ANTHROPOGENIC ACTIVITIES AND THEIR INFLUENCE ON WATER SAFETY IN TSEIKURU WARD, KITUI COUNTY.

FAITH MBITHE WAMBUA

A THESIS SUBMITTED TO THE INSTITUTE OF ANTHROPOLOGY, GENDER AND AFRICAN STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN MEDICAL ANTHROPOLOGY OF THE UNIVERSITY OF NAIROBI.

2023

DECLARATION

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

Signature. _____ Date_15/7/2023_____

Faith Mbithe Wambua

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

Signature. _____ Date ___01-08-2023

Dr. Dalmas Omia

Signature. ____SBukachi_____ Date 1st August ,2023

Prof. Salome Bukachi

DEDICATION

I dedicate this work to my son Blessed Wambua, my mother Winfred Wambua and to my siblings; Agnes Wambua, Patience Wambua and Miriam Wambua, for their love, encouragement and support. To my late father, Moses Ivita, for the great inspiration into my academics.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

ACKNOWLEDGEMENT

First, I thank the Almighty God who granted me the strength, determination and wisdom to pursue my postgraduate studies. Also, I thank God for granting me the opportunities that helped me grow in my academic pursuit.

My heartfelt gratitude goes to my supervisor Dr. Omia who tirelessly guided and offered unwavering support throughout the entire process of this study. I am forever grateful for the academic mentorship. To my second supervisor, Prof. Salome Bukachi, who offered intellectual guidance as well as keen criticism of my work unearthing deep understanding of my work, I am forever grateful. My appreciation also goes to the entire IAGAS staff for their contribution to the study process. My sincere appreciation goes to the University of Nairobi for granting me a scholarship without which I could not have pursued my post graduate studies.

I am grateful to the informants at Tseikuru ward, Mwingi North Sub-County in Kitui County whose contribution to this study made it a success. Specifically, I appreciate the family of Maluki for offering a place I could call home while in the field. Also, I thank Nancy and Mercy for helping out throughout the data collection process. May your support be rewarded tremendously.

Lastly, I sincerely appreciate my son, my mother, siblings and friends for being my motivation and tirelessly encouraging me to pursue my academic growth without wavering. I am forever thankful.

ABSTRACT

This is an ethnographic study on anthropogenic activities influencing water safety around the points of collection, transportation, and storage in Mwingi North Sub-County, Kitui County. Further, the study examined the effects of anthropogenic activities on water safety and the community-level mitigation strategies that address the effects of the activities on water safety. The theory of Reasoned Action and Theory of Planned Behavior was used to assess the people's intentions regarding water safety and whether they have sufficient knowledge and skills that will help them act towards attaining water safety in their community. Data were obtained, through in-depth interviews, unstructured observations, key informant interviews, and focus group discussions. Transcribed data were coded and analyzed thematically guided by the study objectives. The findings established that open defecation, collecting water from open water sources, poor livestock fecal disposal, stepping in, and dipping of jerricans into the water sources affect water safety at the point of collection. On transportation pollutants, repairing broken jerricans with sand, use of unclean jerricans, and unsealed jerricans, and use of nylon and leaves, were pointed out while the use of; uncovered water storage facilities, irregular cleaning of storage facilities, and dipping dirty hands in the water sources pollutes the stored water. These practices affect water by changing its taste, odor, and color thus making it unfit for consumption. To mitigate against water pollution, the community reported boiling and using water guards, praying for the water, use of a stone called "*ivia ya ukuna kiw'u*" to desilt the dirty water, and buying bottled water. Water handling practices like cleaning and rinsing of containers before collection and storage, covering filled containers during transportation, and after storage are also used to preserve water safety. The study concludes that household water safety is a factor of anthropogenic practices across the three nodes of the water supply chain: source, transportation, and storage as informed by lay knowledge of what's worked over the years. Polluted water affects the community's economic productivity as well as their health. The study, therefore, recommends re-socialization of the community to embrace safe water access, transportation, and storage. The community together with the government should reinforce ways that ensure a change of behavior for most of the community members. Since water pollution doesn't occur in isolation, informal and formal levels of water governance need to integrate elements that minimize water pollution as part of addressing water insecurity in the community, this would mean holding water hygiene clinics as part of community engagement in safe and sustainable water consumption. A change of behavior from mishandling water to handling water with caution since it informs everyone's well-being in a community is a great decision in the right direction. Therefore, every community member should endeavor to change their behavior toward clean and safe water for their well-being. A feasibility study on an affordable mobile technology system that tests water quality is highly recommended.

ABBREVIATIONS AND ACRONYMS

CHV	-Community Health Volunteer
FAO	-Food and Agricultural Organization
FGD	-Focus Group Discussion
IDI	-In-depth interviews
IBM	-Integrated Behavior Model
JMP	-Joint Monitoring Programme
KII	-Key Informant Interview
MDGs	-Millennium Development Goals
NACOSTI	-National Commission for Science, Technology, and Innovations
PCA	-Principal Component Analysis
SDGs	-Sustainable Development Goals
TPB	-Theory of Planned Behavior
TRA	-Theory of Reasoned Actions
UNDP	-United Nation Develop Programme
UNEP	-United Nations Environment Programme
UNESCO	-United Nations Educational, Scientific and Cultural Organization
UNICEF	-United Nations International Children's Emergency Fund
WHO	-World Health Organization

CHAPTER ONE: BACKGROUND TO THE STUDY

1.1 Introduction

Water is a basic human right and need that is linked to every form of life on Earth. It is a commodity that is associated with every portion of human everyday undertakings directly or indirectly (Olumana, 2018:165). Everyone has a right to sufficient safe water for cooking, drinking, sanitation, and personal hygiene that does not deteriorate their well-being and self-worth (Olumana, 2018:165). According to WHO (2017), for water to be termed safe, it should neither include pathogens nor protruding points of harmful substances. Contamination from domestic and industrial sources, poor sanitation, and poor hygiene all threaten the safety of water for consumption. Millions of people die due to water-related diseases like cholera, diarrhoea, and dengue fever among others, internationally water-borne diseases kill 25,000 people and 5000 children in a day (Olumana, 2018:166). Therefore, such global loss makes water safety a very important aspect of the global arena.

Acquiring safe water is an essential developmental and health issue at local, national, and global levels. For example, approximately over 50% of the population in Sub-Saharan Africa have no access to safe water, thus exposing many people to waterborne diseases (Osunla and Okoh, 2017:1). The Millennium Development Goals (MDGs) ensured an increase of people using enhanced safe water sources from 76% in 1991 to 91% in 2015 (WHO, 2017). Similarly, Sustainable Development Goals (SDGs) include Goal 6, which emphasizes accessibility and sustainable water management, as well as sanitation by 2030 (WHO, 2017). SDG 6 focuses on achieving affordable and safe drinking water that is universal for all. It is worth noting that clean and safe water guarantees a tangible improvement in health across the globe.

Clean water is an esteemed natural resource that is important for environmental validity and human health. However, anthropogenic activities have resulted in the progressive degrading of most freshwater sources, exposing water users to an increased risk of water-borne diseases (Osiemo et al., 2019). The pollution of drinking water with fecal matter due to the use of unimproved pit latrines has made microbial contamination a key concern in the universal quality of water (WHO, 2017). Dependence on exposed water sources that are not well covered like earth dams, sand dams, and shallow wells, where the wind blows dirt into the wells, animals consume water from the source, and runoffs that have contaminated water flow into the water source lead to outbreaks of

water-borne diseases. Additionally, poor hygiene practices like failure to wash hands after visiting the latrine, bathing at the water source, unclean water transportation, and storage facilities result in an outbreak of common water-borne illnesses (Wasonga et al., 2016). Moreover, humans should have accessible toilets, which dispose of human excreta safely to reduce the spread of fecal illnesses (Medland and Sweetman, 2017).

The use of safe water will prevent any hazardous ill health and deaths that are caused by waterborne diseases, as most of them lead to chronic ill health and death if not well-treated. Thus, water is a vital resource for development. That is why, as the necessity for water intensifies in human settlements, the more the need to guarantee water safety from the available sources (Ratemo, 2018:1). Therefore, water being a medium of disease transmission, sufficient supply of sanitized, safe, and clean fresh water is an element for economic development as well as human consumption.

A study by Thai-Hoang et al., (2022) established that in Vietnam surface water in the Saigon River which is the main source of drinking water in the city, has been influenced by anthropogenic activities and also the seasonal changes of the river. During rainy seasons, most of the contamination is from organic matter and heavy metals (e.g., Cu, Ni, and Zn) from manufacturing and domestic activities. These activities contaminate the quality of water in the river, thereby negatively affecting the health of the people using the water and also the life span of the aquatic animals in the river. The increase in population which requires more industrial activities to ensure survival, makes water bodies hazardous to use due to waterborne diseases. Global population increase and constant or declining water resources have led to an increase in people without access to safe water (Dinka, 2017).

A study by Akhtar et al. (2021) brought out the concerns raised by how anthropogenic activities together with natural processes influence water quality both groundwater and surface. Besides the involvement of human activities, other factors affecting water quality include atmospheric processes, weathered bedrock, deposition of salt and dust by wind, organic matter, natural leaching, and soil nutrients. Water quality comprises biological, physical, and chemical properties. They further stated the key elements that affect water quality as a result of human activities include; trace elements such as heavy metals, organic material, acidic atmospheric runoff, and deposition.

Other elements include nutrients, salinization, herbicides, pesticides, pathogenic agents like enteric viruses, bacterial pathogens, as well as a protozoan. Different people have varying quality requirements when considering water for drinking, recreation, domestic use, agriculture, and industry. Furthermore, the criteria people use to measure water quality vary from one individual to another. For instance, the most purified water is essential for drinking, while less quality water is used in agriculture, and it is acceptable.

