and Obeta and Nwankwo (2015) have discussed the various ways in which water is utilized. However there exist literature gaps about the relationship between water utilization and perception of CBWR sustainability. To address these gaps, the study analyzed the influence of different modes of water utilization and perception of CBWR sustainability.

According to UN-Water, (2016), United Nations, (2015a), Ndurya, (2016) and (de Beer, 2013) the indicators of sustainable water resources are: equitable access to water, affordable cost of water, time spent in water collection. Water quality, water conservation, water availability and integrated water resource management. This study proposes to use the indicators identified above to assess the perception of CBWR sustainability.

Macharia et al. (2015), noted that there is lack of adequate baseline data and information on sustainability of most community based water projects in Kenya thus it is hard to have a national wide picture on sustainability of community water resources. This study therefore seeks to generate knowledge and fill the literature gaps in regard to influence of demographic characteristics, water supply, water consumption, water utilization with perception of CBWR sustainability.

CHAPTER THREE: METHODOLOGY

3.1 Research Design

The study adopted a cross-sectional research design. This design method helped the researcher to gather data from a relatively large number of cases at a particular time. It is a non-experimental design in which the relationship between the independent and dependent variables were analyzed without manipulating the independent variable. According to (Kothari, 2014), the cross sectional research design provides the researcher with the opportunity to study the samples from the population then make statements regarding the population from the sample analysis.

3.2 Measurement of Variables

The measuring parameters for independent variables were:

Demographic characteristics of SHWP members were measured by: Gender, education level, occupation, duration of residence in years, location (zone) where the respondents resided and household size of the respondents.

Water supply was measured by number of years the respondent has been a member of the SHWP, Secondary source of water, Frequency of water disruption in the dry months, Number of days water is supplied per week and number of households' water is supplied to.

Water consumption level was measured by: Volume of monthly water use in cubic meters (M^3) and monthly expenditure on water.

Water utilization was measured by enquiring from study participants the ways in which they use water supplied to them.

The measuring parameter for dependent variable:

***Perception of community based water resource sustainability*:** was measured using 14 indicators which included; Satisfaction with the level of water availability, water supply situation, monitoring water use efficiency in the household, water reuse the household, participation in the SHWP meetings, financing of the SHWP activities, decision making in the SHWP, equity in water supply among the different zones, water charges affordability, ease of access to the SHWP water, monthly water supply adequacy , equity in water supply within the zone , the quality of water received and water conservation using a 5-point Likert scale. Sustainability scores were categorized into four levels (Low, Moderate, High and Very High) based on scores derived from the respondents' perceptions.

3.3 Description of Study Area

The study covered the areas served by the Rironi Self Help Water Project. The SHWP covers three sub locations within Limuru central ward in Limuru Sub-County. Limuru central ward is area located approximately 28 kilometers from Nairobi city to the north. The study area is within the Nairobi metropolitan area a factor that has contributed to rapid demographic changes and consequently changes in water demand. The area is zoned as an agricultural area though the area has experienced rapid land use change from agricultural to residential and commercial development. The SHWP has a total of four boreholes across the study area. Water is supplied through water pipelines with metered connections. The SHWP area of coverage is divided into 9 zones. The SHWP has a total of 1,420 registered members.

3.4 Target and Accessible Population

The target population in this study were the 1,420 households served by the Rironi SHWP. The accessible population were the SHWP registered members.

3.4.1 Exclusion Criteria

The corporate members and inactive SHWP registered members were excluded from the study.

3.4.2 Inclusion Criteria

The active SHWP members were included in the study as long as they were not categorized as corporate members.

3.5 Sampling Technique

The Rironi SHWP membership register was used as the sampling frame. The sampling frame had 1420 registered members divided into 9 zones. The list of inactive members was filtered out from the register. Cluster sampling was used whereby each of the 9 zones was considered as a cluster in this study. From each cluster simple random sampling was used to select the individual members who were engaged in the study. This was done by simple randomly selection of membership numbers. This was aimed at ensuring that a truly representative sample was obtained. The key informants were identified through purposive sampling based on their characteristics they included the management and the founding members of the SHWP.

3.6 Sample Size Determination

Fisher et al. (1998) formula for sample size determination was used.

$$nf = \frac{n}{1 + (n \div N)}$$

nf= Desired sample when the population is < 10,000,

n= 384 (Sample when the population is >10,000)

N= 1,420 (Total target population).

The above components were equated in the formula as follows:-

$$nf = \frac{384}{1 + (384 \div 1{,}420)} = \mathbf{302}$$

The sample size for the study was therefore **302** respondents.

3.6.1 Non response

The study engaged 297 respondents, 33 members from each zone, thus the response rate was 98.34%. A total of 8 Key informants were also engaged in the study.

$$\text{Non Response} = \frac{(302-297)}{302} \times 100 = 1.66\%$$

3.7 Research Instruments

3.7.1 Questionnaires

Questionnaires were used to collect information from the SHWP members. The questionnaire was divided into six sections, Section one covered the introduction, section two the demographic characteristics of the SHWP members, section three water supply, section four water consumption, section five water utilization and section six the perception

of CBWR sustainability. The questions were specific for ease in analysis, coding and comparison of data obtained. The objectives of the study influenced the design of the questionnaires. The data collected through the responses formed the basis of understanding the issue under study and explore the ideas set by the objective.

3.7.2 Interview Guides

A Semi-structured interview guide was used for the SHWP Management and the founder members. The interview guide was developed based on the study objectives. This helped in obtaining the history, in-depth and technical information that may not have been obtained from the questionnaires administered to the respondents.

3.8 Pre-Testing

Pre-testing was done whereby the questionnaire was administered to a small sample of respondents before the full study. The objective of the pre-test was check whether the questionnaire wording was clear and the duration it would take to administer each questionnaire. A sample of 27 members from the 9 zones was selected randomly for the pre-test. The respondents who participated in the pre-test stage were excluded from participating in the main study.

3.9 Validity and Reliability

3.9.1 Validity

To establish the content validity of the research instruments the researcher consulted experts in community water resource management and also pre-tested the instruments before conducting the main study. The unnecessary and ambiguous questions were revised accordingly in order to improve validity.

3.9.2 Reliability

Reliability is determined by the ability of the research instrument to yield consistent results (Kothari, 2014). Reliability was determined by test-retest method. If a research instrument is reliable, then correlation between the two tests is significantly high and has a coefficient of at least 0.7 (Cronbach, 1951). The reliability correlation coefficient for this study was 0.84 therefore the instrument was reliable for use.

3.10 Data Collection

Data was collected with the help of three trained research assistants within fifteen days through questionnaires and interviews. The respondents identified during sampling were informed in advance about the study by phone and arrangements done to meet them at their homes. Appointments were also scheduled with the SHWP Management and the founder members. Before the data collection the respondents were briefed about the purpose of the research. Written informed consent was obtained from the respondents before administering the questionnaires. The responses from the respondents were documented by the research assistants.

3.11 Data Analysis and Presentation

Qualitative and quantitative analysis was done. The quantitative data was cleaned and coded using numeric and alphabetical symbols. The quantitative data was analyzed using statistical package for the social sciences (SPSS) version 24. Descriptive statistics such as percentages and Cross tabulation were used to present the findings. Inferential statistics specifically chi-squares was used to test the association between the independent and the dependent variable while Cramer's V was used to test the strength of the association.

Spearman rank test was used to test the independent and dependent variables that had a monotonic relationship. Data was presented using charts, tables and graphs.

3.12 Ethical and Logical Considerations

The study adhered to ethical guidelines of research. Clearance from Kenyatta University Ethical Review Committee and research permit from the National Commission for Science, Technology and Innovation (NACOSTI) was obtained. Local administration and the SHWP management were requested to provide approval. To maintain anonymity and confidentiality respondent's names were not indicated in any research instrument or during reporting. Written Informed consent was obtained from the respondents before participating in the study. The process was voluntary with the respondents having the right to withdraw at any point from the study. The study findings will be disseminated through public forums to the community members and in writing to the SHWP management team upon completion of the study.

CHAPTER FOUR: RESEARCH FINDINGS

4.1 Perceived levels of sustainability of community based water resource

To determine the perceived levels of sustainability of community based water resource, a 5-point Likert scale with a total of 14 questions was used. Each question had a score ranging from 1 to 5. Based on the 5 level scales for the 14 questions, the lowest possible score would be 14 and the highest 70. The perceived levels of sustainability of community based water resource, were categorized into Low (14-28), Moderate (29-42), High (43-56) and Very High (57-70). The results of the levels of sustainability of community based water resources are presented in Table 4.1.

Table 4. 1: Perception of CBWR sustainability

	CBWR sustainability	**Total Score**	**Frequency**	**Percentage**
1	Low	14-28	0	0%
2	Moderate	29-42	33	11%
3	High	43-56	160	54%
4	Very High	57-70	104	35%
Total		**70**	**297**	**100%**

The scores obtained from the respondents in this study were between 29 and 70, with no recorded scores between 14- 28. The respondents ratings on sustainability were 11% as moderate, 54 % rated as high and 35% as very high. There was no rating of low or very low sustainability.

The results shown in Table 4.2: presents the mean and standard deviation of indicators of community based water resources sustainability.

Table 4. 2: Rating on CBWR sustainability

Indicators of sustainable community based water sustainability	F	%	Mean	Std. Deviation
Satisfaction with the level of water availability	297	100	3.95	.668
Water supply situation currently as compared to the past	297	100	4.03	.676
Monitoring water use efficiency in the household	297	100	3.40	.957
Water reuse the household	297	100	2.57	.934
Participation in the SHWP meetings	297	100	4.43	.600
Financing of the SHWP activities	297	100	4.11	.716
Decision making in the SHWP	297	100	4.14	.881
Equity in water supply among the different zones	297	100	3.43	.811
Water charges affordability	297	100	3.50	.900
Ease of access to the SHWP water	297	100	3.81	.753
Monthly Water supply adequacy	297	100	4.07	.619
Equity in water supply within the zone	297	100	3.40	.840
The quality of water received	297	100	4.35	.574
Water conservation	297	100	3.96	.671
Overall Mean score	**297**	**100**	**3.79**	**0.75714**

The average mean score obtained for the 14 questions was 3.79 (75.8%) out of a maximum of 5 (100%) scores which implies that in general the respondents perceived that the community based water resources were sustainable.

According to Table 4.2, the respondents strongly agreed that; there was active participation of the community members in the management of the SHWP (m=4.4), the quality of water received was safe for drinking (m=4.3), there was adequate financing of the project activities (m=4.1), the project decisions were influenced by the community members (m=4.1), the water supplied to the respondents was adequate throughout the month (m=4.0). The respondents indicated that water supply situation was better compared to the past (m=4.03).

Majority of the respondents were satisfied with the level of water availability (m=3.95). The respondents agreed that they had water conservation strategies (m=3.9). The respondents agreed that water was accessible to all the members (m=3.8).The respondents were neutral on affordability of the water charges (m=3.5), equity in water distribution within their zones (m=3.4), equity across different zones (m=3.4).The respondents occasionally monitored the use of the water supplied to them (m=3.4) and occasionally reused the water supplied to them (m=2.57).

4.2 Influence of demographic characteristics on perceived community based water resource sustainability

4.2.1 Gender of respondents

A total of 297 respondents were involved in this study. Results indicated in Figure 4.1 showed that 52.5% of the respondents were female while 47.5% were male.

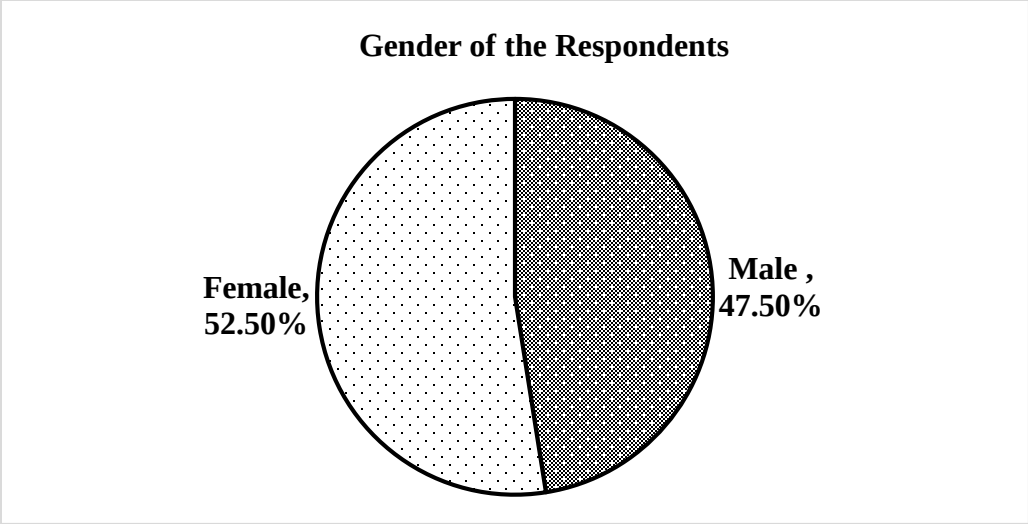


Figure 4. 1 : Gender of the respondents

Cross tabulation was done to determine the influence of gender of the respondents on their perception of community based water resource sustainability. The results in Table 4.3: show cross tabulation between gender and CBWR sustainability

Table 4. 3 *:* Gender and perceived CBWR sustainability

		Gender		Total
		Male	**Female**	
Perceived CBWR sustainability	Moderate	27	7	**34**
		19.1%	4.5%	**11.4%**
	High	56	104	**160**
		39.7%	66.7%	**53.9%**
	Very high	58	45	**103**
		41.1%	28.8%	**34.7%**
Total		141	156	**297**
		100.0%	100.0%	**100.0%**

Notably 41.15% of males perceived CBWR sustainability as very high while over two thirds (66.7%) of the females perceived CBWR sustainability as High. There were more

male respondents that perceived CBWR sustainability as moderate than the female respondent (19.5% vs. 4.5%). This data indicated that gender of the respondents was likely to influence their perception of community water resource sustainability.

From the key informant interviews, the study noted that of the nine committee members, there were only two women. The study established that most women were unwilling to vie for the positions besides the process being democratic.

4.2.2 Age of the respondents

The respondents age was categorized into (18-24 years), (25-35 years), (36-45 years) (46-55 years) and above 55 years. Results shown in Figure 4.2 show the age distribution of the respondents.