In Kenya, a study examined the levels of water contamination at the source and the surrounding environment, as it is transported to the household as well as at storage in Mara River (Nyairo et al., 2015:1). Most people do not have a defined way of ensuring the safety of water for drinking and domestic use, and that's why they use what is available as per its availability. The current study explores the social anthropogenic activities that affect water safety in Tseikuru Ward, Mwingi North Sub-County. It gave a clear picture of how different human activities, affect the safety of water used by people in the Tseikuru ward as well as the effects faced and the mitigating factors put in place to address the effects of anthropogenic activities and their influence on water safety.

Nyairo et al., 2015 express a growing correlation between reducing water quality or safety and increasing anthropogenic activities. Therefore, monitoring water sources and storage facilities often is important because it highlights the implications of human activities on water safety (Goher et al., 2014; Nyairo et al, 2015). The more the populations are growing, the more people are getting civilized leading to more anthropogenic activities, this is making tremendous changes in the amounts of water and water safety (Olumana, 2018:164).

Water polluted by pathogenic microbes; bacteria, viruses, and parasites cause stomach problems, cholera, and typhoid (WHO, 2019). Anthropogenic activity explains a consequence resulting from human activity (Ansari and Matondkar, 2014). Taking baths and/or swimming at the water sources, livestock defecation, human defecation where there are no or minimal toilets, dirty jerricans for storage and transportation of water, water runoffs from the farms with chemical substances, and washing of clothes at the water source explains most of the anthropogenic activities that influence water safety in Tseikuru ward, Mwingi North.

1.2 Problem Statement

Contamination of water by anthropogenic activities has become an alarming issue globally. SDG #6 focuses on achieving universal accessibility of safe water, sanitation, and hygiene, defining a higher level of service, whilst prioritizing the poorest and most vulnerable (UNICEF, 2020). The unsafe water used for domestic purposes like drinking, cooking, and washing, affects the health of the people using it, and that is why it is a world problem (WHO, 2019).

Research by Le Thai-Hoang et al (2022) examined the various water quality parameters for both rainy and dry seasons including; nutrients, antibiotics, physicochemical parameters, and heavy metals in Ho Chi Minh City. The study's methodology was based on testing the potential turbidity, conductivity, temperature, pH, salinity, and dissolved substances to determine the parameters of water quality. However, the study did not examine the social dimensions of water quality and how different anthropogenic activities influence water safety at the point of transportation and storage. Ratemo (2018), examined the effect of anthropogenic activities on water quality in Athi River. The study explored the levels of hydrocarbon pollution, the effect of proximate industrial activities, and coliform levels in that river. However, the researcher did not explain the effects of human activities on water safety in the area of study.

Nyairo et al. (2015) examined the effect of seasons and anthropogenic activities on the quality of water at the Nyangores and Amala tributaries of Kenya's River Mara. This study attempted to understand the water pH, conductivity, temperatures, heavy metals, nutrients, and selenium, which was done by collecting water samples and testing them in a laboratory to understand the different anthropogenic activities that affect the water quality in that river. This study only tested the chemical and physical parameters of water, based on numerous anthropogenic activities at the water collection point, and still, the researchers based their methodology on the chemical and physical determinacy of water quality. The study's scope envisioned less on the effects that the unsafe water has on the people consuming it and how best they address the effects locally.

The methodologies in the three studies were based on the chemical and physical characteristics of water quality parameters and less on how human activities lead to unsafe water in the areas of study creating the need for further research on anthropogenic activities and their influence on water safety. An ethnographic analysis of the anthropogenic activities and their influence on water safety in Tseikuru Ward, Mwingi North Sub-County, Kitui County was conducted. The study evaluated

the anthropogenic activities that influence water safety at the point of collection, transportation, and storage. It further determined the effects of anthropogenic activities on water safety as well as mitigating strategies put into place to address the effects of anthropogenic activities on water safety.

The study responds to the following research questions:

i. What anthropogenic activities influence water safety at the point of collection, transportation, and storage in Tseikuru Ward, Mwingi North Sub-County, Kitui County?
ii. How do these anthropogenic activities affect water safety in Tseikuru ward, Mwingi North Sub-County, Kitui County?
iii. How does the community mitigate against the effects of anthropogenic activities on water safety in Tseikuru ward, Mwingi North Sub-County, Kitui County?

1.3 Objectives of the Study

1.3.1 Overall objective

To assess the anthropogenic activities and their influence on water safety in Tseikuru Ward, Mwingi North Sub-County, Kitui County.

1.3.2 Specific objectives

1. To describe anthropogenic activities that influence water safety at the point of collection, transportation, and storage in Tseikuru Ward, Mwingi North Sub-County, Kitui County.
2. To determine the effects of anthropogenic activities on water safety in the Tseikuru ward, Mwingi North Sub-County, Kitui County.
3. To find out the mitigation strategies put in place to address the effects of anthropogenic activities on water safety in Tseikuru Ward, Mwingi North Sub-County, Kitui County.

1.4 Assumptions of the study

i. Open defecation, animal defecation, and unsafe storage facilities are the anthropogenic activities that influence water safety in Tseikuru ward, Mwingi North Sub-County, Kitui County

ii. Boiling and treatment of water are the household-level mitigation strategies that address the effects of anthropogenic activities on water safety in Tseikuru ward, Mwingi North Sub-County, Kitui County

iii. The use of aluminum sulfate (Ivia ya Ukuna Kiw'u) is a community mitigating strategy that addresses the effects of anthropogenic activities on water safety in the Tseikuru ward, Mwingi North Sub-County, Kitui County

1.5 Justification of the study

Discussions and interviews carried out in this study are significant in providing evidence for creating workable measures and services by the County government and NGOs striving to provide safe water for people in Tseikuru ward, Mwingi North Sub-County. The water stakeholders in the area (County government, NGOs, community elders; chief and Village administrator, and the community) ought to work together to come up with covered shallow wells that reduce the amount of contamination. Besides, working together would ensure the provision of water treatment facilities fit the community without jeopardizing their way of living. Also, reducing the price of water at the improved water sources by the committees will ensure the community can access safer water often.

The information generated by this study will be useful to the community members who uphold water safety, especially during collection, transportation, and storage. Sanctions against anyone not adhering to water safety practices like watering livestock around the water sources shall be implemented. Troughs at a distance from the shallow wells and earth dams will be used to water the livestock to avoid animal defecation that compromises the quality of water for consumption. In a case where one's animals run to the water source and do not get watered away from the source, the owner will be expected to pay Ksh 500 or discontinued using that water source for a while. The community will be involved in training and laying down the regulations on how to adhere to safe ways of drawing, transporting, storing, and using water carefully without threatening its safety.

Academically, the study findings provide a rich source of data for scholars interested in studying anthropogenic activities that influence water safety. The study shows the different anthropogenic activities that influence water safety at different levels, from collection to transportation to storage,

the effects, and the mitigating strategies that address the effects of unsafe water. The findings were anchored, on the Theory of Reasoned Action and Theory of Planned Behavior. From the findings, different households were facing unsafe water whereas each household had its unique way of contaminating it. For example, some families had children that dip their hands in the storage water facilities while others did not clean their water storage facilities. In the area of study, water safety affects women and children more than men, since most of their activities revolve around water.

1.6 Scope and Limitations of the Study.

The study was carried out in the Tseikuru ward, Mwingi North Sub-County in Kitui County. It focused on anthropogenic activities and their influence on water safety in the area. The study's objectives established the anthropogenic activities that influence water safety at the point of collection, transportation, and storage. They further assessed the effects of anthropogenic activities on water safety and the mitigating strategies the community put into place to address the effects.

The assessment of water safety was based on the physical characteristics of water including; taste, odor, and color. This explains why water quality tests were not undertaken, since they are beyond the scope of the current study. The study employed the exploratory study design and the qualitative research methods of data collection. The study applied the Theory of Reasoned Action and the Theory of Planned Behavior to build up the findings.

Limitation: While the area chief and village administrators had approved of the study, some community members declined to participate in the study due to busy schedules and avoidance since prior studies had not helped them. Others refused to be audio-taped for fear of incrimination by the leaders in case the interview data was compromised, and their opinions are known.

Solution: The study assured the confidentiality and anonymity of the participants as well as esteemed the decision of the members who declined to participate in the study but continued to interact with them informally as the study progressed. The study sought verbal informed consent to enhance confidentiality and anonymity. For informants who were willing to participate in the interviews without being recorded, the study decided to jot field notes for easy retrieval of the data.

Limitation: Monetary expectations from the community members due to donor dependency syndrome attitude. This was faced since the community was used to compensation when they participate in any activity with an NGO or a donor-funded project.

Solution: The study stood on its ethical grounds of no monetary compensation. It worked with the willing respondents who did not need any monetary compensation for them to participate in the study. Those who insisted on compensation were released from participating in the study, however, the researchers would interact with them in normal discussions that were not connected to the study.

1.7 Definition of terms

Anthropogenic activities- actions carried out by humans, animals, and nature that make water unsafe for use either in drinking, cooking, bathing, or even for animal consumption. These actions can be when fetching water, ferrying, and storing it

Borehole- a deep hole bored in the ground to access more water from the ground

Domestic water- water household use includes drinking, cooking, washing (clothes, utensils, or houses), and bathing.

Earth dam- a barrier with highly compacted earth that blocks a waterway, hence holding water for a longer period

Ecosystem- a community of animals, plants, or smaller organisms living, feeding, reproducing, and interacting within the same environment

Improved water sources- Water sources that are taps, boreholes, and protected shallow wells

Mitigation- measures taken to counter the effects of anthropogenic activities on water safety

Pollution- adverse or negative outcomes originating from the mismanagement or inappropriate use of resources, therefore, creating detrimental effects on animals, humans, and plants

Potable water- safe water for cooking, drinking, washing, and personal hygiene

Safe drinking water- water that doesn't represent risks to the health of the one consuming it

Sand dam- a strong man-made wall built across seasonal river beds

Shallow well- a slight hole dug by use of machines or mattock to access water

Unimproved water sources- unprotected earth dams, unprotected sand dams, and uncovered shallow wells

Water collection- fetching of water and any other activity that happens at the water source like cleaning of jerricans, drawing water from a shallow well and filling the jerricans, loading of jerricans to the donkeys or carts, etc.

Water safety- water that is harmless to human consumption and is termed free from any contamination from human, natural, and animal activities

Water is termed clean and drinkable due to acceptable taste, smell, and appearance. It is the water that presents an insignificant risk to the health of the person consuming it.

Water transportation- ferrying of water from the water source to the households or hotels or schools or hospitals by use of donkeys, carts, or humans where a household doesn't own a donkey

Water storage- keeping water in a tank or drum or pot or jerrican or bucket depending on what is available

Water source- a place where water is accessed either a borehole, shallow well, sand dam, earth dam, lake, etc.

Water Quality- it is a measure of water condition to the requirements of human desires and needs. Most standards of measuring water quality are related to the safety of human consumption and contact.

CHAPTER TWO: LITERATURE REVIEW AND THEORETICAL FRAMEWORK.

2.1 Introduction

This chapter reviews studies on anthropogenic activities and their influence on water safety. The literature has been reviewed along the following sub-areas: Water safety, anthropogenic activities and their influence on water safety, anthropogenic activities around water collection, anthropogenic activities around water transportation and anthropogenic activities around water storage, effects of anthropogenic activities on water safety and mitigation strategies put into place to address the effects of anthropogenic activities on water safety. A discussion on the Theory of Reasoned Action, the Theory of Planned Behavior, and their relevance to the study concludes this chapter.

2.2 Water Safety

Water sustains all life forms, and freshwater is necessary for the existence of human beings (Pradinaud et al, 2020). Domestic, waste disposal, nutritional, and recreational are different uses of water, as well as ecological because it is a habitat for non-living and living organisms. The provision of safe water enhances human development, and well-being, and acts as an instrument in promoting health and reducing poverty. Unsafe water for domestic use and drinking is from the surface or ground, which makes it contaminated in several ways. For example, it can contain microorganisms like bacteria and parasites that get in the water from human or animal fecal matter. According to European Public Health Alliance (Munyao, 2018), about one-sixth of the World's population accounting for approximately 1.1 billion people do not have access to safe water, and 2.4 billion people lack sanitation. Lack of agricultural, industrial, and urban wastewater management leads to contaminated drinking water for hundreds of millions of people. Human health highly relies on access to clean and safe water (Bahadur et al., 2016:1349).

According to WHO (2018), the mortality rate of 842,000 people and 361,000 children each year is a result of unsafe drinking water, sanitation, and hygiene. Transmission of typhoid, cholera, and stomach aches are caused by contact with polluted water and poor sanitation. If there is the provision of safe water there will be less expenditure on health, as people are less likely to fall ill and incur medical costs amounting to their productivity in their economy.

Similarly, safe water is the tenet of the health and well-being of a society, which makes it a crucial indicator for the development of the country (Olumana, 2018:165). If a nation is healthy, it will grow and develop because when people are doing well, and energetic, the productivity rate is high. They are open to many ideas and opportunities for their growth, and in the process, the country grows, since change starts with an individual. Furthermore, water is interrelated with other developmental sectors like agriculture and industry and factors like socio-economic, health, education, and environmental, at local, national, regional, and international levels (Olumana, 2018).

According to Derara et al, (2018), anthropogenic activities are highly polluting the available freshwaters as well as reducing the availability of potable water. These activities influencing water safety needs to be resolved in the best and most sustainable way to ensure a healthy family and a healthy nation.

2.3 Anthropogenic Activities and their influence on water safety

Water is an important resource in the survival of all ecosystems, although, it is not accessible to all living things that have a right to sufficient water. Besides, the provision of safe drinking water is a human right (Meride and Ayenew, 2016). Most people are deprived of this right (Peiyue et al., 2017) especially, in developing countries because they suffer from unsafe water and poor sanitation (Peiyue et al., 2017). Clean water is a valuable natural resource vital to human health, and ecological integrity most freshwater sources are increasingly being despoiled by human activities thus, exposing people to waterborne diseases (Osiemo et al, 2019). Freshwater may even become more limited as the days go by because of the increased population leading to advanced anthropogenic activities that affect climate change, water quality, and urbanization (Peiyue et al., 2017).

Water used in domestic activities, farming, industrial and environmental use, provides the medium for growth, hydration, safety, and living for the sea animals, hence it has to be available and safe for activity efficiency. When water is contaminated, it causes waterborne diseases that affect the well-being of a person, even at times leading to death, it can transmit diseases like cholera, stomach problems, typhoid, and dysentery. There is a concern because most children's deaths are caused by diarrhea due to the intake of contaminated food and water.

Urban activities are highlighted as contributors to the pollution of surface water bodies in Asian countries (Liyanage & Yamada, 2017). In a highly-populated area, water quality is at its worst state, and water quality is better in a less populated area. The more the population grows there is more the need for survival tactics. However, it gives people a way of surviving by being industrious as well as producing sufficient food that can feed the population. They then opt to use pesticides and fertilizers when washed into the groundwater affecting the quality of the water, leading to the death of fish, birds, and other aquatic animals leading to an effect on human life.

When a population has grown, the disposal of domestic and agricultural wastes is not done as per health expectations. The dirt is left to flow into the water sources hence affecting the potential of hydrogen, conductivity, safety, and the chemical substance of water.

According to Tagoe and Mantey, 2017, the Weija Reservoir in Ghana is a water body that has been affected by anthropogenic activities along the banks and within the reservoir itself over the years. Human activities such as irrigation, pollution, sand winning, and encroachment on the reservoir, and along its boundaries have caused harm to the surrounding environment and scarcity in the water supply. Areas that are dominated by industrial and agricultural activities are more vulnerable to unsafe water because all the refuse is drowned in the water reservoirs either cleaned or not cleaned in the long run affects the health of the people who stay in that area.

In Kenya, several studies have been carried out on different water sources by researchers who wanted to prove the anthropogenic activities that affect water quality and how it has been hazardous to the people living around the water source and the ecosystem at large. According to Weber and Sciubba, 2019, the growth of the population and its concentration and the declining environmental concern explains why substantial challenges are posed to the water source due to the increase in human activity in that area. This challenge intensifies in developing nations categorized by fast-growing populations and expectations of quality life, which ends up destroying water quality in the water sources when such dirt is directed to the wetlands or the water sources.

Water use and increase in demand are directly proportional to unsafe water. Nature and how the magnitude of human activity determines the extent and the kind of pollution as well as the status of water quality at the water source (Akhtar et al, 2021). This contamination can remain in the water sources for months or even years and they influence the safety of the water over time.

These anthropogenic activities affect water quality around the water source, water collection, water transportation, and water storage.

2.3.1. Anthropogenic activities and their influence on water safety at the point of collection

According to Zhou et al., (2022), humans have made the rivers the center of much activity, making it a sink for waste from all kinds of their activities which degrades the quality of the water. Rivers, streams, lakes, and dams' pollution and scarcity of clean water are increasingly becoming a problem. Pollution has led to three-quarters of the rural population and one-fifth of people living in urban centers lacking access to reasonably safe water supplies. The problem was initially associated with industrial wastes, which was a concern to the developed countries. Although, it has recently become a global issue as industrialization and development is not concerned about the universal dimensions and other wastes from domestic and commercial activities. They cause pollution in freshwater sources as industrial wastes (Onuaha et al., 2018).

Runoffs from agricultural activities are major water pollutants as they contain phosphorous and nitrogen compounds from salts, fertilizers, poultry, and livestock wastes wash down into the water sources. If waste management is poor it affects the environment and the health of the community members (Khan et al, 2019). When domestic waste is not handled well it pollutes groundwater sources like the shallow wells and the earth dams. For waste management to be effective, it must have appropriate and affordable techniques which the community can use at the disposal of the waste.

When collecting water, many activities happen at the water source when it comes to rural areas, people fetch water from the earth dams, sand dams, and shallow wells. Activities like fetching water while stepping on the source, defecation around the water source, and dipping of jerricans at times are dirty into the source affects the safety of the water. Moreover, some bathing beside the water source, and people fetch water with donkeys that defecate around the water source, when one is drawing water from the 10 feet deep shallow wells, they stop at the mouth of the well. However, the dirt carried by their shoe's spills into the well, use ropes to draw water, which then water flows into the source from the dirty ropes. When water is contaminated by different polluters it becomes unsafe for human consumption hence leading to water-borne diseases which lead to more people suffering if at all the disease is infectious.

2.3.2 Anthropogenic Activities and their influence on water safety at the Point of Transportation

When we transport water, we move it from its source to where we need it or where we want to use it. The supply of water in the household is a vital requirement for human life. Water is used at the domestic level while cooking, drinking as well as hand washing. Even though some activities that need water can be carried out away from home like doing laundry, they still need water for their accomplishment. Depending on the amount of water available for household use and its safety influences sanitation, hygiene, and public health. Water is accessed from the sources clean and safe but in the process of ferrying it to its destination whether home or to the market or institutions, it is then contaminated depending on how it is handled by the person transporting it.

Water can either be transported using pipelines, canals, tunnels, tankers, donkeys, human backs, vehicles, a cart, a bicycle, and a wheelbarrow, in the study area people dominantly depend on donkeys to access and transport water from the water sources, although those who lack donkeys use their backs to access water. When carrying water home, dust can blow into the jerricans which are carrying the water if not well sealed. Also, the jerrican leads used and papers used to seal the jerrican can be contaminated, in most cases, the paper used to help hold the lead well on the jerrican is collected anywhere and they are contaminated with pathogens and bacteria, in most cases, many people are concerned about spillage and not the quality of the water. People use their hands which at times are not washed to seal the jerricans this leads to contamination because in most cases people do not clean their hands after using the toilets or latrines or after touching the dirt.