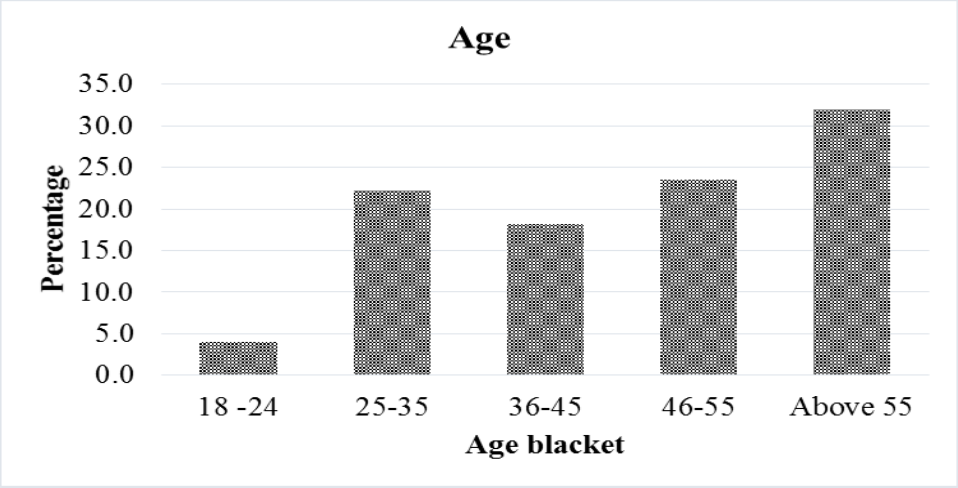


Figure 4. 2: Age of the respondents

The study established that 4% of the respondents were between the ages of 18-24 years, 22.2% were between 25-35 years, 18.2 % were between 36-45 years, 23.6% were between 46-55 years and 32 % were above 55 Years. This indicated that the youth (18-35) comprised 26.2 % of the respondents, the middle-aged respondents were 41.8% while the older respondents over 55 years were 32%.

Cross tabulation was done to compare the age categories of the respondents with their perception of community water resources sustainability. Results presented on Table 4.4 show the results of cross tabulation between age and perception of community water sustainability.

Table 4. 4 : Age and perceived CBWR sustainability

		Age					Total
		18 -24	**25-35**	**36-45**	**46-54**	**Above 55**	
	Moderate	0	10	5	16	3	**34**
Perceived		0.0%	15.2%	9.3%	22.9%	3.2%	**11.4%**
CBWR	High	4	35	28	43	50	**160**
sustainability		33.3%	53.0%	51.9%	61.4%	52.6%	**53.9%**
	Very	8	21	21	11	42	**103**
	high	66.7%	31.8%	38.9%	15.7%	44.2%	**34.7%**
Total		12	66	54	70	95	**297**
		100.0%	100.0%	100.0%	100.0%	100.0%	**100.0%**

The respondents in the age bracket 18-24 years had the highest proportion of participants at the very high perceived CBWR sustainability, while the other age categories had the highest proportion of participants at the high perceived CBWR. The study findings also showed that the respondents in the age bracket (18-24 years) and those over 55 years had more representation in very high sustainability (66.7% and 44.2%) and few representation at the moderate sustainability (0% and 3.2%) as compared to those aged 25-35 , 36-45 and 46-54 who had fewer representation at very high Sustainability (31.8%, 38.9% and 15.7%) and slightly more representation at moderate sustainability (15.2%, 9.3% and 22.9%

respectively) . The variations observed in the sustainability level representation among the different age brackets indicated that age influenced the perception of CBWR sustainability.

4.2.3 Education level of the respondents

Education level was categorized into primary level, secondary level and tertiary level. Figure 4.3 shows the Education status of the respondents.

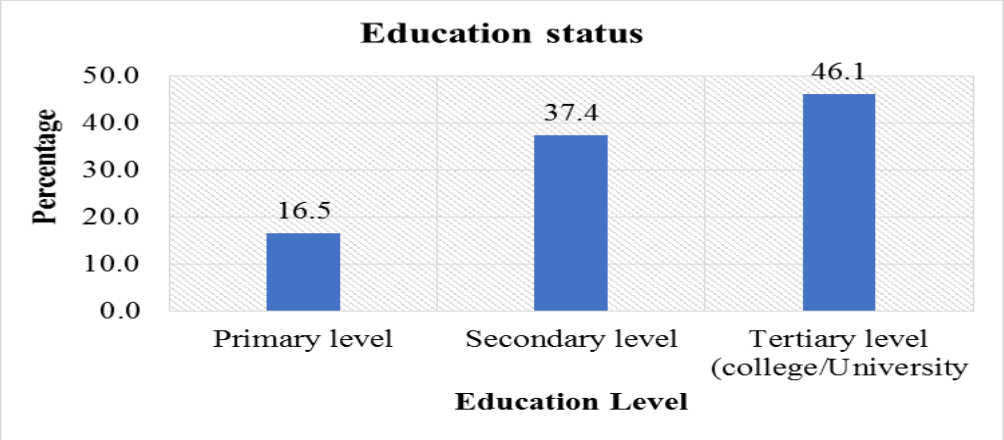


Figure 4. 3: Education status of the respondents

Data obtained revealed that 16.5% of the respondents had primary level of education, 37.4% secondary level and 46.1% tertiary level. The study sought to determine the influence of education on the respondent's perception of CBWR sustainability. Table 4.5 presents the result of cross tabulation between education level of the respondents and their perception of CBWR sustainability.

Table 4. 5*: Education and perceived CBWR sustainability*

		Education			Total
		Primary level	**Secondary level**	**Tertiary level (college/University**	
Perceived CBWR Sustainability	Moderate	2	17	15	**34**
		4.1%	15.3%	10.9%	**11.4%**
	High	35	48	77	**160**
		71.4%	43.2%	56.2%	**53.9%**
	Very high	12	46	45	**103**
		24.5%	41.4%	32.8%	**34.7%**
Total		49	111	137	**297**
		100.0%	100.0%	100.0%	**100.0%**

The study observed that majority of the respondents with primary level of education had a more representation at high sustainability and fewer representation at Moderate sustainability (High 71.4% and Moderate 4.1%) as compared to those in Secondary and tertiary level of education that had fewer representation at high sustainability and slightly more representation at the moderate sustainability (High 43.2% and Moderate 15.3%) and (56.2% High and 10.9% Moderate) for tertiary level.

4.2.4 Occupation of the respondents

Occupation was categorized into farming, self-employed/business, casual laborer, formal job and retired. Figure 4.4 shows the occupation of the respondents.

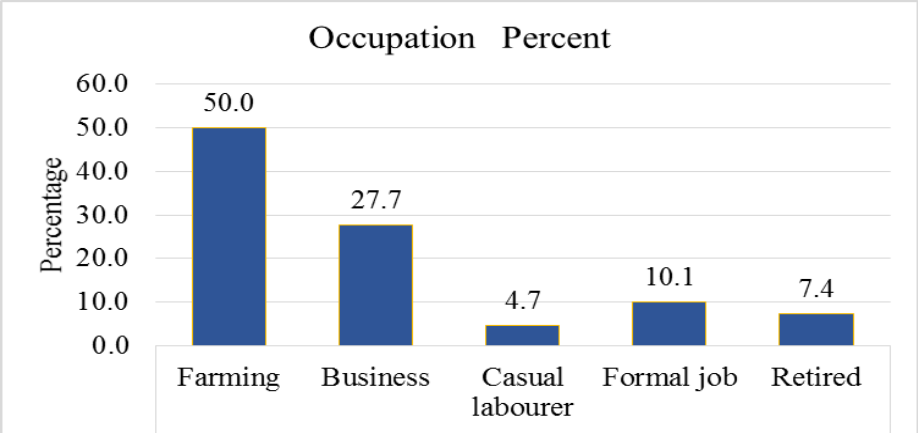


Figure 4. 4 : Occupation of the respondents

The respondents' occupation in percentage was farming (50%), self-employed (27.7%), casual labor (4.7%), formal employment (10.1%) and retired (7.4%).

Cross tabulation was done to determine the influence of occupation on the perception of CBWR sustainability. Table 4:6, presents the results of cross tabulation between occupation and the perception of CBWR sustainability.

Table 4. 6 *:* Occupation and perceived CBWR sustainability

		Occupation					Total
		Farming	**Business**	**Casual laborers**	**Formal job**	**Retired**	
Perceived CBWR Sustainability	Moderate	12	8	5	6	3	**34**
		8.1%	9.8%	35.7%	20.0%	13.6%	**11.5%**
	High	86	44	9	10	10	**159**
		58.1%	53.7%	64.3%	33.3%	45.5%	**53.7%**
	Very high	50	30	0	14	9	**103**
		33.8%	36.6%	0.0%	46.7%	40.9%	**34.8%**
Total		148	82	14	30	22	**296**
		100.0%	100.0%	100.0%	100.0%	100.0%	**100.0%**

The study findings indicated that only the formally employed had majority of respondents at Very high sustainability level. Participants in other occupations had the highest representation at high perceived CBWR sustainability level. The farmers, business people/Self-employed had fewer moderate Sustainability level representation (8.1% and 9.8%) as compared to the casual laborers, formally employed and the retired (35.7%, 20% and 13.6%) respectively.

4.2.5 Duration of residence in the study area by the respondents

Duration of residence was categorized into 1-10 years, 11-20 years, 21-30 years and Over 30 years. Figure 4.5 show duration of residence by the respondents

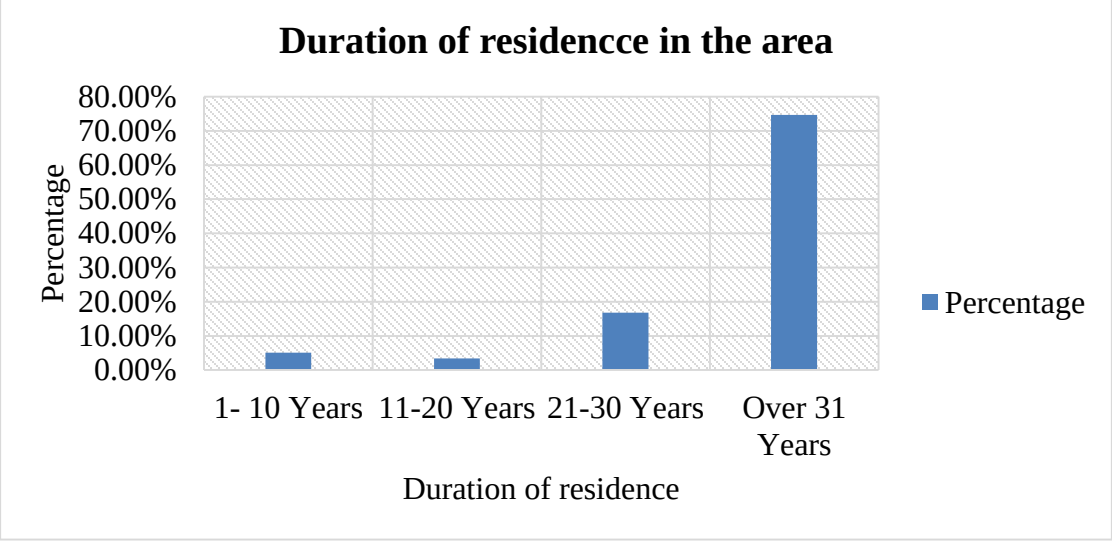


Figure 4. 5: Duration of residence

Data obtained showed that 5.1 % of the respondents had lived in the area between 1-10 years, 3.4 % for 11-20 years, 16.8% for 21-30 years and 74.7 % for over 31 Years. The key informants noted that increased population in the study area from the year 2000 has continued to threaten the sustainability of the water resources.

Cross tabulation results presented in Table 4.7 show the influence of duration of residence on sustainability levels.

Table 4. 7*:* Duration of residence and perceived CBWR sustainability

		Duration of residence				Total
		1-10 Years	**11-20 years**	**21-30 Years**	**Over 31 years**	
Perceived CBWR Sustainability	Moderate	0	0	7	27	**34**
		0.0%	0.0%	14.0%	12.2%	**11.4%**
	High	5	10	23	122	**160**
		33.3%	100.0%	46.0%	55.0%	**53.9%**
	Very high	10	0	20	73	**103**
		66.7%	0.0%	40.0%	32.9%	**34.7%**
Total		15	10	50	222	**297**
		100.0%	100.0%	100.0%	100.0%	**100.0%**

The respondents that had resided in the area for less than ten years had majority of respondents at very high (66.7%). The respondents that had resided in the area for 1-10 years and 11-20 years had 0% representation at moderate sustainability as compared to those that had resided in the area for 21-30 years (14%) and over 31 years (12.2%). This trend indicated that the respondents that had resided in the area for less than 20 years had 100% representation in high and very high sustainability as compared to those that had resided in the area for 21-30 years (86%) and over 31 years (87.8%). This indicated that duration of residence influenced their perception of CBWR sustainability.

4.2.6 Geographical Location – zone

The study area is divided into nine zones with each zone covering a particular geographical area. The key informants observed that the SHWP had expanded over time thus serving

more people in the three sub locations under the study. The initial membership of the project was 72 members in 1971, as at 2018 the membership number had increased to 1,400 members. The study established that due to the increasing population the SHWP coverage was sub-divided into 9 zones with each zone having a representative at the committee.

> For effective management of the project the membership had to be subdivided based on geographical location. Each geographical location is known as a zone. Every zone has a membership of about 220 members and one representative to the SHWP committee, (Key Infomart Interview, 2018)

Cross tabulation was used to compare respondents' perceptions of the CBWR sustainability level from each of the nine zones. Table 4.8 show the results of Cross tabulation between zone and perception of CBWR sustainability.

Table 4. 8 ***: Geographical*** **zone and perceived CBWR sustainability**

		zone									Total
		1.00	**2.00**	**3.00**	**4.00**	**5.00**	**6.00**	**7.00**	**8.00**	**9.00**	
Perceived	Moderate	3	5	0	0	9	0	3	8	6	**34**
CBWR		9.1%	15.2%	0.0%	0.0%	27.3%	0.0%	9.1%	24.2%	18.2%	**11.4%**
Sustainability	High	25	20	8	18	20	8	14	22	25	**160**
		75.8%	60.6%	24.2%	54.5%	60.6%	24.2%	42.4%	66.7%	75.8%	**53.9%**
	Very	5	8	25	15	4	25	16	3	2	**103**
	high	15.2%	24.2%	75.8%	45.5%	12.1%	75.8%	48.5%	9.1%	6.1%	**34.7%**
Total		33	33	33	33	33	33	33	33	33	**297**
		100.%	100.0%	100%	100%	100.0 %	100%	100%	100%	100.0 %	**100%**

Respondents in zone 1, 3, 4, 6, 7 had fewer representation at moderate sustainability (9.1%, 0%, 0%, 0% and 9.1%) as compared to zone 2, 5, 8 and 9 that had slightly more representation at moderate sustainability (15.2%, 27.3%, 24.4%, and 18.2%). This trend indicated that most respondents from zone 1, 3, 4, 6, 7 had more representation at high and very high Sustainability as compared to those in zone 2, 5, 8 and 9. This indicated that the geographical location of the respondent influenced their perception of CBWR sustainability.

4.2.7 Household members

The respondents in the study were asked to indicate the total number of their household members. Figure 4.7 show the number of household members.

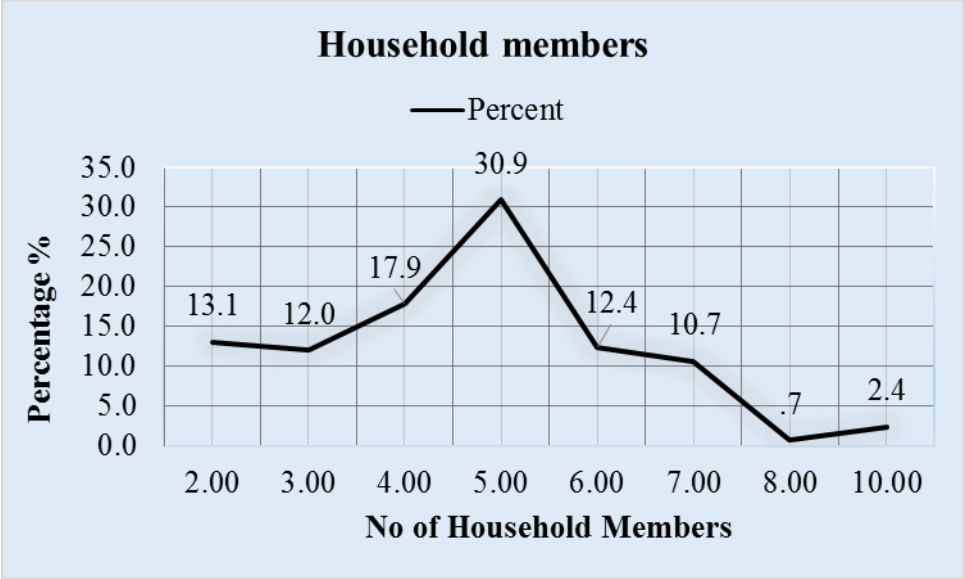


Figure 4. 6: Number of household members

Majority of the respondents' households had 5 members at 30.9%, others included 2 members at 13.1%, 3 members at 12%, 4 members at 17.9%, 6 members at 12.4%, 7 members at 10.7%, 8 members at 0.7% and 10 members at 2.4%.

4.2.8 Inferential statistics on the influence of demographic characteristics of SHWP members on their perception of CBWR sustainability

Null hypothesis – HO 1

HO 1: Demographic characteristics of SHWP members do not influence their perception of CBWR sustainability.

Chi-Square test was used to test if there was significant association between the demographic variables (Independent) and the perception of CBWR sustainability (dependent) at p=0.05 significance level. To determine the strength and direction of the association Cramer's V was used at p=0.05 significant level. The Cramer's V values used were; 0.1-0.29 representing weak to moderately weak and 0.30-0.59 –moderate to strong, while anything above 0.60-1.0 was Strong to very strong (Clark & Foster, 2015).

Spearman's rank was used to test the strength and direction of the relationship between household members (demographic variable) and the perception of CBWR sustainability at p=0.05 significance level. To test the strength of the association the following Spearman's Correlation Coefficient values were used; below <0.20- very weak, between 0.21-0.40 weak, between 0.41-0.60 – moderate, between 0.61-0.80- strong, between 0.81-1.0 very strong.

The results presented in Table 4.9, show the results of the chi-square and Cramer's V.

Table 4. 9 *:* Chi-Square and Cramer's V results for demographic variables

	Chi-Square			Symmetric Measures	
Variables	χ^2	**d.f**	**P value**	**Cramer's V**	**P value**
Zone	113.862	16	0.001	0.416	0.001
Gender	27.117	2	0.001	0.302	0.001
Age	31.532	8	0.001	0.230	0.001
Occupation	23.01	8	0.003	0.187	0.008
Duration of residence	22.256	6	0.001	0.172	0.008
Education	12.135	4	0.016	0.143	0.016

**Significant level (P<0.05)*

Gender of the respondents was found to be significantly associated with their perception of CBWR sustainability (χ^{22} =27.117, d.f =2; *P* = 0.001). There was Moderate association between the two variables (Cramer's V = 0.302, *P* = 0.001).

Age of the respondents was significantly associated with their perception of CBWR sustainability (χ^2 =31.532, d.f =8; *P* = 0.001). There was moderately weak association between the two variables (Cramer's V = 0.230, *P* = 0.001). Education of the respondents was significantly associated with their perception of CBWR sustainability (χ^2 =12.135, d.f =4; *P*= 0.016). There was weak association between the two variables (Cramer's V = 0.143, *P* = 0.016). Occupation of the respondents was significantly associated with their perception of CBWR sustainability (χ^2 =23.010, d.f = 8, *P* = 0.003). There was weak association between the two variables (Cramer's V = 0.187, *P* = 0.008). Duration of residence by the respondents was significantly associated with their perception of CBWR sustainability (χ^2 =22.256, d.f=6; *P*=0.001). There was weak association between the two variables (Cramer's V = 0.172, *P*=0.008). The geographical location of the respondent Zone was significantly associated with their perception of CBWR sustainability (χ^2 =113.862,

d.f =16; *P*= 0.001). There was moderately strong association between the two variables (Cramer's V = 0.416, *P*= 0.001).

Spearman's Correlation

From the results in Table 4.10, number of household members had a significant positive moderate relationship with the perceived level of sustainability (*P=0.001, rs* =0.240).

Table 4. 10 : Spearman's rank order correlation for no. of household members and perceived CBWR sustainability

Correlations			
			CBWR Sustainability
Spearman's rho	Number of household members.	Correlation Coefficient	.240**
		Sig. (2-tailed)	.000
		N	291

**Significant level (P<0.05)*

The analysis done on the influence of demographic variables on the perception of CBWR sustainability showed significant association between the two variables. The null hypothesis 'Demographic characteristics of SHWP members do not influence their perception of CBWR sustainability' was therefore rejected at 0.05 significance level.

4.3 The influence of SHWP water supply perception of CBWR sustainability

4.3.1 Number of years of membership to the SHWP

Number of years of membership to the SHWP was categorized into 1-5 Years, 6-10 Years, 11-15 Years, 16-20 Years and Over 21 Years. Results in Figure 4.7, show duration the SHWP had served the respondents.

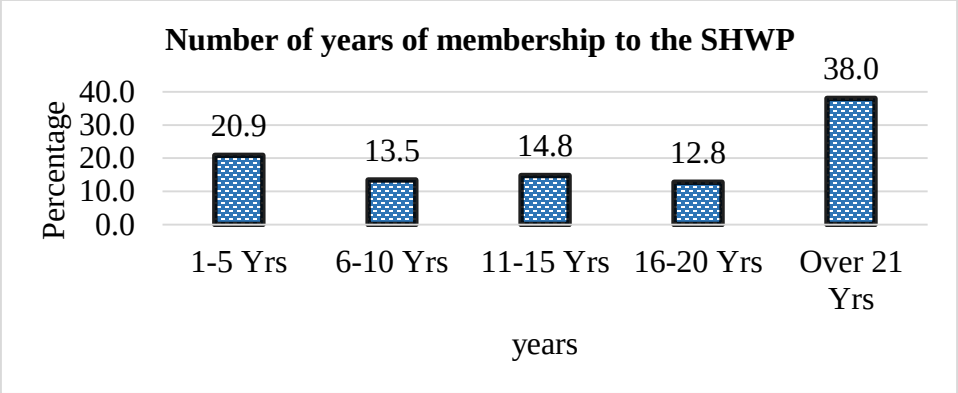


Figure 4. 7 : Number of years of membership to the SHWP

Data obtained showed that 20.9% of the respondents had been served by the SHWP for 1-5 years, 13.5% for 6-10 years, 14.8% for 11-15 years, 12.8% for 16-20 years and 38% for over 21 years.

Cross tabulation was used to compare the duration served by the SHWP with the perception of CBWR sustainability. Table 4.11 show the results of cross tabulation between duration the respondents had been served by the SHWP and their perception of CBWR sustainability.

Table 4. 11*:* Number of years of membership to the SHWP and perceived CBWR sustainability

		Number of years of membership to the SHWP					Total
		1-5 Years	6-10 Years	11-15 Years	16-20 Years	Over 21 Years	
	Moderate	7	3	4	4	16	**34**
Perceived		11.3%	7.5%	9.1%	10.5%	14.2%	**11.4%**
CBWR	High	25	26	33	27	49	**160**
Sustainability		40.3%	65.0%	75.0%	71.1%	43.4%	**53.9%**
	Very	30	11	7	7	48	**103**
	high	48.4%	27.5%	15.9%	18.4%	42.5%	**34.7%**
Total		62	40	44	38	113	**297**
		100.0%	100.0%	100.0%	100.0%	100.0%	**100.0%**

Majority of the respondents whose years of membership to the SHWP was below 5 years had majority of respondents at Very high CBWR sustainability (48.4%) as compared to those that had 6-10 Years, 11-15 Years, 16-20 Years and Over 21 years of membership that had majority of their respondents at High CBWR sustainability (65%) (75%) (71.1%) and (43.4%).

4.3.2 Secondary source of water

Figure 4.8 presents the secondary source of water for the respondents.

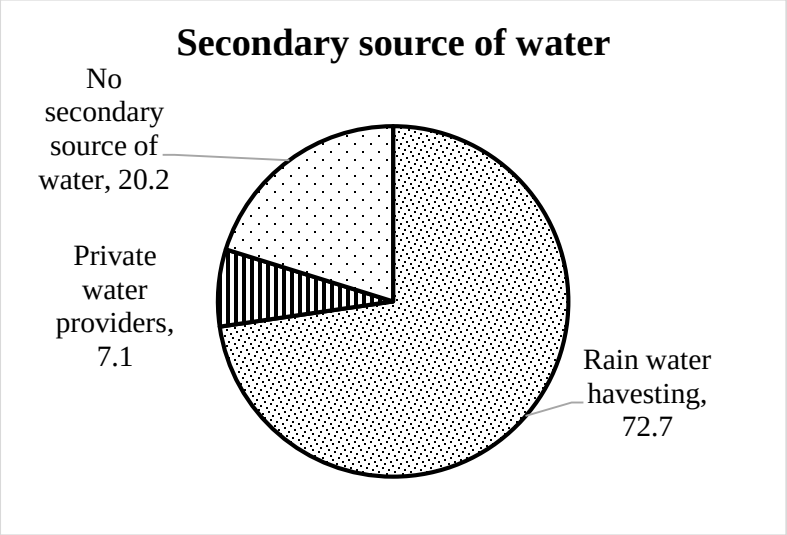


Figure 4. 8 : Secondary source of water

The secondary source of water for majority of respondents was rainwater harvesting by 72.7%. The secondary source of water for 7.1% of the respondents was private water providers, while 20.2% of the respondents did not have any secondary source of water.

Cross tabulation was used to compare the respondents' secondary source of water with their perception of CBWR sustainability. Table 4.12 show the results of the cross tabulation.

Table 4. 12*:* Secondary source of water and perceived CBWR sustainability

		Secondary Source of water			Total
		Water harvesting	**Private water Providers**	**Non**	
Perceived CBWR sustainability	Moderate	20	9	5	**34**
		9.3%	42.9%	8.3%	**11.4%**
	High	115	12	33	**160**
		53.2%	57.1%	55.0%	**53.9%**
	Very high	81	0	22	**103**
		37.5%	0.0%	36.7%	**34.7%**
Total		216	21	60	**297**
		100.0%	100.0%	100.0%	**100.0%**

The results in Table 4.12 show that more of the respondents that relied on private water providers perceived sustainability as moderate (42.9%) as compared to those that had water harvesting that had fewer representation at moderate sustainability (9.3%). Remarkably, the respondents that relied on private water providers did not have any representation at very high CBWR sustainability. The data also shows that the respondents that had water harvesting as their secondary source of water and those that did not have any secondary source of water had more representation at high and very high Sustainability levels compared to those that relied on private water providers.

4.3.3 Frequency of water supply disruption in dry months

Water disruption in the dry months was categorized into never, rarely (less than two times in a week), occasionally (Three to Four times in a week), frequently (Five to six times in a week) and always. Figure 4.9 show the frequency of water supply disruption in the dry months.

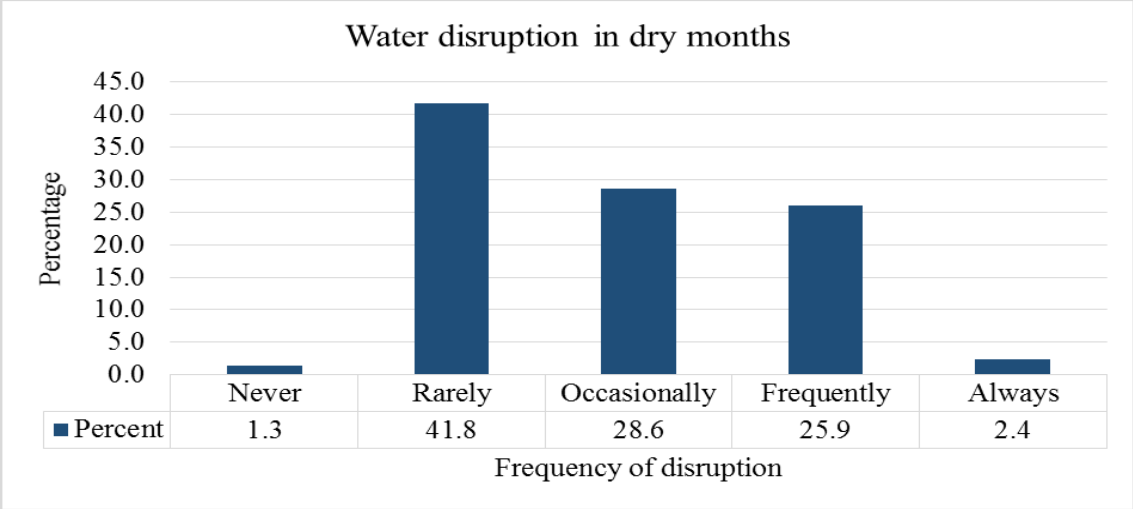


Figure 4. 9: Water supply disruption in the dry months

Majority of the respondents at 41.8% indicated that water disruption was rare, 28.6%, occasional, 25.9% frequent, 2.4% always and 1.3% never.

The study established from key informants that the situation was that way due to the increase in water demand from the members who in most cases have exhausted their secondary sources of water. To address the issue water rationing was done whereby the zones are supplied with water on a particular day and certain hours. This however was not effective as some zones where the water towers are located had access to water always during the dry seasons. The study noted that 20% of the respondents that did not have any source of secondary source of water were from the zones where the water towers were located.