2.3.3 Anthropogenic Activities and their influence on water safety at the Point of Storage

Water storage is a fundamental activity in most households in many communities in the world (Manga et al, 2021). For food preparation, drinking, and domestic use, water should be collected, transported, and stored effectively for the well-being of the community members. Household water storage is necessary because of access to a distant water source only, relying on rainwater and undependable piped water supply. Improvement of water sources to the people is not always an assurance of water safety at the point of use since it can be contaminated succeeding collection. The issue of water storage is a major concern in many countries, especially in places that don't

have running water in their households. A person must often travel long distances to fetch water from a river or a dam or a well, then transport water home for storage, because it would be too much trouble to be constantly traveling back and forth to the water sources whereby some of them are many kilometers away from home.

After transportation, water needs to be stored so that it can be used shortly for the intended purposes. Various families store water in jerricans, concrete tanks, metallic tanks, pots, and drums that aid the self-sufficiency of water. When water storage tanks are not handled in hygienic ways like cleaning and sealing them, they influence water safety. Water-borne diseases are caused by water stored in an unhygienic manner which leads to re-contaminated. According to Derara et al., (2018), the water stored for 1 to 9 days showed 67% of increased contamination which could be the reason for the increment of coliforms as storage time increased, this is a result of re-growth bacteria in stored water.

According to Issaka et al., (2015), how effective a storage tank is for preserving water quality is depending on preventing organic matter, sunlight, and macro & micro-organisms from entering the tank. Stored water can be dirtied due to poor preservation and cleaning of the storage facilities. Storage facilities either tanks or jerricans in and/or out of buildings, if not covered properly and not cleaned regularly, may be prone to water recontamination during storage (Manga et al, 2021). Also, tank materials influence water quality, whereby the high presence of heavy metal ions in storage tanks could be very important if corrosion is evident, as well as when the tank is not cleaned (Ziadat, 2005; Issaka et al., 2015). Concentrations of metal traces in drinking water can cause infant mortality, cancer, and cardiovascular syndrome (Pier & Bang, 1980; Issaka et al, 2015).

2.4 Effects of anthropogenic activities on water safety

Water is a very vital resource in the lives of organism's quality should be enhanced so that it doesn't keep on affecting biodiversity leading to deaths of the same. Water safety and enough supply enhance the prospects of new livelihood activities as well as promote good health which lack in poor health leading to poverty (UNESCO, 2006; Munyao, 2018). Various people have access to polluted water, which is a carrier of many diseases, and when taken it harms human health. 3.4

million deaths annually are caused by water-related diseases especially among children under 5 years (Osiemo et al, 2019).

Moreover, anyone can contract water-contact diseases caused when one's skin is in contact with contaminated water like Bilharzia; the eggs of the bacteria are in the infected person's urine/feaces. Where there is no water and sanitation investment, the likelihood of contracting diseases like diarrhea and typhoid is high leading to insufficient work and provision because one cannot work when sick. Water available for ingestion through food and direct consumption should be safe to avoid risks to human health.

Water is contaminated by inorganic, microbial, and inorganic substances the influence of pollution on water sources is manifested by poor water quality increasing toxicity to mammals, and aquatic life. Contamination reduces the activities that water can be used for, hence making it very expensive to treat and a high cost to the water supply. The water sources are polluted by pesticides, detergents, solvents, and a variety of industrial organics making it a global problem.

The effects of these toxic substances are diverse as they include cardiovascular difficulties, cancer, diabetes, endocrine disruptions, reproductive inhibition, immunotoxicity, development toxicity, dermatological ailments, neurological conditions, and reproductive inhibition (Anyanwu et al, 2018). Causes of pollution substances and nutrient enrichment in the aquatic ecosystems can be attributed to urbanization, agriculture, and industrialization wastes. Ecosystems are extremely dynamic, and they respond to very tiny changes in the environment. Surface and groundwater are equally affected by eutrophication since nutrient-enriched water on the surface may filter into groundwater supplies. Depletion of oxygen causes the death of fish and other aquatic animals. The increased growth of algae shows the increase of the primary cause of eutrophic ecosystems. Chemicals in a water source encourage the growth of algae and form a layer on top of the water source; bacteria feed on these algae hence reducing the amount of oxygen in the source severely affecting the aquatic life in the water source.

Koshland Science Museum, (2018) posits that water-insecure communities are economically poor and trapped in an ongoing cycle of poverty. Different opportunities are lost due to extensive illness in a community as well as the influence of the time-consuming process of acquiring water in an insecure place. Moreover, children miss or drop out of school due to diseases that are caused by unsafe water. Such effects affect the wellbeing of the people in the case of a cholera outbreak

people might die if not well treated or controlled. Death of people affects the development of the nation at large because for people to carry out successful processes that ensure development, they should be healthy. Anthropogenic activities are affecting the environment, hence causing damage to the ecosystem and leading to diseases and deaths. That's why this study endeavors to explore anthropogenic activities and their influence on water safety in Tseikuru Ward, Mwingi North.

2.5 Mitigation strategies put in place to address the effects of anthropogenic activities on water safety

Water is an essential need in the life of every ecosystem. Available and safe water is very important to public health, domestic use, and also for the production of food in households and communities. When water quality parameters have been compromised by irregularities from human activities, water is said to be polluted and unsafe for the expected purpose. According to Inyinbor et al. (2018; 37), an effective, cheap, and accessible method of contaminated water treatment is a channel for taking care of the water environment. Basic sanitation helps communities dispose of human excretion safely to improved facilities hence helping with solving the waterborne diseases that occur due to runoffs from the forests where open defecation happened. Treatment of water after collection and before usage assists in solving the puzzle of waterborne diseases due to unsafe water (Edokpayi et al, 2018). When the community takes clean and safe water their productivity will be excellent and through that, their families will have enough for their needs and upkeep.

The community should be motivated through capacity building by training them on how to supplement anthropogenic activities that are detrimental to water safety with other activities that are environmentally friendly and sustainable. Well-built toilets should be embraced in these communities for ease in enhancing sanitation that will ensure the health of the people in the long run. Prevention of contamination at the water sources will heighten the collection of safe water for domestic use by the people living in the areas. Preventing re-contamination during transportation, in storage, and more importantly, during usage is equally necessary for maintaining water quality targets. Safely managed drinking water as well as treatment of drinking water at storage level or collection point will make water safe for use which will reduce diarrheal among other waterborne diseases.

For waterborne diseases to be prevented, pathogens ought to be controlled by effectively using herbal disinfection which has no negative effects on the human body. One specific herb might not

be effective in treating water; however, a combination of various herbs serving the same purpose should give a more pronounced solution (Inyinbor et al., 2018). The use of locally available herbs to purify water can be a very key solution to rural area water usage; however, it will need further research to understand the most appropriate herb for the work. As herbal purification is being researched, it is key for the water stakeholders as from the government water officers to the community shallow well owners; to work together to ensure water safety is acquired.

Putting into place a water safety plan in every community will help manage and understand the complete water system from collection, through transportation to storage and usage. For the plan to work the community members ought to understand the complete system and where there are problems arising and how best to solve the issues even before they arise. For example, instead of carrying a jerrican without a lid, the community member should ensure every of their jerrican can be sealed well and protect against any contamination during transportation of water. Since prevention is better than cure, it will be useful for every household to identify the best working system that works effectively for them then identify any loophole in the system as well as solve the problems beforehand so that safety can be assured in every household. When every member is responsible, it will accrue to all people and the community will enjoy healthy lives and have a productive life for both adults and children. Safe and clean water cannot be overemphasized since its one of the real instruments that help in promoting health and reducing poverty in the long run.

2.6 Theoretical Framework

2.6.1 Theory of reasoned action (TRA).

The theory of reasoned action (TRA) was first introduced in 1967 by Fishbein and extended by both Fishbein and Ajzen in 1975 (Fishbein, 2008). The theory was created to understand a person's intentions that give the reason to perform a certain behaviour. TRA explains that a person's intention determines whether they will perform a behaviour or not. An intention is a function of attitude towards the behaviour and subjective norm. Strong intentions to perform an action and/or behavior most people are informed by whether the action is positive and if their peers approve of it (Ajzen, 1985). Attitude is a function of personal beliefs concerning the consequences of actions, which determines whether the action will be carried out (Ajzen and Fishbein, 2005). The subjective norm is the person's belief that his/her peers think he/she should or should not act.

The theory asserts that the higher the intentions to perform a behaviour the greater the effort and likelihood for the behaviour to be executed. The direct cause of behavioural intentions is the attitude to perform a behaviour, which is then determined by a person's behavioural beliefs of whether the outcome of the action is done or not. Griffin et al. (1995) used the theory of reasoned action to examine the impact of health risk messages. The threat probability affects the belief that taking infected water leads to individual illness. The subjective norm, attitude, and behavioral beliefs influenced the intentions to either drink the water or not. The information given about the danger involved interacted with the variables, and that is why it affected the behavioural belief due to the outcome after the individual takes the unsafe water.

The TRA theory was used by Nguyen et al. (2018) to predict climate change behaviour intentions that are used to develop interventions in Vietnam. The study evaluated TRA constructs, how they are applied, and other relevant factors put into place to predict behaviour beliefs and intentions as well as change behaviour tendencies. The theory explained that past knowledge and behavior are factors that highly predict and influence the intentions of a behaviour. It indicated that subjective norms and attitudes were vital in the prediction of the intentions to engage in climate change behavior. This study tested whether a communication intervention designed according to key constructs of TRA increased the intentions of school children in Vietnam to take climate change adaptation actions. TRA allows the prediction of intentions and behaviour, and it has been widely used in related sustainability research.