The study established from the key informants that supplying water during the dry months was the most challenging aspect.

> The demand for water is usually very high in the dry season. Supplying adequate water during this period is challenging. Rationing has to be done in most cases (Key informants interview, 2018)

Cross tabulation was used to compare water disruption in the dry months with the perception of CBWR sustainability. Table 4.13 show the results of cross tabulation

Table 4. 13*:* Water supply disruption in the dry months and perceived CBWR sustainability

		Water disruption in the dry months of the year					**Total**
		Never	Rarely	Occasion-ally	Frequently	Always	
Perceived	Moderate	0	13	3	13	5	**34**
CBWR		0.0%	10.5%	3.5%	16.9%	71.4%	**11.4%**
Sustaina-	High	2	60	51	45	2	**160**
bility		50.0%	48.4%	60.0%	58.4%	28.6%	**53.9%**
	Very	2	51	31	19	0	**103**
	high	50.0%	41.1%	36.5%	24.7%	0.0%	**34.7%**
Total		4	124	85	77	7	**297**
		100.0%	100.0%	100.0%	100.0%	100.0%	**100.0%**

Respondents that had never, rarely, occasionally and frequently had water disruption in the dry months had few representation at moderate sustainability (0%, 10.5%, 3.5% and 16.9%) as compared to those that always had water disruption in the dry months (71.4%) that had majority of respondents at moderate CBWR sustainability level. The data indicated that respondents that had never, rarely and occasionally had water disruption in the dry months had more representation at high and very high sustainability (100%, 89.5% and 96.5%) as compared to those that frequently and always had water disruption in the dry

months (83.7% and 28.6%). The variations in the sustainability based on water disruption in the dry months indicated that there could be an association between water supply disruption and the respondents' perception of CBWR sustainability.

4.3.4 Number of Days water was supplied

The respondents engaged in the study indicated the number of days they received water from the SHWP. Figure 4.10 shows the number of days water was supplied.

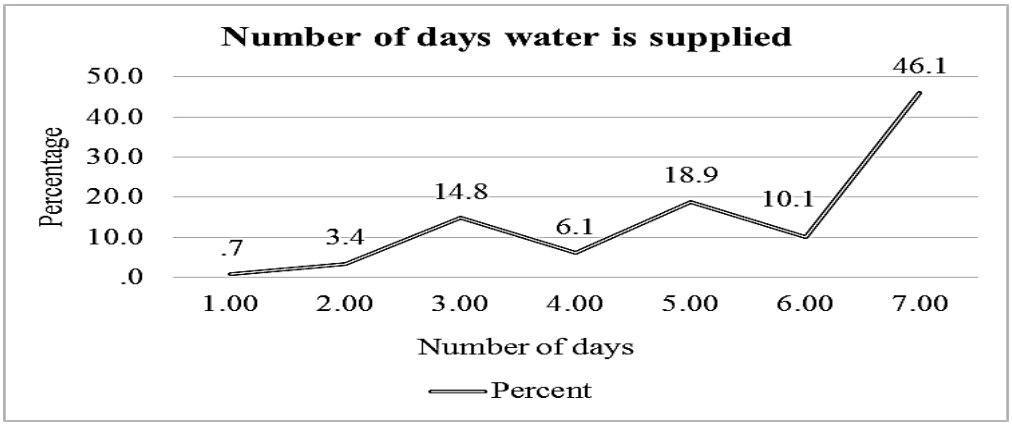


Figure 4. 10 : Number of days water is supplied

Majority of the respondents received water for 7 days (46.1%), for 6 days (10.1%), for 5 days (18.9%), for 3 days (14. 8%), for 2 days (3.4%) and for 1 day (0.7%) in a week.

4.3.5 Households using the water supplied

Figure 4.12 shows the number of households using the water supplied per meter connection.

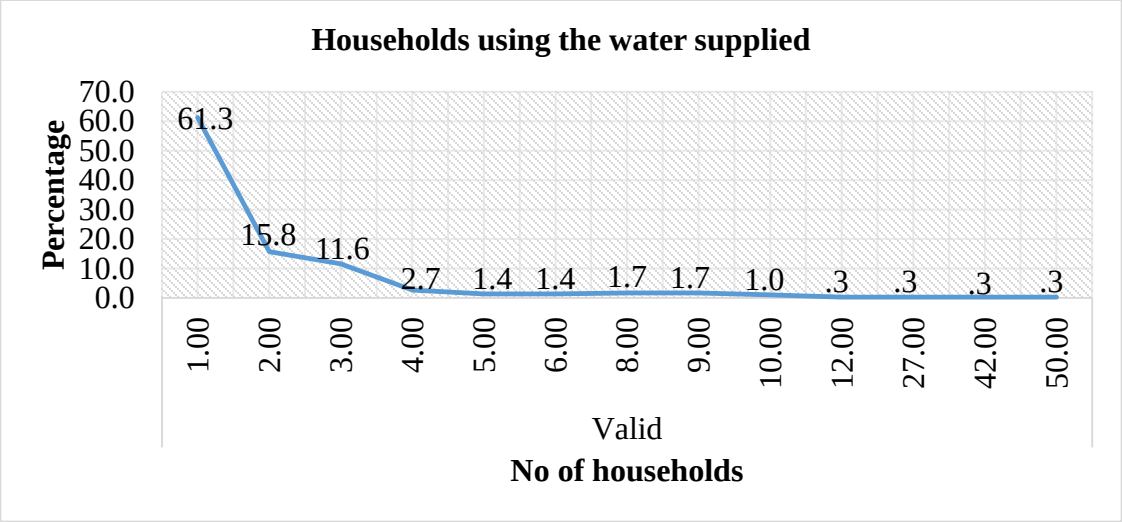


Figure 4. 11: Households using the water supplied

The water supplied to the respondents was mainly used by a single household at 61.3 %. 15.8% of the respondents supplied the water to 2 households, 11.6% had the water used by 3 households and 2.7% by 4 households. The respondents that owned residential houses and apartments had the water supplied to more than 5 households using one meter connection. This included 1.4% for 5 households, 1.4% for 6 households, 1.7% for 8 households, 1.7% for 9 households, 1% for 10 households, 0.3% for 12 households, 0.3% for 27 households, 0.3% for 42 households and 0.3% for 50 households.

4.3.6 Inferential statistics on effect of SHWP water supply on CBWR sustainability

Null hypothesis - HO 2 "Water supply to community members does not influence their perception of CBWR sustainability"

To establish if the influence of SHWP water supply on perception of CBWR sustainability Chi-Square test was used. The Chi-Square tested if there was significant association between SHWP Water supply variables (Independent) and perception of CBWR

sustainability (dependent) at 0.05 significance level. To determine the strength and direction of the association Cramer's V was used at p=0.05 significant level.

Spearman's rank was used to test the strength and direction of the relationship between number of days water was supplied, households using the water supplied and perception of CBWR sustainability at 0.05 significance level. Results shown in Table 4.14 show the Chi square results for water supply variables.

Table 4. 14 Chi-Square and Cramer's V results for water supply variables

	Chi-Square			**Symmetric Measures**	
Water supply variables	χ^2	**d.f**	**P value**	**Cramer's V**	**P value**
Water disruption in the dry months	30.705	8	0.001	0.253	0.001
Secondary source of water	27.428	4	0.001	0.215	0.001
Duration served by the SHWP	25.892	8	0.001	0.209	0.001

**Significant level (P<0.05).*

Duration the respondents had been served by the SHWP was significantly associated with their perception of CBWR sustainability. (χ^2 =25.892, d.f= 8; *P*= 0.001). There was moderately weak association between the two variables (Cramer's V = 0.209, *P*=0.001).

The respondents' secondary source of water was significantly associated with their perception of CBWR sustainability. (χ^2 =27.428, d.f=4; *P*=0.001). There was moderately weak association between the two variables (Cramer's V = 0.215, *P*=0.001).

Water disruption in the dry months was significantly associated with the perception of CBWR sustainability. (χ^2 =30.705, d.f= 8; *P*= 0.001). There was moderately weak association between the two variables (Cramer's V = 0.253, *P*=0.001).

Spearman's rank Correlation

The results in Table 4.15 show the number of days that water was supplied had a significant positive strong relationship with the level of CBWR sustainability (P=0.001, rs =0.250); (rs^2 0.625).

Table 4. 15 : Association between water supply variables and perceived CBWR sustainability

			CBWR Sustainability
Spearman's rho	**No. of Days water is supplied per week**	Correlation Coefficient	.250*
		Sig. (2-tailed)	.000
		N	297

**Significant level (P<0.05).*

From the analysis of the inferential statistics above there was significant association between water supply and perception of community based water resource sustainability. The Null hypothesis 'Water supply to community members does not influence their perception of CBWR sustainability' was rejected at 0.05 significance level.

4.4 The influence of water consumption on perception of CBWR sustainability

4.4.1 Water disconnection

Water disconnection by the SHWP occurs if a member fails to pay the water bill in 15 days after billing. In this study water disconnection was categorized into never, rarely (less than three times a year), occasionally (four to six times annually), frequently (seven to eleven

times annually) and always (every month). Figure 4.12 shows the frequency of water disconnection.

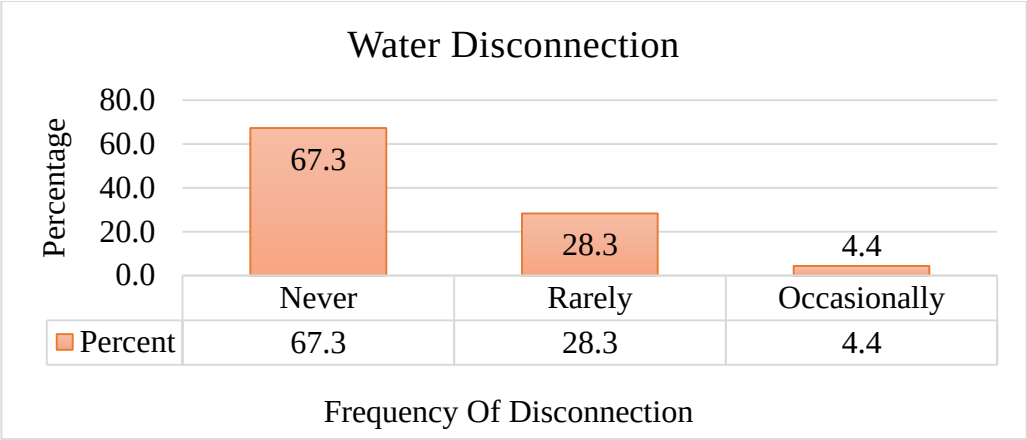


Figure 4. 12 : Frequency of water disconnection

Majority of the respondents 67.3 % had never had their water disconnected, 28.3% rarely had their water disconnected and 4.4% occasionally had their water disconnected. Water disconnection affects the water consumption rate of the member since reconnection takes about 1 week a period in which the member would not be supplied with water from the SHWP.

> There is no limitation on the amount of water a member can consume. The meter readings are taken monthly by the project staff. The bills are sent monthly and should be paid before the 15th day of the month failure to which water is disconnected (Key Informants Interview, 2018)

Cross tabulation was used to compare water disconnection with the perception of CBWR sustainability. Table 4.16 shows the results of Cross tabulation.

Table 4. 16 : Water disconnection and perceived CBWR sustainability

		Water disconnection			Total
		Never	**Rarely**	**Occasionally**	
Perceived CBWR Sustainability	Moderate	19	15	13	**34**
		9.5%	17.9%	100.0%	**11.4%**
	High	99	48		**160**
		49.5%	57.1%	0.0%	**53.9%**
	Very high	82	21	0	**103**
		41.0%	25.0%	0.0%	**34.7%**
Total		200	84	13	**297**
		100.0%	100.0%	100.0%	**100.0%**

Respondents that never and rarely had water disconnected had more representation at high CBWR Sustainability level (49.5%) and (57.1%) while those that occasionally had water disconnected had all (100%) of the respondents at moderate perceived CBWR sustainability. The variations in the sustainability based on water disconnection indicated that water disconnection affected the respondents' perception of CBWR sustainability.

4.4.2 Volume of water used

The monthly volume of water used was categorized into low use (1-10M^3), moderate use (11-20M^3) and high use (Above 21 M^3). Figure 4.13 shows monthly volume of water used.

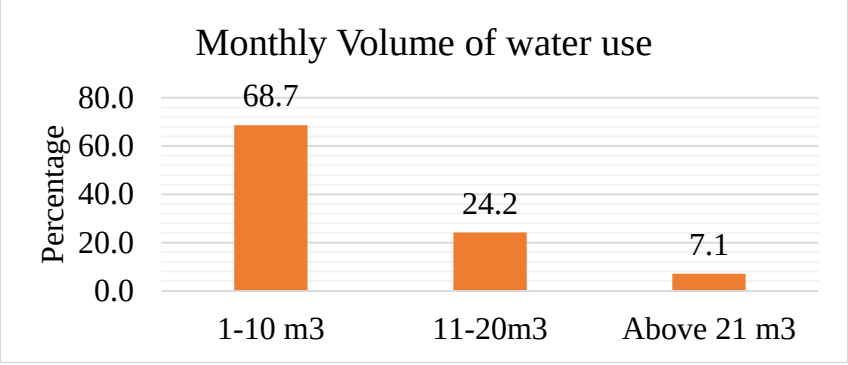


Figure 4. 13 : Monthly volume of water use

Majority of the respondents at 68.7% were low volume users, 24.2 moderate users and 7.1% high users. The study established that Most of the high volume water consumers were the members that owned residential apartments and those that practiced greenhouse farming.

Table 4.17 shows the results of cross tabulation between volume of water use by the respondents and their perception of CBWR sustainability.

Table 4. 17 : Volume of water use and perceived CBWR sustainability

		Approximate volume of water use per month			**Total**
		1-10 m^3	**11-20m^3**	**Above 21 m^3**	
Perceived CBWR Sustainability	Moderate	19	15	0	**34**
		9.3%	20.8%	0.0%	**11.4%**
	High	109	38	13	**160**
		53.4%	52.8%	61.9%	**53.9%**
	Very high	76	19	8	**103**
		37.3%	26.4%	38.1%	**34.7%**
Total		204	72	21	**297**
		100.0%	100.0%	100.0%	**100.0%**

Majority of the respondents that used over 21m^3 of water monthly perceived CBWR sustainability at high at 61.8% followed by those that used 1-10 m^3 (53.1%) and 11-20m^3 (52.8%). The low volume users and the high volume users had low representation at moderate CBWR sustainability level at 9.3% and 0.0% as compared to the Moderate users that had 20.8% at moderate CBWR sustainability level.

4.4.3 Monthly Expenditure on water

Figure 4.14 shows the monthly water expenditure in Kenya Shillings per household. In 2020, the currency equivalent of Ksh. 100 was one ($1) American Dollar

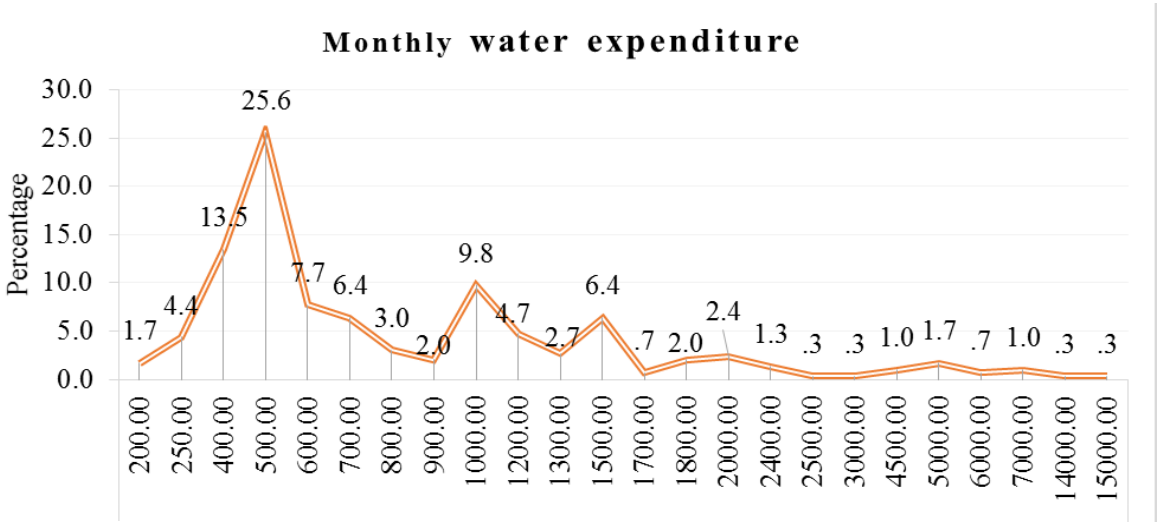


Figure 4. 14 : Monthly water expenditure

The monthly average water expenditure for majority of the respondents ranged between Ksh. 200 and Ksh. 1000 comprising 74.1% while 25.9% paid between Ksh. 1001 and 15,000. The members noted that sometimes in the dry months the water supply is not adequate they have to buy water to meet the demand thus increasing their expenditure on water.

4.4.4 Inferential statistics on the influence of water consumption on perception of CBWR sustainability

HO 3: Water consumption does not influence the perception of CBWR sustainability.

To establish if the influence of water consumption on the perception of CBWR sustainability was significant, a Chi-Square test was used. The Chi-Square tested if there

was significant association between Water consumption variables (Independent) and the perception of CBWR sustainability (dependent) at 0.05 significance level. To determine the strength and direction of the association Cramer's V was used at 0.05 significant level. Spearman's rank was used to test the strength and direction of the association between Monthly Expenditure on water and the perception of CBWR sustainability at 0.05 significance level.

Results in 4.18 show the results of Chi-Square and Cramer's V results for water consumption variables.

Table 4. 18 *:* **Chi-Square and Cramer's V results for water consumption variables**

	Chi-Square			**Symmetric Measures**	
Water consumption variables	χ^2	**d.f**	**P value**	**Cramer's V**	**P value**
Water disconnection	24.942	4	0.001	0.185	0.001
Level of water use	10.919[a]	4	0.027	0.136	0.027

**Significant at p<00.5*

Frequency of water disconnection was significantly associated with perception of CBWR sustainability (χ^2 =24.942, d.f= 4; *P*= 0.001). There was weak association between the two variables (Cramer's V = 0.185, *P*=0.001).

Level of water use was significantly associated with the perception of CBWR sustainability (χ^2 =10.919, d.f= 4; *P*= 0.027). There was weak association between the two variables (Cramer's V = 0.137, *P*=0.027).

Spearman's rank Correlation

Results presented in Table 4.19 showed that the average expenditure on water per month had a significant negative and weak relationship with the level of CBWR sustainability (P=0.03, rs =-0.126) (rs^2=0.158).

Table 4. 19 : Association between water consumption variables and perceived CBWR Sustainability

			CBWR Sustainability
Spearman's rho	Expenditure on water per month	Correlation Coefficient	-.126*
		Sig. (2-tailed)	0.03
		N	297

**Significant at p<00.5*

The inferential statistics show that water consumption influenced the perception of CBWR sustainability**.** The Null hypothesis that stated 'Water consumption does not influence the perception of CBWR sustainability' was therefore rejected at 0.05 significance level.

4.5 The influence of water utilization on the perception of CBWR sustainability

4.5.1 Major uses of water supply

The respondents were asked to indicate the main use of the water supplied to them. Water use was categorized into domestic use and agricultural/commercial use. Domestic use included use of water within the respondents' households. Agricultural and commercial use of water included the use of the water to support the respondents' income generating activities such as farming and supply of the water to multi-dwelling houses owned by the respondents. Results shown in Figure 4.15 indicate the respondents' main mode of Water use.

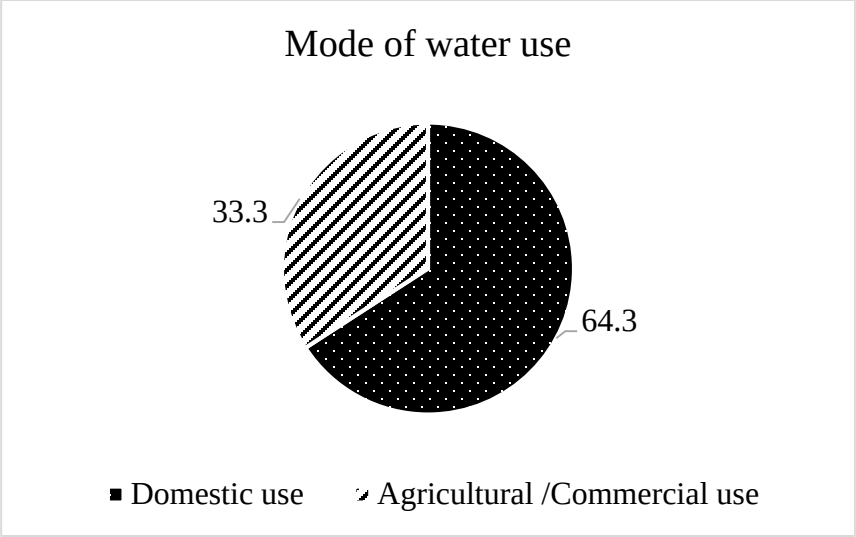


Figure 4. 15: Main mode of water use

The respondents who used the water for domestic use only accounted for 33.3% while those that used the water for agricultural/commercial use were 64.3%. The study area is mainly an agricultural area thus most of the members use the water supplied to them for both domestic and agricultural use.

The key informants noted that: The study area is within the Nairobi Metropolitan area where demand for housing is high, the respondents that own commercial and residential houses distribute the water supplied to them to those houses. The water was also used to support the members' income generating activities in the agricultural sector.

Cross tabulation was used to compare the main water use by the respondents with perception of CBWR sustainability. Table 4.20. Shows the results of the cross tabulation.

Table 4. 20 : Major use of water supplied and perceived CBWR sustainability

		What is the major use of water supplied		Total
		Domestic use	Agricultural /Commercial use	
Perceived CBWR Sustainability	Moderate	22	12	**34**
		11.5%	12.1%	**11.7%**
	High	107	53	**160**
		56.0%	53.5%	**55.2%**
	Very high	62	34	**96**
		32.5%	34.3%	**33.1%**
Total		191	99	**290**
		100.0%	100.0%	**100.0%**

The respondents that used the water supplied to them for domestic use only and those that used the water to support income generating activities did not have significant variation in their sustainability levels.

4.5.2 Water requirement for domestic activities

Water requirement for domestic activities showed that the water supplied to the respondents' households was used for washing of clothes, food preparation, general house cleaning and personal hygiene (showers/toilets). The activity that was water demanding was washing of clothes followed by general house cleaning and shower/toilet flushing. Food preparation had the lowest level of water consumption.

4.5.3 Water requirement for agricultural activities

The respondents used the water for agricultural activities that included: dairy farming, sheep/goats keeping, pig farming, poultry farming and green house faming. Majority of the respondents practiced dairy farming. The respondents indicated that dairy farming, pig

farming and green house farming were the highest consumers of water. Water use for poultry and sheep/goats farming was low.

4.5.4 Inferential statistics on the influence of mode of water utilization on perception of CBWR sustainability.

Null hypothesis - Ho 4: Mode of water utilization do not influence the respondents perception of CBWR sustainability.

To establish if the mode of water utilization influenced the perception of CBWR sustainability, Chi-Square test was used. The Chi-Square tested if there was significant association between type of water Utilization variables (Independent) and perception of CBWR sustainability (dependent) at 0.05 significance level. The results presented in Table 4.23 show the results of the Chi-Square and Cramer's V results for water utilization.

Table 4. 21 : Chi-Square and Cramer's V results for water utilization

	Chi-Square			**Symmetric Measures**	
Water utilization variables	χ^2	**d.f**	**P value**	**Cramer's V**	**P value**
Mode of Water utilization	0.163[a]	2	0.922	0.024	0.922

Water utilization was not significantly associated with the level of CBWR sustainability (χ^2=0.163[a], d.f = 2; *P*= 0.922). The null hypothesis stating that the mode of water utilization does not influence the respondents the perception of CBWR sustainability was therefor was accepted at 0.05 significance level.

CHAPTER FIVE: DISCUSSION OF RESEARCH FINDINGS

5.1 The influence of demographic characteristics of SHWP members on their perception of CBWR sustainability

There were significant association in the perception of CBWR sustainability between the male and female respondents (x^2 =27.117, d.f=2; P = 0.001) (Cramer's V = 0.302, P = 0.001) at 0.05 significance level. The study attributed this to the gender roles and decision making on water management at the household level. Despite the important role women play in management of community water resources their representation in the SHWP management is low. The study concurs with Marks et al. (2014), that gender roles influence the decision made in the management of water resource at the household level besides women having low representation in the management of water resource at the community level.

The study established that the age of the respondents significantly influenced their perception of community based water resource sustainability (x^2 =31.532, d.f=8; P = 0.001) (Cramer's V = 0.230, P = 0.001) at 0.05 significance level. The respondents in the age bracket 18-24 years were likely to have fewer water demands thus they perceived the community water resource as sustainable since their water needs were adequately met. This was unlike the respondents at respondents' age bracket 25-35 years, 36-45 years, 46-55 years and over 55 years who had more water needs and therefore felt that the community water resources were less sustainable.

There were significant association in the perception of CBWR sustainability with the respondents education levels (χ^2 =12.135, d.f=4; P= 0.016) (Cramer's V = 0.143, P = 0.016)

at 0.05 significance level. The respondents with primary level of education had more representation at high sustainability and few representation at moderate sustainability as compared to those with secondary level and tertiary level of education. The study established that the individual knowledge on water resource management was likely to determine their awareness on the sustainability issues affecting community water resources. The respondents with secondary and tertiary level of education were more aware of the challenges threatening the sustainability which affected their perception of community water resource sustainability.

The study established significant association in perception of CBWR sustainability level with the respondents' occupations (χ^2 =23.010, d.f= 8; *P* = 0.003) (Cramer's V = 0.187, *P* = 0.008) at 0.05 significance level. The respondents that practiced farming and the self-employed relied mainly on the community based water supply for their livelihood unlike the casual laborers, formally employed and the retired. The study noted that the respondents that relied on the community water resources for their livelihood had developed better coping strategies thus had better sustainability level. This included the farmers and the self-employed respondents that had fewer representation at moderate CBWR sustainability. The study findings concur with Tantoh & Simatele (2017), that natural resources are important to rural livelihoods as they are linked to economic development of the rural areas.

There was significant association between the duration of residence and the respondents' perception of community based water resource sustainability (χ^2=22.256, d.f= 6; *P*=0.001) (Cramer's V = 0.172, *P*=0.008) at 0.05 significance level. Analysis of duration of residence indicated that those that had resided in the area for less than 20 years had more representation at high and very high sustainability as compared to those that had resided in

the area for over 20 years. As noted from the key informant interviews, the respondents who had resided in the area for over 20 years felt that the management of community water resources was increasingly been threatened by progressive increase in water demand due to the increased population unlike in the past when the demand was low. The findings are in line with Sally et al. (2014) that noted that due to population increase the community based water projects membership increases significantly over time bringing about complexities.

The geographical location influenced the perception of CBWR sustainability (χ^2=113.862, d.f= 16; P= 0.001) (Cramer's V = 0.416, P= 0.001) at 0.05 significance level. The respondents in zone 1, 3, 4, 6 and 7 had more representation at high and very high sustainability levels as compared to zone 2, 5, 8 and 9 that had fewer representation at high and very high sustainability. The zones that had higher sustainability representation had water distribution towers located within their zones. The zones that had lower sustainability representation were located far from the water distribution towers. Other factors that influenced the representation included the terrain of the zones. The study findings are in line with the FAO (2015) observation that geography and levels of economic and technological development contribute to the water accessibility disparities with some areas having ample supply of water while others face extremely high levels of water scarcity. The study findings also concur with Obeta & Nwankwo (2015) that community based water supply is influenced by topographical features of the area,

Number of household members had a significant positive but moderate relationship with the perception of CBWR sustainability. The results obtained in the study indicated that

households with more members perceive the community water resource as more sustainable. The study attributed this to the efficiency in water use by the large households.

5.1.1 Null hypothesis – HO $_1$

The demographic variables Gender, age, education, occupation, duration of residence, geographical location (zone) and number of household members were significantly associated with the variations in the perception of CBWR sustainability at $p< 0.05$ significance level. Geographical location (zone) of the respondents and their gender had the greatest influence on their perception of CBWR sustainability. The null hypothesis stating that 'demographic characteristics of SHWP members do not influence their perception of CBWR sustainability' was therefore rejected at 0.05 significance level.

5.2 The influence of SHWP water supply on the perception of CBWR sustainability

There was an association between the years of respondents membership to the SHWP and their perception of CBWR sustainability (χ^2 =25.892, d.f=8; *P*= 0.001) (Cramer's V = 0.209, *P*=0.001) at 0.05 significance level. The trend observed in the study showed that respondents that had been members to the SHWP for 1-5 years had few representation at moderate sustainability and more representation at very high sustainability levels as compared to those that had been members for (6-10 years), (11-15 years), (16-20 years) and over 21 years. The respondent served by the SHWP for over 21 years felt the situation had worsened due to the stress in water supply unlike in the past when they joined the project. The study observations are in line with Spaling et al. (2014) that observed that the initial conditions that fostered water supply may change over time and hence threaten the viability of the community water resources. This may have resulted from expansion of the

supply systems to accommodate more members. The study findings however contradict Sally et al., (2014) that indicated that new members to the water projects may lack the sense of ownership since they have not invested much in the community water projects.