2.6.2 Theory of planned behavior (TPB)

The theory of planned behavior (TPB) has been used to understand different behaviour. The theory was developed by social psychologist Ajzen in 1991 to explain behaviours that are not performed at will but require skill, knowledge, and resources to ensure their execution. This theory explains how different situations determine a person's decision to express a certain behaviour. To accommodate those behaviours Ajzen (1991) added perceived behavioural control to the theory. Perceived behavioural control is the simple or hardness of performing the behaviour, past experiences, and expected obstacles/challenges. The beliefs and overall evaluation of a behaviour inform the attitude towards the behaviour.

A personal opinion over a certain behaviour explains the subjective norm of the behaviour. Perceived behaviour control is assumed to have a direct influence on intentions as it explains the margin a person feels a behaviour is under their control, which explains whether they will intend to follow that behaviour or not. Yang and Wenyan (2018) used TPB to offer solutions for understanding the methodology of developing an empirical model and behaviour intervention mechanisms. Water management and operations have an influence on water hygiene practices as well as on the management of the risk of contracting diseases to enhance community health. Yang and Wenyan's 2018, research tried to fill the gap on how to develop an understanding of the residential conservation of water behaviour interventions.

The theory of planned behavior was used by Zoellner et al. (2012) to investigate specific cultural attitudes, perceived behavioural control, and subjective norms and ideologies relating to the consumption of sugar-sweetened beverages, artificially sweetened beverages, and water. The study established that one's intentions and perceptions of behaviour control towards the consumption of sugar-sweetened beverages predicted their behaviour, whether to consume it or not. TPB proposes that attitude, perceived behaviour control, and subjective norms can affect one's behaviour through their intentions. The theory can be used for all phases of behavioural intervention development, implementation, and evaluation.

2.6.3 Integrated Behavior Model

The Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB), developed by Fishbein and Ajzen (1980) were combined by Fishbein in 2000 to form the Integrated Behavior Model (Fishbein, 2000). This model explains what informs the intentions and behaviour of people. TRA explains that one's attitude about behaviour is determined by behaviour beliefs and how a person evaluates the outcomes. On the other hand, TPB suggests that normative beliefs and a person's motivation to comply determine their perception of the perceived social pressure to perform or not to perform the behaviour (Ajzen, 1991; 188).

According to Glanz et al (2008; 70), the intention is the most crucial determinant of behaviour adoption and it is highly determined by attitude and subjective norms. Furthermore, other external variables like personality traits, individual perceptions, demographics, and attitudes, also affect the way behaviour intentions are formed. Persons' beliefs and power determine their perceived control of the situation, which together with attitude and subjective norms are the constructs that determine one's intention to perform a behaviour. Knowledge, the salience of behaviour, habit, environmental constraints as well as function attitudes, injunctive norms, and perceived self-efficacy are the key determinants of behaviour.

This model suggests that the following four factors affect whether the behavior will be carried out and at times they outdo the intention of the behaviour. The four factors are:

1) Knowledge and skills: A person may decide to avoid performing a certain behaviour if they lack the knowledge and the skill of the same even if its intention exists and seems clear.

2) The salience of the behaviour: This refers to when a person is intentional about a certain behaviour but they do not understand the importance of performing the probability that it does not happen, which is high.

3) Environmental constraints: Behaviour can be a part of the social or physical environment, which exposes an individual to challenges that limit their ability to do what they intended to.

4) Habit: A new way of life can be hard to remember and put into action since it does not exist in a person's daily routine

Behavioural control is similar to self-efficacy and depends on the individual's perception of how they can behave. For example, the more intentional a person's attitude is towards behaviour and subjective norms, the greater the behavioural control hence their strong intentions to perform the behaviour.

2.6.4 Relevance of the Theories to the Study

The theory of reasoned action holds that one's intentions will determine if an individual will perform a certain behaviour or not. This theory explains the psychology of behavior change; how people uphold healthy behaviors and discard unhealthy behaviors. The theory helps target the persuasive efforts of changing the behaviours of a community. For example, a person might decide to exercise because they believe it leads to great health benefits but still, they can refuse if there is a degree of injury associated with it. One's attitude towards a behaviour is highly depended on the consequences the person will have if they perform their actions. Various behaviours that are concerned with assuring water safety are determined by the interplay of different concepts that informs whether the behaviour of water quality assurance is performed or not. For every community member to safely handle water to avoid contamination, their actions will be highly informed by their attitude and belief that water safety is good for their health and they should pursue it.

Community members and their leadership should come up with norms that govern how water safety ought to be assured in the area across collection points, during transportation, and when in storage. However, according to the theory of planned behaviour, the community members will adhere to the norms depending on their social pressure. Therefore, if the community was informed and aware of the effects of unsafe water, it would be easier to have intentions that will ensure water safety and sustainability of water projects. Knowledge of the dangers that influence water safety at the point of collection, during transportation, and also in storage will enable the community to make the right choice of maintaining clean water. The building of permanent toilets by every household shows how every member of society is taking part in solving the contaminated water issue that causes waterborne diseases during or immediately after the rainy seasons. The members of the community should have the intention of rightfully mitigating all the effects caused by the consumption of unsafe water either by treating or boiling it to avoid further effects. The habits of

every person in the area should ensure the safe handling and storage of water for healthy living and well-being.

Before a community and/or a household decides on what to follow and adhere to, knowledge of the aspect at hand as well as why it is important to accept the new normal is key since there are old habits and tactics of survival that the community has been living with. Meaning if people know the importance of safe water in their well-being and life, it will be easier for them to treat or boil water as well as wash their Jerri cans often to ensure they use and drink safe water. The intention to change might be good but if the importance is not clear then the people might not be ready to leave their old ways and embrace the new lifestyle. Therefore, for the government and the NGOs to preach to the communities about water safety, they should ensure they are well informed of the benefits that will accrue if the new habit is put into practice. This will be accepted if the community is involved in decision-making and providing the right skills that will help in ensuring water safety is an important aspect to look forward to as a community, a household, or an individual.

2.6.5 Conceptual framework

According to Ngechu (2004), a diagrammatical representation of a research problem is referred to as a conceptual framework, and its role is to portray the relationship between various factors that are seen as vital in the study. This framework is shown in Figure 2.1. The framework shows how different behavioural activities work together with the right environment, knowledge, and skills, the importance of the behaviours to water safety, and habitual practices that interplay to ensure water safety in an area. Group sanctions enforced in the study area cannot achieve the main goal of water safety unless people change their behaviours. Some of the behaviours should include the construction of toilets by every household and every institution to ensure the environment is clean. Knowing waterborne diseases and skills that can help achieve water safety, will help the community members to acquire such knowledge and skills as boiling water, using soap and water to wash hands after visiting the toilet, washing Jerri cans after storing and transporting water for a long period. The changed behaviour will help the community ensure safe water that is clear, tasty, and odourless.

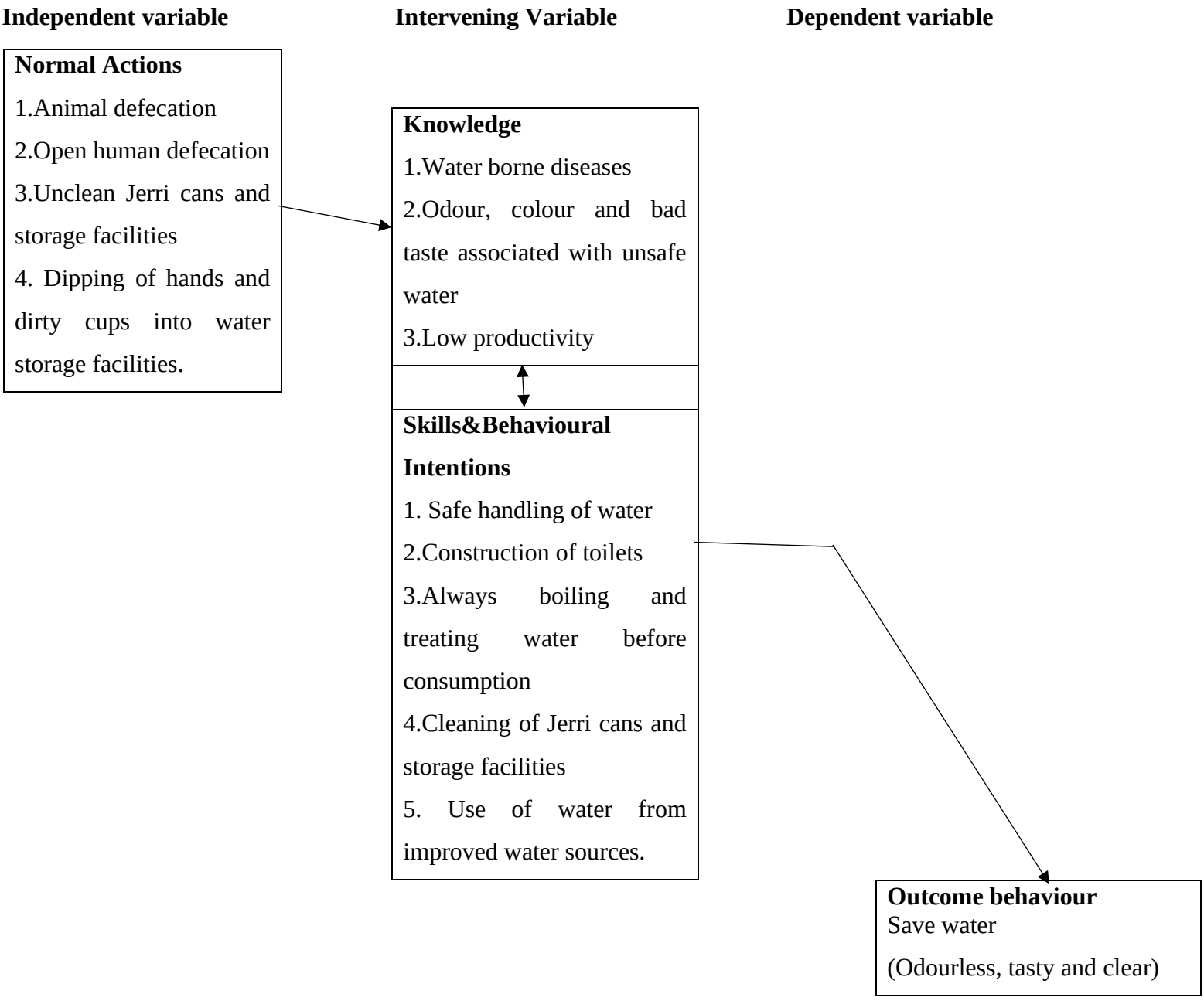

Figure 2.1: Conceptual framework

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the context in which the study was carried out. The chapter describes the study site in terms of information on the administrative boundaries, the climatic conditions, the water situation, and the people's livelihoods. The chapter also provides information on the research design, the study population, the sample population and sampling procedure, the data collection methods, data processing, and analysis, as well as the ethical considerations the study observed.