There was significant association between secondary source of water and the respondents perception of CBWR sustainability ($\chi 2$ =27.428, d.f=4; P=0.001) (Cramer's V = 0.215, P=0.001) at 0.05 significance level. The respondents that had water harvesting and those that did not have any source of secondary water perceived the management of community water resources as more sustainable compared to those that had private water providers as their secondary source of water.

The study established that most of the respondents that had continuous water supply though out the year and were located close to water distribution towers did not have secondary sources of water since they felt the water supply was reliable. The respondents that had rain water harvesting had better water conservation strategies, which contributed to their more representation on high and very high CBWR sustainability level. The respondents that had private water providers as their secondary source of water felt that the water supply was not reliable thus perceived the management of the community water resources as less sustainable. The study observations concur with Kiveu (2016) who observed that water resource conservation is an important factor in ensuring water supply reliability. This study results are supported by observations of Nyanchaga, (2016) who noted that rain water harvesting is the best way of solving endemic water problems. This is also in line with the recommendations made by Obeta & Nwankwo (2015), that community members should have water storage tanks for water harvesting during the rainy season. From which water could be used in the dry months when the yield from the boreholes is low.

There was significant association between water disruption in the dry months and the respondents perception of CBWR sustainability (χ^2=30.705, d.f=8; *P*= 0.001), (Cramer's V = 0.253, *P*=0.001) at 0.05 significance level. The trend observed in water disruption during the dry months negatively affected the perception of CBWR sustainability. The respondents that never, rarely, occasionally had water disruption had higher CBWR sustainability levels than the respondents that had frequent and always experienced water supply disruption in the dry months. This is supported by key informants who noted that supplying water during the dry months was the most challenging aspect.

The study findings are in line with Behailu, Katko, & Hukka (2017) who noted that during the dry months there is low water yield hence most water sources dry up and the community members do not receive adequate water. As noted by Bonsor, MacDonald, Casey, Carter, & Wilson (2018) many rural areas in Africa are expected to have ground water supplies as the main sources of improved water to the community, thus the need to formulate ways to supplement the ground water extraction.

Number days water was supplied had a significant positive strong relationship with the respondents' perception of CBWR sustainability (P=0.001, rs =0.250) at 0.05 significance level. The study findings support Kiveu, (2016) observations that community based water Projects that are able to continuously supply water assures the households benefit from the projects in a long term basis.

5.2.1 Null hypothesis – HO $_2$

The SHWP water supply variables were significantly associated with the perception of CBWR sustainability at 0.05 significance level. The number of days water was supplied by the SHWP had the highest influence on the perception of sustainable management of community water resource. The Null hypothesis 'Water supply to community members does not influence their perception of CBWR sustainability' was rejected at 0.05 significance level.

5.3 The influence of water consumption on the perception of CBWR sustainability

There was significant association between water disconnection level and the respondents perception of CBWR sustainability (χ^2=24.942, d.f= 4; *P*= 0.001) (Cramer's V = 0.185, *P*=0.001) at 0.05 significance level. The trend observed in the study indicated that the higher the rates of water disconnection negatively affected the respondents' perception of CBWR sustainability. The respondents that had never had their water disconnected had higher sustainability representation as compared to those that had their water disconnected. The study established that the respondents that perceived the cost of water to be unaffordable were more likely to have their water supply disconnected. The study findings support the use of tariff structure of pricing to promote the efficient use of water by the different level of water consumers as observed by Singh, (2016). As noted by Nyanchaga, (2016) it is important to protect the vulnerable groups by use of tariff system. This is whereby the low volume users pay less per cubic meter of water as compared to the high volume consumers.

There was significant association between level of water use and the respondents perception of CBWR sustainability ($\chi 2$=10.919a, d.f=4; P= 0.027) (Cramer's V = 0.137, P=0.027) at 0.05 significance level. Low volume water users and high volume users had higher sustainability representation. This meant that they perceived community based water resources as more sustainable unlike the moderate users. The study established that most of the active participants in the management of the community water resources were the low volume water users and high volume users a factor that contributed to their positive perception of sustainability of community based water resources.

Average expenditure on water per month had a significant negative but weak relationship with the respondents' perception of CBWR sustainability (P=0.03, rs = -0.126). The results confirmed that majority of the respondents that had low expenditure on water had higher sustainability representation compared to the respondents that had high expenditure on water resulting from the purchase of water from private water providers. The current study findings agree with Purshouse, Evans, Roxburgh, Javorszky, & Sleigh (2015) that most high level water users commonly hire water tankers to supplement their piped water supply. The study findings also concurred with Fan, Liu, Wang, Geissen, & Ritsema (2013) that water consumption is influenced by many factors, for instance seasonal variability, water availability, water supply rationing, tariff structure of pricing and the characteristics of households.

5.3.1 Null hypothesis – HO $_3$

The water consumption variables influenced the perception of CBWR sustainability at 0.05 significance level. The Null hypothesis that stated 'Water consumption does not influence the perception of CBWR sustainability' was therefore rejected at 0.05 significance level.

5.4 The influence of mode of water utilization on the perception of CBWR sustainability

Majority of the respondents used the water supplied to them to support their livelihood. The respondents that utilized the water for domestic activities only and for those that used utilized the water to support their livelihood did not have variations in their perception of CBWR sustainability (χ^2 =0.163, d.f. = 2; *P*= 0.922) at 0.05 significance level. This meant that the different ways in which water was used for did not influence the users' perception of CBWR sustainability.

The study findings concurred with Cobbinah, (2015) who noted that community involvement in the management of natural resources contributes to greater support if both social and economic benefits are derived leading to positive impact of the resource on the livelihood of the community members. The study agrees with the observation that efficient rural water supply is linked to improved rural livelihood because agriculture remains the primary economic activity in the rural areas (Obeta & Nwankwo, 2015).

5.4.1 Null hypothesis – HO $_4$

The mode of water utilization (domestic and agricultural/commercial uses) was not found to be significantly associated perception of CBWR sustainability. This implied that the mode of water utilization did not influence the respondents' perception on sustainable management of community water resource. Therefore, the null hypothesis stating that "the mode of water utilization does not influence the perception of CBWR sustainability was thus accepted at 0.05 significance level.

CHAPTER SIX: SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary of the major findings

6.1.1 The influence of demographic characteristics of SHWP members on their perception of CBWR sustainability.

The influence of demographic variables of the SHWP members on their perception of CBWR sustainability was ranked as follows:-

Geographical Zone: There was significant strong association between zone and perception of CBWR sustainability (x^2 =113.862, d.f= 16; *P*= 0.001) (Cramer's V = 0.416, *P*= 0.001).

Gender: There was significant moderate association between gender and perception of CBWR sustainability (x^2 =27.117, d.f=2; *P* = 0.001) (Cramer's V = 0.302, *P* = 0.001).

Age: There was significant moderately weak association between age and perception of CBWR sustainability (x^2 =31.532, d.f=8; *P* = 0.001) (Cramer's V = 0.230, *P* = 0.001).

Household members: Number of household members had a significant moderately weak relationship with the perception of CBWR sustainability (*P=0.001, rs* =0.240).

Occupation: There was significant weak association between occupation and perception of CBWR sustainability (χ^2 =23.010, d.f= 8; *P* = 0.003) (Cramer's V = 0.187, *P* = 0.008).

Duration of residence: There was significant weak association between Duration of residence and perception of CBWR sustainability (χ^2=22.256, d.f= 6; *P*=0.001) (Cramer's V = 0.172, *P*=0.008).

Education: There was weak association between Education level and perception of CBWR sustainability (χ^2 =12.135, d.f=4; *P*= 0.016) (Cramer's V = 0.143, *P* = 0.016).

Null hypothesis HO 1

From the analysis above the null hypothesis 'Demographic characteristics of SHWP members do not influence perception of CBWR sustainability' was hence rejected at 0.05 significance level.

6.1.2 The influence of SHWP water supply on the perception of CBWR sustainability

From the analysis done the study ranked the influence of SHWP Water supply on the perception of CBWR sustainability as follows;

Number of days water was supplied: The number days water was supplied had a significant positive strong relationship with the perception of CBWR sustainability (*P=0.001, rs* =0.250). (rs^2 0.625)

Water disruption in the dry months: There was significant moderately weak association between water disruption in the dry months and the perception of CBWR sustainability (χ^2=30.705, d.f=8; *P*= 0.001), (Cramer's V = 0.253, *P*=0.001).

Secondary source of water: There was significant moderately weak association between secondary source of water and the perception of CBWR sustainability (χ^2 =27.428, d.f=4; *P*=0.001) (Cramer's V = 0.215, *P*=0.001).

Years of respondents membership to the SHWP: There was significant moderately weak association between years of respondents membership to the SHWP and the perception of CBWR sustainability (χ^2 =25.892, d.f=8; *P*= 0.001) (Cramer's V = 0.209, *P*=0.001).

Null hypothesis HO 2

From the analysis above the Null hypothesis 'SHWP Water supply has no effect on the perception of CBWR sustainability' was therefore rejected at 0.05 significance level.

6.1.3 The influence of water consumption on the perception of CBWR sustainability

From the analysis done the study analyzed the influence of water consumption on the perception of CBWR sustainability as follows;

Water disconnection: There was significant weak association between water disconnection level and the perception of CBWR sustainability (χ^2=24.942, d.f= 4; *P*= 0.001) (Cramer's V = 0.185, *P*=0.001).

Level of water use: There was significant weak positive association between Level of water use and the perception of CBWR sustainability (χ^2=10.919[a], d.f=4; *P*= 0.027) (Cramer's V = 0.137, *P*=0.027).

Expenditure on water: Average expenditure on water per month had a significant negative weak relationship with the level of CBWR sustainability (*P=0.03*, *rs* = -0.126).

Null hypothesis HO $_3$

From the analysis above the Null hypothesis 'Water consumption has no influence on the perception of CBWR sustainability' was consequently rejected at 0.05 significance level.

6.1.4 The influence of mode of water utilization on the perception of CBWR sustainability

The study analyzed the various uses of the water supplied to the respondents and established that 64.3% of the respondents used the water supplied to them to support their livelihood. The mode of Water utilization was not significantly associated with the respondents perception of CBWR sustainability (χ^2 =0.163, d.f. = 2; *P*= 0.922).

Null hypothesis HO $_4$

The Null hypothesis stating that 'mode of water utilization do not influence the perception of CBWR sustainability' was thus accepted at 0.05 significance level.

6.2 Conclusion

Based on research findings, this study therefore concludes that:-

a) Demographic characteristics of SHWP members influenced the perception of CBWR sustainability.
b) Water supply to the members of the self-help water project influenced the perception of CBWR sustainability.
c) Water consumption level influenced the perception of CBWR sustainability.

d) The mode of water utilization did not influence the perception of CBWR sustainability.

6.3 Recommendations for Policy

1. Gender had a significant relationship with the perception of CBWR sustainability, and therefore there is need for the SHWP management to consider the gender issues in the management of community water resources.
2. The SHWP management should put in place control measures to ensure that water supply is done equitably in the different zones and within the zones to reduce the variations in the number of days water is supplied to members especially during the dry months.
3. There was significant association between water disconnection and the perception of CBWR sustainability. The SHWP needs to put in place measures that safeguard the economically vulnerable members of the community from water disconnection.
4. There is need for training and capacity building of the SHWP members on good water resource management practices at the household level for sustainable CBWR.

6.4 Recommendations for Practice

1. There is need to limit the coverage of the SHWP to the existing area since further extension would contribute to more water stress in some zones thus threatening the CBWR sustainability.
2. There is need for the SHWP to invest in water distribution towers in the zones that the respondents had lower percentage in their perception of CBWR sustainability.

3. There is need for SHWP members to have water conservation strategies such as water harvesting and adequate water storage tanks. This would ensure that the members have water reserved in the dry months when there is water rationing.

6.5 Recommendations for Further Research

The study recommends further study on the following:

1. A study could be conducted on the effect of operational cost on community water resource management.
2. A similar study could be conducted to assess the effectiveness of management of community water resources by self-help groups in other Counties.

REFERENCES

Ajayi, R., & Otuya, N. (2016). Women's participation in self-help community development projects in Ndokwa agricultural zone of Delta State, Nigeria. *Community Development Journal*, *41*(2), 189–209. https://doi.org/10.1093/cdj/bsi044

Arvonen, V., Kibocha, S. N., Katko, T. S., & Pietilä, P. (2017). Features of Water Cooperatives: A Comparative Study of Finland and Kenya. *Public Works Management & Policy*, *22*(4), 356–377. https://doi.org/10.1177/1087724X17715267

Awortwi, N. (2013). The riddle of community development: Factors influencing participation and management in twenty-nine African and Latin American communities. *Community Development Journal*, *48*(1), 89–104. https://doi.org/10.1093/cdj/bsr071

Behailu, B. M., Katko, T. S., & Hukka, J. J. (2017). Service Failures of Rural Water Supply Systems in Ethiopia and Their Policy Implications. *Public Works Management & Policy*, *Vol. 22*(2), 179– 196. https://doi.org/DOI: 10.1177/1087724X16656190

Behailu, B. M., Suominen, A., & Katko, T. S. (2015). Evolution of Community-Managed Water Supply Projects From 1994 to the 2010s in Ethiopia. *Public Works Management & Policy*, *20*(4), 379–400. https://doi.org/10.1177/1087724X15593955

Beyerl, K., Putz, O., & Breckwoldt, A. (2016). The Role of Perceptions for Community-Based Marine Resource Management. *Frontiers in Marine Science*, *3*(238). https://doi.org/10.3389/fmars.2016.00238

Bonsor, H., MacDonald, A., Casey, V., Carter, R., & Wilson, P. (2018). The need for a standard approach to assessing the functionality of rural community water supplies. *Hydrogeology Journal*, *26*, 367–370. https://doi.org/10.1007/s10040-017-1711-0

Chepyego, C., & Kamiya, D. (2018). Challenges Faced by the Kenya Water Sector Management in Improving Water Supply Coverage. *Journal of Water Resource and Protection*, *10*, 85-105. https://doi.org/10.4236/jwarp.2018.101006

Chepyegon, C., & Kamiya, D. (2018). Challenges Faced by the Kenya Water Sector Management in Improving Water Supply Coverage. *Journal of Water Resource and Protection*, *10*, 85–105.

Clark, T., & Foster, L. (2015). *Chi-Square: Introducing the "Goodness of Fit " Test and the "Test of Association."* University of Sheffield. www.social-policy.org.uk

Cobbinah, P. B. (2015). Local attitudes towards natural resources management in rural Ghana. *Management of Environmental Quality: An International Journal*, *26*(3), 423–436. https://doi.org/10.1108/MEQ-04-2014-0061

de Beer, F. (2013). Community-based natural resource management: Living with Alice in Wonderland? *Community Development Journal*, *48*(4), 555–570. https://doi.org/10.1093/cdj/bss058

El Khanji, S., & Hudson, J. (2016). Water utilization and water quality in endogenous economic growth. *Environment and Development Economics*, *21*(5), 626–648. https://doi.org/10.1017/S1355770X16000061

Fan, L., Liu, G., Wang, F., Geissen, V., & Ritsema, C. J. (2013). Factors Affecting Domestic Water Consumption in Rural Households upon Access to Improved Water Supply: Insights from the Wei River Basin, China. *PLoS ONE*, *8*(8), 1–9. aph.

Government of Kenya. (2008). *Kenya Vision 2030*. Government printer.

Government of Kenya. (2010). *Constitution of Kenya*. Government Printer.

Heymans, C., Eberhard, R., Ehrhardt, D., & Riley, S. (2016). *Providing Water to Poor People in African Cities Effectively: Lessons from Utility reforms*. Water and Sanitation Program.

Huby, M., & Stevenson, S. (2013). Meeting need and achieving sustainability in water project interventions. *Progress in Development Studies*, *3*(3), 196–209. https://doi.org/10.1191/1464993403ps061oa

Ibrahim, S. H. (2016). Community-Based Water Projects' Sustainability: Lessons and Challenges – A Case study from Sudan. *International Journal of World Policy and Development Studies*, *2*(6), 38–45.

Ibrahim, S. H. (2017). Sustainability Assessment and Identification of Determinants in Community-Based Water Supply Projects using Partial Least Squares Path Model. *J. Sustain. Dev. Energy Water Environ. Syst.*, *5*(3), 345–358. http://dx.doi.org/10.13044/j.sdewes.d5.0153

Ilaya-Ayza, A. E., Benítez, J., Izquierdo, J., & Pérez-García, R. (2017). Multi-criteria optimization of supply schedules in intermittent water supply systems. *Journal of Computational & Applied Mathematics*, *309*, 695–703. https://doi.org/10.1016/j.cam.2016.05.009

Jain, S. K., & Kumar, P. (2014). Environmental flows in India: Towards sustainable water management. *Hydrological Sciences Journal*, *59*(3–4), 751–769. https://doi.org/10.1080/02626667.2014.896996

Kilonzo, R., & George, V. (2017). Sustainability of Community Based Water Projects: Dynamics of Actors' Power Relations. *Journal of Sustainable Development*, *10*(6). https://doi.org/doi.org/10.5539/jsd.v10n6p79

Kiveu, S. (2016). *Determinants of sustainability of community water projects in Webuye East Sub-County, Bungoma, Kenya*. University of Nairobi.

Kothari, C. R. (2014). *Research Methodology; Methods and Techniques* (2nd ed.). New Age International Publisher.

Leclert, L., Nzioki, R. M., & Feuerstein, L. (2016). Addressing governance and management challenges in small water supply systems – the integrity management approach in Kenya. *Aquatic Procedia*, *6*, 39–50. https://doi.org/10.1016/j.aqpro.2016.06.006

Macharia, E. W., Mbassana, M., & Oduor, Mr. J. (2015). Assessing Sustainability Of Rural Water Projects In Naivasha, Kenya, Case Study: Maraigushu Water Project. *European Journal of Business and Social Sciences*, *4*(7), 52–83.

Marks, S. J., Komives, K., & Davis, J. (2014). Community Participation and Water Supply Sustainability: Evidence from Handpump Projects in Rural Ghana.

Journal of Planning Education and Research, *34*(3), 276–286. https://doi.org/10.1177/0739456X14527620

Ministry of Water and Irrigation. (2016). About the ministry of Water and Irrigation. *Ministry of Water and Irrigation*. http://www.water.go.ke/?page_id=6

Mugera, E. W., Agwata, J. F., & Anyango, S. O. (2014). Sources, Accessibility and Reliability of Water for Various Uses in Ruiru District of Kiambu County, Kenya. *International Journal of Sciences: Basic and Applied Research*, *14*(1), 164–173.

Ndurya, D. (2016). *Determinants Of Sustainable Water Supply Programme Implementation In Kenya: A Case Of Mombasa Water Supply And Sanitation Company LTD*. University of Nairobi.

Nyanchaga, E. N. (2016). *History of Water Supply and Governance in Kenya (1895-2005) Lessons and Futures.* Tampere University Press. https://doi.org/10.26530/OAPEN_610992

Obeta, M. C., & Nwankwo, C. F. (2015). Factors Responsible For Rural Residential Water Supply Shortage In Southeastern Nigeria. *Journal of Environmental Geography*, *8*(3–4), 21–32. https://doi.org/10.1515/jengeo-2015-0009

Olela, E. S., & Wanyonyi, L. (2018). Factors Influencing Sustainability Of Water Supply Projects For Rural Communities In Arid And Semi Arid Lands: A Case Of Garbatula Sub County In Isiolo County, Kenya. *International Academic Journal of Information Sciences and Project Management*, *3*(2), 516–537.

Ondigo, D. A., Kavoo, A. M., & Kebwaro, J. (2018). Water Resources and Management under Increasing Urban Demography: A Kenyan Perspective—A Review. *Journal of Water Resource and Protection*, *10*, 919–938.

Ongw'en, K. L., Kyalo, D. N., Mulwa, A. S., & Matula, D. (2014). Community participation in development projects in Kenya: Analytical review of factors influencing sustainable water projects in Shianda Division, Kakamega County. *Prime Journal of Business Administration and Management*, *4*(8), 1552–1562.

Purshouse, H., Evans, B., Roxburgh, N., Javorszky, M., & Sleigh, A. (2015). *Modelling Formal and Informal Domestic Water Consumption in Nairobi*. Water and Sanitation for The Urban Poor.

Rathnayaka, K., Malano, H., & Arora, M. (2016). *Assessment of Sustainability of Urban Water Supply and Demand Management Options: A Comprehensive Approach*. *8*. https://doi.org/10.3390/w8120595

Rironi SHWP. (1973). *Brief History Of Rironi Self Help Water Project* (Records). N/A.

Sally, Z., Gaskin, S. J., Folifac, F., & Kometa, S. S. (2014). The effect of urbanization on community-managed water supply: Case study of Buea, Cameroon. *Community Development Journal*, *49*(4), 524–540. https://doi.org/10.1093/cdj/bst054

Singh, K. (2016). Managing Water for Sustainable Development: An Economist's Perspective. *IIM Kozhikode Society & Management Review*, *5*(1), 1–4. https://doi.org/10.1177/2277975215619564

Spaling, H., Brouwer, G., & Njoka, J. (2014). Factors affecting the sustainability of a community water supply project in Kenya. *Development in Practice*, *24*(7), 798–810. https://doi.org/10.1080/09614524.2014.944485

Tantoh, H. B., & Simatele, D. (2017). Community-based water resource management in North-west Cameroon: The role of potable water supply in community

development. *South African Geographical Journal*, *99*(2), 166–183. https://doi.org/article: https://doi.org/10.1080/03736245.2016.1208589

United Nations. (2015). *Compilation of Metadata Received on Indicators for Global Monitoring of the Sustainable Development Goals and Targets* (Inter-Agency and Expert Group on Sustainable Development Goals Indicators). http://unstats.un.org/sdgs/meetings/iaeg-sdgs-meeting-01.html

The 2030 Agender For Sustainable Development, A/RES/70/1 (2015). sustainabledevelopment.un.org

United Nations World Water Assessment Programme (WWAP). (2016). *The United Nations World Water Development Report 2016: Water and Jobs.* UNESCO.

UN-Water. (2016). *Integrated Monitoring Guide for SDG 6 Targets and global indicators*. www.unwater.org/sdgs/en/

Water Services Regulatory Board. (2013). *Drinking Water Quality and Effluent Monitoring Guideline* (p. 9).

World Bank Group. (2016). *Providing Water to Poor People in African Cities Effectively: Lessons from Utility Reforms* [Water and Sanitation Program].

World Water Assessment Programme. (2015). *The United Nations World Water Development Report 2015.Water For Sustainable World.Facts and Figures*. http://www.unesco.org/water/wwap

WWAP (United Nations World Water Assessment Programme). (2015). *The United Nations World Water Development Report 2015: Water for a Sustainable World.*

WWAP (United Nations World Water Assessment Programme), & UN-Water. (2018). *The United Nations World Water Development Report 2018: Nature-Based Solutions for Water*. UNESCO.

Yadav, B. D., Bigsby, H. R., & MacDonald, I. (2016). Elitism: Normative ethics of local organisation in community-based natural resources management. *International Journal of Organizational Analysis*, *24*(5), 932–955. https://doi.org/10.1108/IJOA-06-2015-0873

APPENDIX 1: Informed consent form.

Dear Respondent,

I am a student from Kenyatta University undertaking an academic study titled: `` Assessment of Community Based Water Supply, Consumption, Utilization and Perceived Sustainability: A Case of Rironi Self-Help Water Project, Kiambu County Kenya``.

Procedure to be followed

As a member of Rironi Self-Help Water Project, You have been selected randomly to participate in this study. Participation in the study is voluntary therefore you may stop at any time if necessary. Feel free to ask questions in regard to this study any time before or after consenting.

Discomforts and risks

In case there is a question that you find uncomfortable to respond to you can choose not to answer it or stop participating in the study any time without penalty. The questionnaire will take approximately 15 Minutes to complete.

Benefits

By participating in this study you will help in providing information on the relationship between household demographic characteristics, household water consumption, water utilization and sustainable water management. The study findings will assist in the development of strategies that will promote sustainability of CBWR.

Reward

There are no financial rewards or any other incentives for participating in this study. The researcher will however appreciate your contribution.

Anonymity and confidentiality

To maintain confidentiality and anonymity your name will not be indicated in any research instruments.

Contact information

If you have any questions you may contact Dr. Lucy Ngige at ngige.lucy@ku.ac.ke or Dr. Lucy Kathuri-Ogola at kathuri.lucy@ku.ac.ke or the Kenyatta University Ethical Review committee Secretariat on kuerc@ku.ac.ke

Participant's statement

The above information has been explained to me to the best of my understanding by the researcher. I voluntarily agree to participate in the study. I understand that information that I will provide will be held in confidentiality and that I can leave the study at any time without any penalty.

_____ _____

Signature of participant Date

Investigator's statement

I, the undersigned have explained to the volunteer the procedures to be followed in this study, the risks and benefits involved.

_____ _____

Signature of researcher Date

Name: Godfrey Njugi Ng'aari

Adm. **No:** H60/37761/2016

Mob: 0786 560 435

APPENDIX II: QUESTIONNAIRE

Section 1: Introduction

The purpose of this questionnaire is to help in gathering information to be used in the ` Assessment of Community Based Water Supply, Utilization and Sustainability: Case of Rironi Self-Help Water Project In Kiambu County``. The information obtained will be treated with confidentiality and anonymity.

Section 2: Demographic characteristics of members

1. Gender

(1) Male **[]** (2) Female **[]**

2. Age

(1) 18-24 **[]** (2) 25-35 **[]** (3) 36-45 **[]** (4) (46-54) **[]** (5) above 55**[]**

Level of education

(1) Primary level **[]** (2) Secondary level **[]** (3) Tertiary level (college/University) **[]**

3. Occupation

(1) Farming **[]** (2) Business **[]** (3) Casual laborer **[]** (4) Formal job **[]** (5) Retired **[]**

4. How long have you lived in Limuru sub county?

(1) 1-10 Years **[]** (2) 11-20 years **[]** (3) 21-30 Years **[]** (4) Over 31 years **[]**

5. How many members does your household have?

_____

Section 3: Water supply

6. How long have you been served by the SHWP?

(1) 1-5 Years **[]** (2) 6-10 Years **[]** (3) 11-15 Years **[]** (4) 16-20 Years **[]** (5) Over 21 **[]**

7. What is your secondary source of water?

(1) Water harvesting **[]** (2) Private water provides **[]** (3) Others (Specify) _____

8. How often is water supply disruption in the dry months of the year?

(1) Never **[]** (2) Rarely(less than two times in a week) **[]** (3) Occasionally (Three to Four times in a week) **[]** (4) Frequently (Five to six times in a week) **[]** (5) Always **[]**

9. How many days is water supplied to your household per week?

_____ Days

10. How many households use the water supplied to you?

_____

Section 4: Water consumption.

11. How often have you had your water disconnected for late payment?

(1) Never **[]** (2) Rarely **[]** (3) Occasionally **[]** (4) Frequently **[]** (5) Always **[]**

12. What is your total approximate volume of water use per month?

(1) 1-10 m^3**[]** (Low user) (2)10-20m^3**[]** (Moderate user) (3) Above 21 m^3 **[]** (High User)

13. What is the average cost of expenditure on water per month?

Ksh._____

14. Do you agree that Water supplied is safe for consumption?

(1) Strongly Agree **[]** (2) Disagree **[]** (3) Neutral **[]** (4) Agree **[]** (5) Strongly Agree **[]**

Section 5: Water utilization

15. What is the major use of water supplied to your household?

(1) Domestic use **[]** (2) Agricultural /commercial use **[]**

16. Kindly indicate the level of water requirement for the following domestic activities in your household (**where applicable.)**

Water requirements for domestic activity	Very high	High	Moderate	Low	Very low
Washing of clothes					
Food preparation					
General house cleaning					
Shower and toilets flushing					
Other (specify)					

17. Kindly indicate the level of water requirement for the following agricultural activities (**where applicable.)**

	Very high	High	Moderate	Low	Very low
Dairy farming					
Sheep /goats					
Poultry					
Green house farming					
Other (specify)					

Section 5: CBWR Sustainability

18. Read the following statements and tick the box that best reflects your opinion.

CBWR Sustainability	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
The quality of water supplied is satisfactory.					
The SHWP water is available equitably to all members					
The water supplied to you is adequate throughout the month					
The SHWP water is accessible to all members					
Water charges are affordable					
There is equitable distribution of water supply in your zone					
The water project decisions are influenced by the SHWP members					
There is adequate financing of the project activities					
There is active participation in management of SHWP by the members					
You have water conservation strategies in place.					