3.2. Study site

The study was conducted in Tseikuru ward, Mwingi North Sub County, Kitui County (Fig.3.1). The Ward covers a total area of 1,328.40 km². Mwingi North Sub-County lies within latitude 0° 55’ 59.88’’ and longitude 38° 3’ 59.76’’. In 2019, the population of the Tseikuru ward was approximately 40,871 (County Government of Kitui, 20183).

3.2.1 Administrative Boundaries

Mwingi North Sub-County is divided into five wards: Tseikuru, Ngomeni, Kyuso, Mumoni, and Tharaka. Tseikuru ward is divided into thirteen administrative sub-locations, namely, Kitovoto, Kasaini, Kathiani, Kaningo, Kyandani, Kyenini, Ngalange, Usueni, Ngereni, Nziitu, Kaivirya, Ngongoni and Kasyathuni. The Ward is the driest and with minimal economic activities taking place, many of the people are said to be living below the poverty level (County Government of Kitui, 2018).

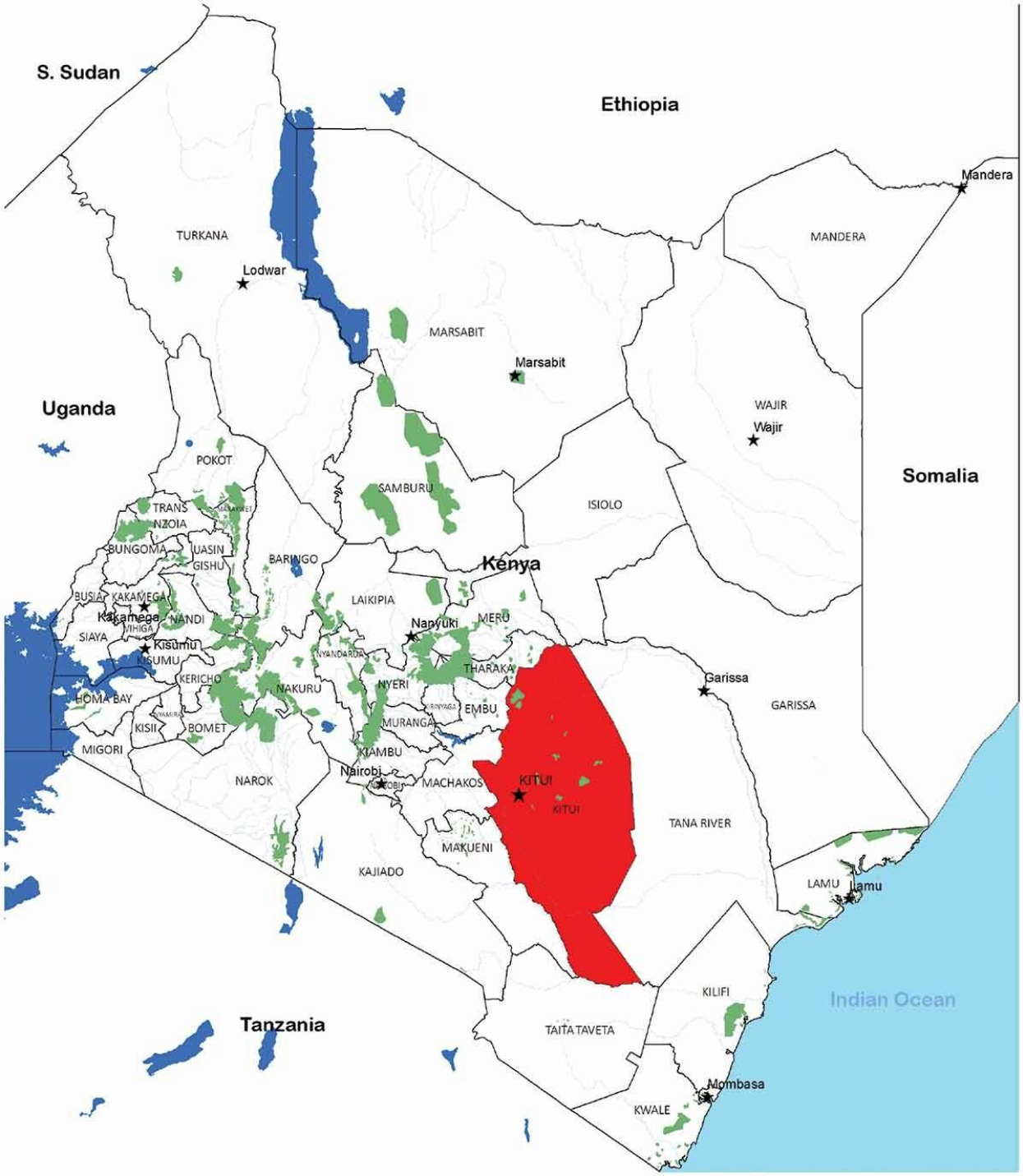

Figure 3.1: Map of Kenya showing Kitui County

Source: reachwater.org.uk 2019.

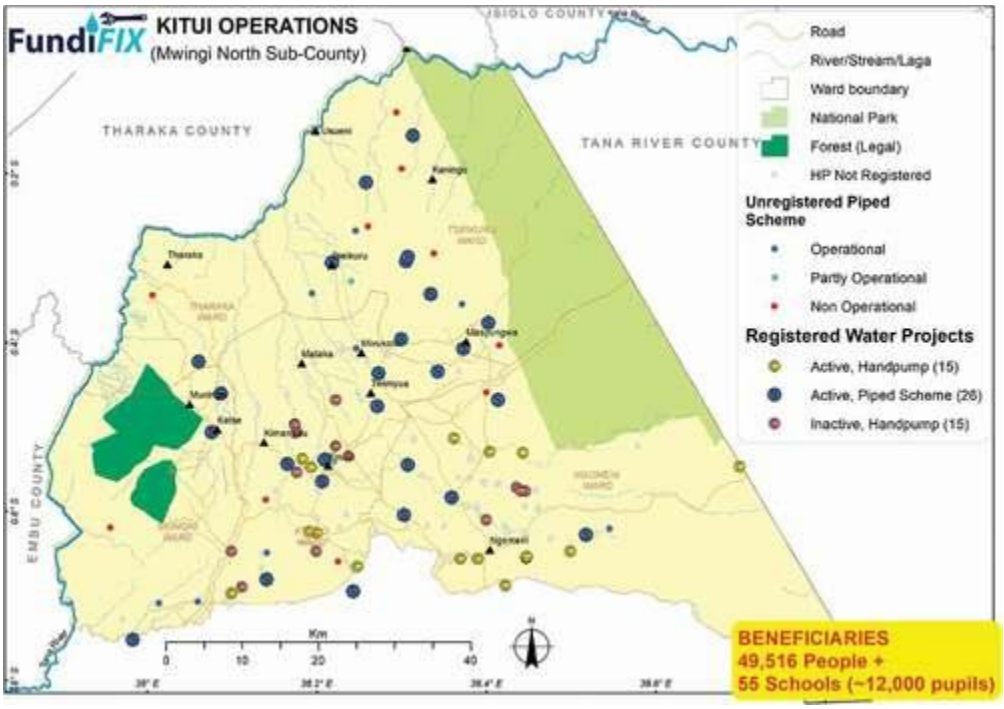

Figure 3.2: Map of the study area: Mwingi-north Sub-County.

Source: reachwater.org.uk 2019.

3.2.2 Cultural Nuances of the Akamba Community on Water

The Akamba community believes that water is life because there is no living thing that can survive without the existence of water. All their activities concerning feeding, drinking, cooking, sanitation, and animal watering, among other activities, depend on water for their effectiveness. This is confirmed by how the community members camp at the water sources to at least get a Jerri can or two of water when there is drought. Some walk for almost 20km to access water and when they do they have to sleep at the water sources for a day or two because of the huge numbers of people who are on the line waiting to access the water. They risk their lives since at such times there are wild animals such as hyenas walking around at night so that they can fetch water for their household consumption.

The community believes that one should not suffer if one is in a position to help. Due to the harsh climatic conditions in the area water insecurity has been a factor that cannot be evaded. In the

Tseikuru ward, women and children are the main water collectors except in cases of commercial water; when children are at school, women become the sole water collectors in the area as they juggle other household activities. For them to access water they walk for half a day to and from the water sources during the hot and dry seasons. In such cases, they fetch water twice a week and if they finish what they had fetched then they leverage social capital and water sharing. They borrow water and pay with foodstuff or, at other times, they refund the amount of water they borrowed after they get water for their households. These nuances have helped the community overcome the toughest dry seasons in the area.

3.2.3 Climatic conditions

Tseikuru ward is hot and dry with undependable rainfall, hence being termed as the arid part of Kitui County. The Ward experiences temperatures of 14°C to 34°C throughout the year, in which September to November and January to February are the hot months. The highest temperature in the year ranges between 26°C and 34°C whereas the lowest is between 14°C and 22°C. July has low temperatures of 14°C while September rises to 34°C.

According to the County Government of Kitui (2014), the area experiences two rainy seasons every year with the long rains from March to May, and the short rains between November and December. However, rainfall is unreliable in most of the seasons, which makes people find their way to survival by depending on boreholes and shallow wells operating in the area.

3.2.4 Water situation in Kitui County

In Kitui County there are different players in matters concerning water safety including the public and the private sector. The public sector has the County government administrators in the Ministry of Water and Community health workers trained on how to ensure safe water. In the private sector, some NGOs help with sinking boreholes, earth dams, and shallow wells. In addition, there are private profit-making organizations that help with repairs and maintenance of boreholes at the expense of the communities.

The main water sources in Kitui County include earth dams, sand dams, shallow wells, rivers, and boreholes, some of which have fresh water while others have salty water. Most people walk for at least 7 kilometers or even 14 kilometers to access water in a day (County Government of Kitui,

2018). People depend on these water sources to access water for domestic use, for drinking, for construction, and consumption.

Most of the water sources in the area of study are unimproved, which exposes them to any dirt that is washed into them by water and/or blown into them by wind and/or dropped into them by humans, livestock, or wild animals.

3.2.4.1 Earth dam

An earth dam (Plate 3.1) is a barrier with highly compacted earth that blocks a waterway, hence holding water for a longer period. People living in Tseikuru ward depend on these earth dams for three to four months after the rainy seasons. The earth dams are highly used in the area after the rains since the water is free and anyone can access the water as many times as possible, apart from the private earth dams whose owners have sanctions that govern water access. Most households have private earth dams which hold water for a month or two after the rainy season depending on how deep they are. Water from the earth dam is boiled or treated before consumption by some of the households. However, most of them take the raw water and that is why there is a record of waterborne diseases immediately after the rainy season.

Plate 1: Kwa Mbiti earth dam immediately after the rains

3.2.4.2 Sand dam

A sand dam is a strong man-made wall built across a seasonal river bed. The dam is, in most cases, made to reserve more water for farming and livestock, although in some areas the water can be used for domestic purposes especially when there is water insecurity in the area. However, sand dams are not common in the area of study and so they are not commonly used apart from immediately after the rains because, during the dry season, they are for watering livestock only. They are, therefore, the least in the hierarchy of water sources in the area.

3.2.4.3 Shallow well

A shallow well (Plate 3.2) is a slight hole dug using machines or mattocks to access water. The water is drawn up using electric pumps or even buckets that are connected to a rope that enhances mechanical raising or hand raising. They are common in the area of study. The community highly value and depend on water from the shallow wells. However, only a few people own the wells

while the larger community uses a seasonal payment mode to access water during the dry season and after the rainy season. Water from the wells is used for drinking, cooking, watering livestock, and other domestic uses. This water is considered to be clean, and so people do not treat or boil it unless they are under medication, and taking boiled water is one of the requirements, but that elapses after they are through with the prescriptions. For a person to be allowed to access water in another well they pay KES 500 and above depending on how many donkeys they will be using to fetch the water and how many livestock they own; a donkey carries four Jerri cans of twenty liters each.

Plate 2: Kwa Mbiti shallow well immediately after March to May rains.

3.2.4.4 Borehole

A borehole (Plate 3.3) is a deep hole drilled in the ground to access more water. The water is pumped from the ground using electric power, a generator, or solar panels depending on the sunlight in the area. However, in the study area, there are only a few boreholes and these are far away from most households. The community believes that this water is safe for consumption and

that is why they never treat or boil it. The community buys water from the boreholes at KES 4 or KES 5 per Jerri can. People start using the borehole water during the dry seasons more than during the rainy season because the earth dams are dry and people prefer buying from the boreholes instead of moving for long distances to access water from the shallow wells. This water is used for domestic use, drinking, cooking, and watering livestock.

Plate 3: Community members fetching water at Kasaini borehole

3.2.5 Livelihood Sources

Tseikuru ward is inhabited by the Kamba people who are a mixed farming community raring goats, cattle, and donkeys and cultivating drought-resistant foodstuffs like sorghum, pigeon peas, cowpeas, green grams, and pearl millet. Most people depend on farming, casual work, and small businesses within the area, making them live a hand-to-mouth way of subsistence, and the small harvests they receive from their farms they sell to at least earn a living, buy water, seek health care and pay school fees for their children (County Government of Kitui, 2014).

3.3 Research Design

The exploratory research design was used to assess new in-depth information on anthropogenic activities that influence water safety in the study area. The fieldwork was carried out over ten months from August 2018 to June 2019; this was to observe the seasonal variation across rainy and dry seasons. Qualitative data collection methods were employed to collect data, namely, in-depth interviews (IDIs), key informant interviews, and focus group discussions. Given the exploratory nature of the study, focus group discussions and unstructured observations complemented information obtained from in-depth interviews.

For the effectiveness of the data collection methods, the study started by holding informal interviews with individuals fetching water at shallow wells, earth dams, and boreholes. Unstructured observations were also used at the initial stage of the study. During interviews emerging themes were probed further and the study deduced them to the three objectives that guided this study. After creating rapport with the community, in the second month, the study introduced in-depth interviews with the purposively sampled informants. The in-depth interviews documented anthropogenic activities that influenced water safety at the points of collection, transportation, and storage.

The IDIs further explored the effects of anthropogenic activities that influence water safety as well as the mitigating strategies put into place to address the effects on water safety. Focus group discussions (FGDs) were introduced in the eighth month of the study after finalizing and analyzing the in-depth interviews. After analyzing data from IDIs and FGDs, there were emerging themes that were clarified by key informants (KIs). Having received information from the informants on the objectives, key informant interviews (KIIs) were carried out to collect professional information on the objectives of the study as well as clarify issues raised by the community. The collected data were analyzed thematically by the specific objectives. In the presentation of the findings, direct quotations were used to express the voices of the informants.

3.4 Study Population and Unit of Analysis

The study population comprised of Kamba people living in Tseikuru Ward who fetch water from earth dams, sand dams, boreholes, and shallow wells. The unit of analysis was the individual, either male or female, using water from shallow wells, earth dams, sand dams, or boreholes in the Tseikuru ward.

3.5 Sample and sampling procedure

The study sampled a total of 30 households for in-depth interviews with a representation of one member in each family. Kitovoto and Kasaini sub-locations in the Tseikuru ward were sampled since they only depend on the four water sources unlike other sub-locations in the ward which have alternatives like hand pumps and piped water. The 30 households in Kitovoto and Kasaini sub-locations were conveniently sampled and interviewed based on the availability and willingness of the family member to participate in the study. As well as their knowledge and responsibility for water accession and water safety.

The focus group discussants were sampled purposively based on the following inclusion criteria:

i) Able to give verbal informed consent voluntarily.

ii) Willingness to participate in the study.

iii) After establishing one's residence as from the targeted sub-location and one's continued use of water from the earth dams, boreholes, sand dams, or shallow wells in the area, one was purposively selected and recruited as a study participant.

Being Kamba speakers, the researchers conducted the interviews in the local dialect for ease of communication. Living in the area for a long time (four to five months) earned the researcher trust from the community which led to scheduling interviews and accompanying the interviewees through the water collection journey up to storage and use. Some of the participants agreed to allow the researchers to accompany them to the water sources and back to their homes, while others were reluctant about it since they felt the research team was intruding into their business. Moreover, being followed by outsiders would affect their normal conversations and whenever seen with an unknown person it would raise questions from the community members. Walking with them to their homes enabled the researcher to see what affected water quality at the point of

transportation and storage as well as helping her come up with emerging themes used in the analysis.

Four key informants were purposively selected for interviews based on their knowledge, occupation, and experience of anthropogenic activities and water safety. The village administrator was selected for being in charge of water projects in the area since he understands what affects water safety in the area. From the in-depth interviews, it was noted that the Clinical officer in the area was advising the community members on how to improve water safety especially immediately after the rains when waterborne infections were rampant. Having done training for his patients in the area of study and treating people for infections, he was recruited as one of the key informants. The Community Health Volunteer was sampled because she takes part in championing and training the community on how to enhance water safety and how to handle water in the household. It was established that she tirelessly teaches people how to treat and store water safely as well as the need to build toilets in every home.

The study sampled the Regional Director of World Vision due to the knowledge and understanding he has in water safety for he had been working in the area for seventeen years. The NGO helped in providing stable water to the community and had training on water safety and the effectiveness of the same to the community. In focus group discussions, the study gave guidelines to the Village administrator who suggested people for the four different discussions; then the researcher purposively sampled them based on their knowledge of the human activities that influence water safety at the different water points, during transportation, and at storage. The focus group discussions were conducted with two male groups and two female groups in both Kasaini and Kitovoto Sub-locations. These consisted of ten (10) male participants at Kasaini Sub-location, nine (9) female participants at Kasaini Sub-location, Ten (10) male participants in Kitovoto Sub-location and Ten (10) female participants in Kitovoto Sub-location.

Table 3.1 Participants reached in different data collection methods

Data collection methods	**Male**	**Female**	**Total**
In-depth Interviews	8	22	30
Key Informant Interviews	3	1	4
Focus Group Discussions	20	19	39
Total	31	42	73

3.5.1 Field entry

To conduct effective fieldwork on the topic of water and more so in a rural setting where monetary expectations from donors and researchers have become the custom, required strategic entry. First, we went through the Sub-County water representative, the Village administrator, and the chief who have worked with the community on different projects concerning water safety and water security. The officers helped create trust among the sampled study participants as well as explained the nature of the study as academic research to avoid any harassment especially if the monetary expectations were not met. However, it was not easy because the community still had expectations since they thought the study could be carried out in their community if there was no funding and hence, they thought the funding should benefit them too. Working with a community guide from the area at least helped us explain to them the value and the implications of the study to the community.