19. How often do you reuse the water in your household?

(1) Never **[]** (2) Rarely (less than two times in a week) **[]** (3) Occasionally (Three to Four times in a week) **[]** (4) Frequently(Five to six times in a week) **[]** (5) Always **[]**

20. How often do you monitor water use efficiency in your household?

(1) Never **[]** (2) Rarely(less than two times in a week) **[]** (3) Occasionally (Three to Four times in a week) **[]** (4) Frequently (Five to six times in a week) **[]** (5) Always **[]**

21. How is water supply situation now as compared to the past?

(1) Much worse **[]** (2) Worse **[]** (3) Same **[]** (4) Better **[]** (5) Much better **[]**

22. How satisfied are you will the level of water availability

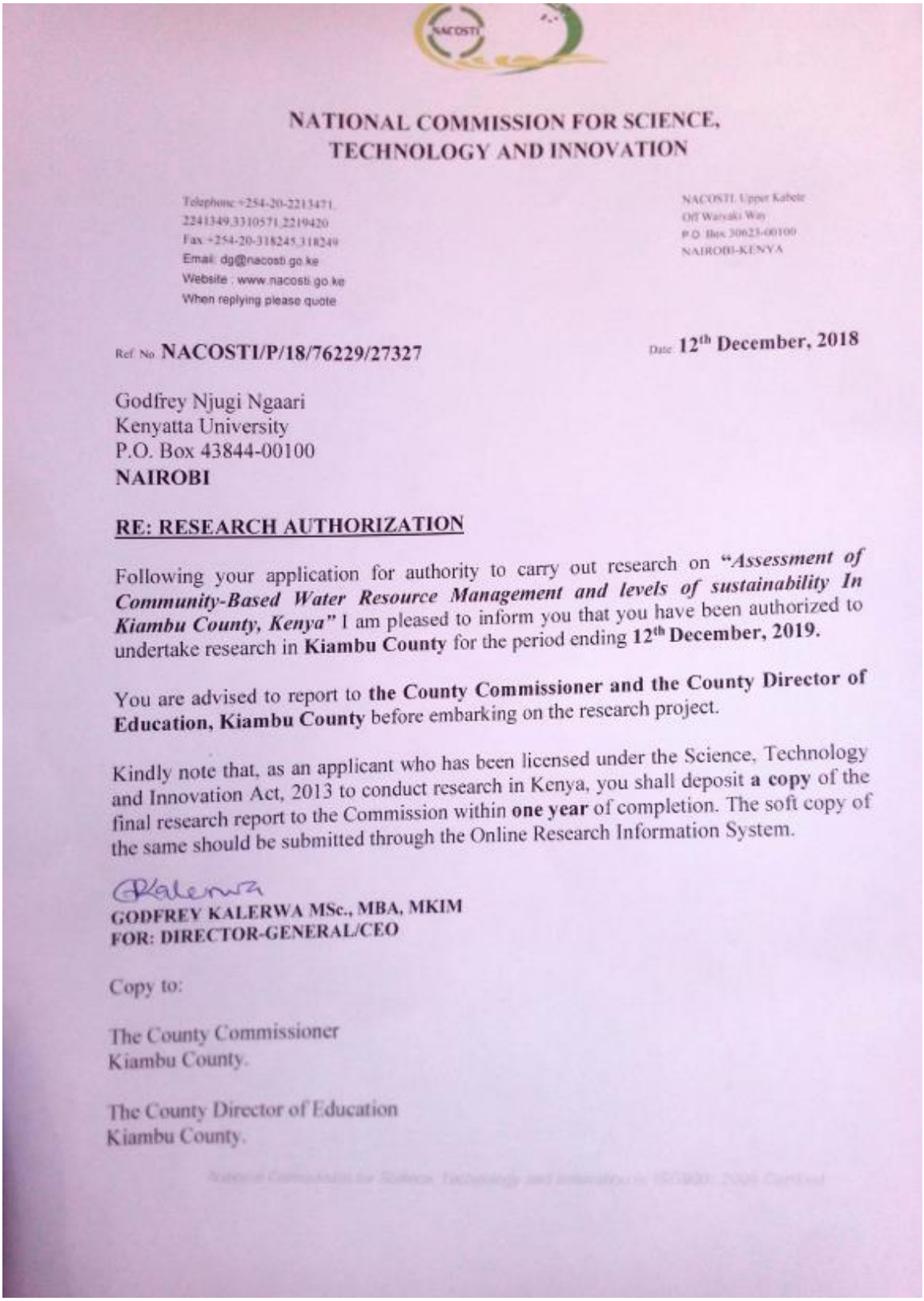
1. Very unsatisfied **[]** 2.Un Satisfied **[]** 3. Neutral **[]** 4. Satisfied **[]** 5.Very Satisfied **[]**

Your participation is highly appreciated, thank you.

APPENDIX III: INTERVIEW SCHEDULE FOR THE SHWP MANAGEMENT

1) How was Rironi self-help project started?
2) How many members does the project have?
3) How is the project managed?
4) How many employees do you have?
5) What is the average water yield per borehole in a day?
6) How do you monitor water supply distribution systems?
7) What technology do you use to cut the cost water production?
8) What is the approximate volume of water supplied by the project per day?
9) What are the plans to meet the changing water demands?
10) What challenges does the project face?
11) How have you addressed the challenges confronted?
12) How many boreholes have been drilled since the project started?
13) How many boreholes have dried up/closed since the project started?
14) What measures do you have to ensure that the water resource management is sustainable over time?

APPENDIX VI: NACOSTI PERMIT



NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

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

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref. No **NACOSTI/P/18/76229/27327**

Date **12th December, 2018**

Godfrey Njugi Ngaari
Kenyatta University
P.O. Box 43844-00100
NAIROBI

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Assessment of Community-Based Water Resource Management and levels of sustainability In Kiambu County, Kenya"*** I am pleased to inform you that you have been authorized to undertake research in **Kiambu County** for the period ending **12th December, 2019.**

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

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

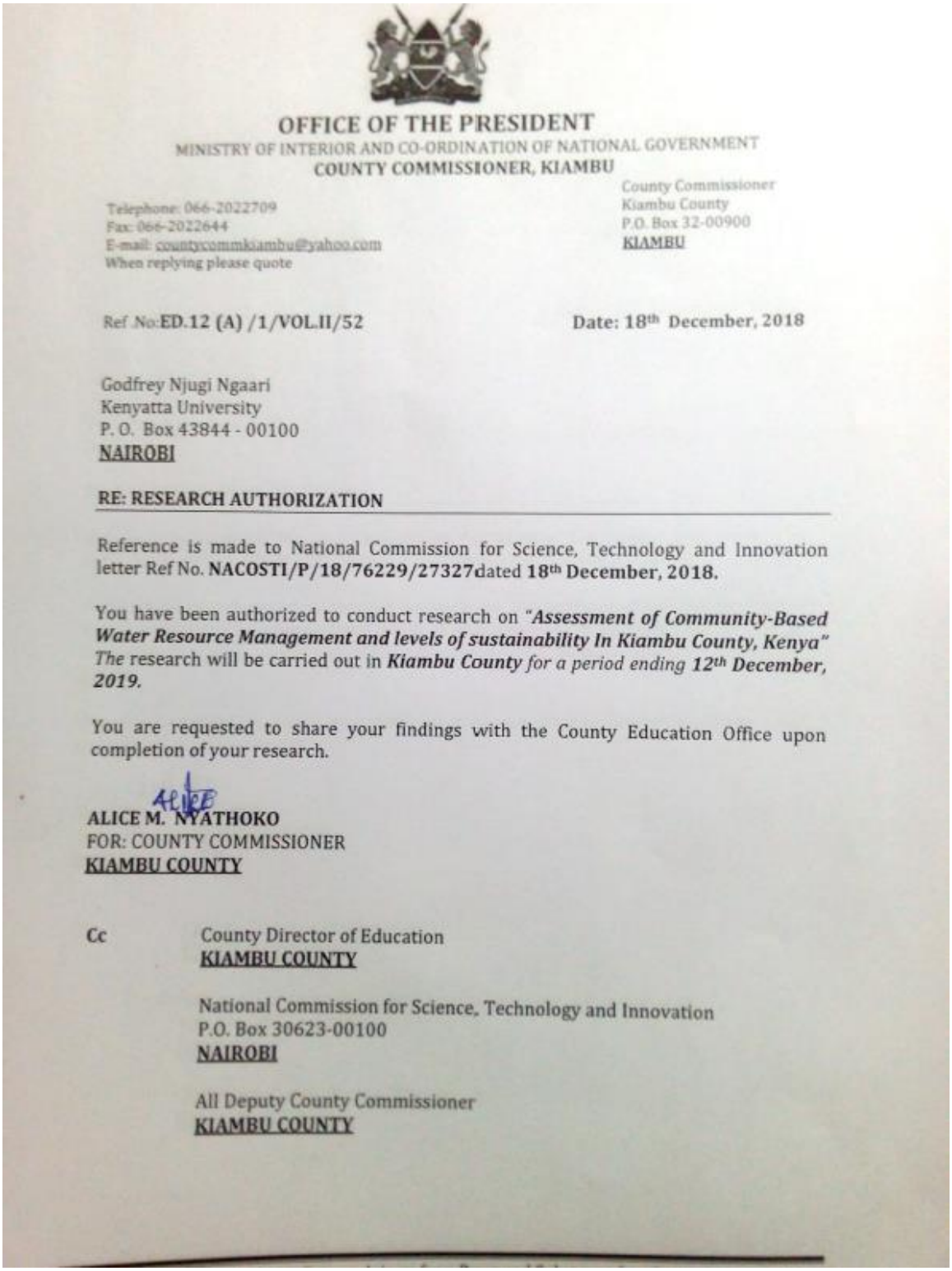
GKalerwa
GODFREY KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Kiambu County.

The County Director of Education
Kiambu County.

APPENDIX VII: KIAMBU COUNTY RESEARCH AUTHORIZATION



OFFICE OF THE PRESIDENT
MINISTRY OF INTERIOR AND CO-ORDINATION OF NATIONAL GOVERNMENT
COUNTY COMMISSIONER, KIAMBU

Telephone: 066-2022709
Fax: 066-2022644
E-mail: countycommkiambu@yahoo.com
When replying please quote

County Commissioner
Kiambu County
P.O. Box 32-00900
KIAMBU

Ref No:ED.12 (A) /1/VOL.II/52

Date: 18th December, 2018

Godfrey Njugi Ngaari
Kenyatta University
P. O. Box 43844 - 00100
NAIROBI

RE: RESEARCH AUTHORIZATION

Reference is made to National Commission for Science, Technology and Innovation letter Ref No. **NACOSTI/P/18/76229/27327**dated **18th December, 2018.**

You have been authorized to conduct research on *"**Assessment of Community-Based Water Resource Management and levels of sustainability In Kiambu County, Kenya"*** *The* research will be carried out in ***Kiambu County*** *for a period ending* ***12th December, 2019.***

You are requested to share your findings with the County Education Office upon completion of your research.

ALICE M. NYATHOKO
FOR: COUNTY COMMISSIONER
KIAMBU COUNTY

Cc County Director of Education
KIAMBU COUNTY

National Commission for Science, Technology and Innovation
P.O. Box 30623-00100
NAIROBI

All Deputy County Commissioner
KIAMBU COUNTY

APPENDIX VIII: KUERC PERMIT

KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE

Fax: 8711242/8711575
Email: kuerc.chairman@ku.ac.ke
kuerc.secretary@ku.ac.ke
Website: www.ku.ac.ke

P. O. Box 43844,
Nairobi, 00100
Tel: 8710901/12

Our Ref: **KU/ERC/ APPROVAL /VOL.1/233** Date: 21st November, 2018

Ng'aari Godfrey Njugi
P.O Box 43844-00100
NAIROBI

Dear Ng'aari ,

APPLICATION NUMBER:PKU/925/I985 "ASSESSMENT OF COMMUNITY-BASED WATER RESOURCE MANAGEMENT AND LEVELS OF SUSTAINABILITY IN KIAMBU COUNTY, KENYA

2. IDENTIFICATION OF PROTOCOL

The application before the committee is with a research topic "**Assessment of Community-Based Water Resource Management and levels of sustainability in Kiambu County, Kenya** received on 1st November, 2018 and discussed on 20th November, 2018

2. **APPLICANT**

Ng'aari Godfrey Njugi

3. **SITE**

Kiambu County, Kenya

4. **DECISION**

The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines and **APPROVED that the research may proceed for a period of ONE year from 20th November , 2018.**

5. ADVICE/CONDITIONS

i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.
ii. Serious and unexpected adverse events related to the conduct of the study are reported to this committee immediately they occur.
iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.
iv. Submit an electronic copy of the protocol to KUERC.

When replying, kindly quote the application number above.
If you accept the decision reached and advice and conditions given please sign in the space provided below and return to KU-ERC a copy of the letter.

KENYATTA UNIVERSITY
OFFICE OF THE CHAIRMAN
06 DEC 2018
ETHICS REVIEW COMMITTEE
P.O. BOX 43844 - 00100 NAIROBI

PROF. JUDITH KIMIYWE
CHAIRMAN ETHICS REVIEW COMMITTEE

I Godfrey Njogi Ng'aari ....accept the advice given and will fulfill the conditions therein.

Signature..... Dated this day of.....6/12..... 2018.

cc.
DVC-Research Innovation and Outreach

APPENDIX IX: GRADUATE SCHOOL PROPOSAL APPROVAL

KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 810901 Ext. 57530

Internal Memo

FROM: Dean, Graduate School

DATE: 15th October, 2018

TO: Ng'aari Godfrey Njugi
C/o Population, Reproductive Health
& Community Resource
Management Department.

REF: H60/37761/2016

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

This is to inform you that Graduate School Board, at its meeting of 19th September, 2018 approved your Research Proposal for the M.P.H Degree Entitled, "Assessment of Community-Based Water Resource Management and Levels of Sustainability in Kiambu County, Kenya".

You may now proceed with data collection, subject to clearance with the Director, General, Commission for Science, Technology & Innovation.

As you embark on your data collection, please note that you will be required to submit to Graduate School completed Supervision Tracking forms per semester. The form has been developed to replace the progress report forms. The supervision Tracking Forms are available at the University's website under Graduate School webpage downloads.

Thank you.

KENYATTA UNIVERSITY OFFICE OF DEAN 15 OCT 2018 GRADUATE SCHOOL P.O. BOX 43844-00100 NAIROBI

JULIA GITU
FOR: DEAN, GRADUATE SCHOOL

c.c. Chairman, Department of Population, Reproductive Health & Community Resource Management

Supervisors:

1. Dr. Lucy Ngige
C/o Department of Population, Reproductive Health & Community Resource Management
Kenyatta University

2. Dr. Lucy Kathuri Ogola
C/o Department of Population, Reproductive Health & Community Resource Management
Kenyatta University

JG/rwm