During every meeting with the participant's explanation of the scope of my study was done, sharing and interpretation of the concepts in the consent form especially the confidentiality of the participants and eventually maintaining anonymity in the presentation of the findings. The researcher explained the voluntary nature of the study to every participant. At this point, we requested to accompany the participants to the water points to observe and understand the

anthropogenic activities that influence water safety at the point of collection and the point of transportation. The community believes that having strangers follow them exposes one to bad omen and, so, most people were unwilling to accept the proposal of accompanying them to the water sources. Some participants were reluctant and thus they voluntarily excused themselves. The sampled participants, who accepted to take the study at their homes, helped the researcher to observe and understand the anthropogenic activities that influence water safety at the point of storage.

3.6 Data collection methods

The study involved the collection of primary and secondary data using the following data collection methods:

3.6.1 In-depth interviews (IDIs)

In-depth interviews (IDIs) were the primary method of data collection in the study. IDIs give room for probing, making them vital in exploratory studies (Bernard, 2000; Creswell, 2002). The interviews were conducted with a member of each household that uses water from either earth dams, shallow wells, sand dams, or boreholes. The interviews ran concurrently with unstructured observations which confirmed much of the results obtained from the in-depth interviews. In the study, IDIs were conducted with 30 informants from Kasaini and Kitovoto sub-locations. They generated data on community practices that affect water safety at the point of water collection such as bathing at the water points, dipping Jerri cans in the water, and allowing livestock at the water points. In transportation, the community practices include the use of unclean Jerri cans, repairing broken Jerri cans by using sand, and use of unsealed Jerri cans. Finally, storage use of uncovered storage facilities, irregular cleaning of storage facilities, and unhealthy handling of water like fetching water with dirty bowls from the storage, were the common causes of unsafe water.

The data were collected using an in-depth interview guide (Appendix II).

3.6.2 Key informant interviews (KIIs)

Key informant interviews (KIIs) provide information and insights that can only be obtained from the knowledgeable group in the community who understand the topic of concern (Krishna, 1989). KIIs were conducted with public and private actors in water safety and health professionals. The

key informants provided information on the interventions on water safety that were carried out in the area and their effectiveness. Waterborne diseases including typhoid, amoeba, and stomach aches were the main effects of the use of unsafe water in the area. From the interviews, the study learned that training was done by NGOs and Community Health Volunteers on water treatment by boiling and using water guards. A key informant guide was used to collect the data (Appendix III).

3.6.3 Focus Group Discussions (FGDs)

A focus group discussion is a technique of interviewing that involves a group of eight to twelve members. Focus group discussions (FGDs) enable the researcher to understand the reason behind activities since they probe further and get different people's viewpoints (Bryman, 2012). The focus group discussions responded to the specific objectives of anthropogenic activities and their influence on water safety in the Tseikuru ward. The discussions revealed that water odour was the main effect of anthropogenic activities on water quality and most households boiled the water to reduce the odour which at times did not work. However, even when this did not work, the water was still used since there was no alternative. To restore watercolor, households used a stone (aluminum sulfate) which, in most cases was soiled, due to the sources. The results of the FGDs assisted in the verification of information that was obtained from the in-depth interviews. The discussions were facilitated by the use of a focus group discussions guide (Appendix IV), and audio recordings were done with the participant’s consent.

3.6.4. Unstructured observation method

An observation guide was used to collect data on observable anthropogenic activities at the point of water collection, point of transportation, and point of storage. The observations informed the study on how different households handled water at the storage level. Most of them lacked a specific clean bowl to fetch water from the storage facilities; everybody in the house was using anything to access the water. The study observed that water from the boreholes was safer as compared to other sources; however, it would be important to have this water tested to ascertain its safety for the communities. Besides, more boreholes need to be drilled to enhance easy access to water for every household in the area. Data from the observations strengthened the information attained from the in-depth interviews.

3.6.5 Secondary sources

The study development relied on published and unpublished materials to inform the background and debate across the objectives when reviewing the literature. Some of the key materials used included books, articles, peer-reviewed articles, journals, the internet, reports, and other relevant documents published by WHO, UNICEF, and the County Government of Kitui on water, sanitation, and hygiene. The secondary data continued to be used throughout the study.

3.7 Data Processing and Analysis

The researcher systematically organized and analyzed the collected data thematically. The data were transcribed verbatim from Kamba and Swahili to English; then the transcribed data were checked alongside the audio recordings to ensure resemblance of quality. The interview tools were constantly adjusted accordingly to suit new information from the informants. The researcher read through all the transcriptions after collecting each data set, starting with in-depth interviews, then focus group discussions, and, finally, the key informants; to identify codes that were used to create a codebook. The qualitative data were analyzed thematically by manually coding as well as identifying themes that were coherent with the study objectives. Direct quotations and selected comments were integrated and presented in the research findings to give a deep description of the objectives and arising themes profoundly.

3.8 Ethical considerations

The study observed key research ethical considerations and principles in line with the anthropological code of ethics. The study obtained approval and permission from CUREC international ethical, University of Nairobi (Reference SOGE 18A-193), as well as the National Commission of Science, Technology, and Innovation research permit number NACOSTI/P/18/3232/20890 and NACOSTI/P/19/1689. The study obtained verbal consent (Appendix I) from the participants. Oral consenting to participate in the study served both those who know how to read and write as well as those who do not.

During the study, informants were appropriately updated on the purpose of the study, duration of the study, nature of the research work, the target groups, and the prospective use of the research findings as well as the expectations of the research team. The interviews would only proceed if the informant gave consent. The rights accorded to the informant to disqualify themselves upon feeling

unfit for the study were explained, although measures were taken to encourage full involvement in the study. The study released respondents who felt they could not participate if they were not compensated for their time, since it is unethical to reimburse them. Participation was free and fair to every person who was willing to participate in the study.

Throughout the interviews, consent was requested for taping of the discussions which would later be transcribed and verified with the written notes during analysis. Additionally, all participants were assured of anonymity by the use of pseudonyms during the publications of the findings. According to CUREC international ethics, the data were to be protected within the bigger project and access to it would require one to write an application explaining the purpose and nature of use. Therefore, confidentiality was highly held as per the research permits. Publications of the study will be shared with the scientific community and information obtained from the study will be availed through copies of the final thesis at the University of Nairobi library.

CHAPTER FOUR: ANTHROPOGENIC ACTIVITIES AND THEIR INFLUENCE ON WATER SAFETY

4.1 Introduction

This chapter presents the findings on and discussion of anthropogenic activities around water collection, transportation, and storage, the effects of anthropogenic activities on water safety, and the mitigating strategies put into place in the Tseikuru ward of Mwingi North Sub-County, Kitui County.

4.2 Anthropogenic Activities and their influence on water safety at the Point of Collection

Human-related activities at the point of collection, transportation, and storage were key to the thesis of this study. The findings and discussions in this respect have been carried out along the following sub-areas: open defecation, access to water from open shallow wells, stepping on the water sources and dipping of Jerri cans into the water sources, and animal defecation.

4.2.1 Human-related anthropogenic activities

4.2.1.1 Open defecation

Open defecation refers to the practice of excreting in fields, forests, bushes, bodies of water, or other open spaces. The findings from the in-depth interviews revealed that most people in the area of study do not have toilets in their homes or even at the water sources. Therefore, they defecate in the bushes or on farms, and the feaces are swept into the water sources during the rainy season. The study participants, especially those in the Kasaini sub-location stated that they do not have toilets because they lack funds that can enable them to construct decent toilets that will last them a long time. On their part, the key informants affirmed that the community has been taught a lot about hygiene and sanitation but in most cases, they never put into practice what they have learned due to their low income levels.

It has been normal for the community members to defecate in the bushes on their way to fetch water since they walk for very long distances to get to the water sources and they are not expected to request permission to use anyone's toilets. This confirms what the theory of reasoned action depicts that one's intentions are highly dependent on one's past experiences and behaviours. Even though homesteads are far apart and this in a way encourages open defecation in the forests/bushes,

defecating in the bushes continues because people find it normal. Open defecation assumes cultural relativity of dirt within the community, it is culturally appropriate to defecate far from human habitats. Therefore, people who defecate in the bushes and near the water points do not receive social sanctions since they are not viewed as polluting the human-inhabited spots. The people, therefore, felt that since the defecation was far from their homes there was no or very little chance of the water being polluted by their actions in this regard.

When it rains the run-offs flow to the water sources including the earth dams, the shallow wells, and the sand dams. The boreholes have a long-term effect from the open defecation contamination, Kasaini borehole water was tested and was found polluted by *Salmonella typhi*.

> *In Kwa Mbondo, water is not clean because it is open ground any dirt carried by the wind or by the people who fetch water is deposited into the earth dam, hence most people end up boiling drinking water because it is not clean for raw consumption. Though other people take it like that. In Kwa Mwasi (Masyungwa), water is not clean because most of the wells are open so dirt gets into it anytime* **(IDI_Female, 55 years).**

Key informants observed that for the community to overcome forest defecation, households should construct permanent toilets. There are few toilets, especially in Kasaini Sub-location, therefore, sanitation and hygiene are not keenly observed, and due to the unsafe water people get ill especially during the rainy season since they depend on water from earth dams. Water runoffs from the forests to the water sources influence the safety of the water explaining the frequent outbreak of diarrhea, typhoid, and stomach aches in post-rain seasons.

> *During the rainy season dirt inform of feaces are swept into the dam from bushes because people defecate in the forests because there are not enough toilets. This leads to people being affected after they take that water especially if they don't treat or boil it* **(IDI_ Female, 53 years, Kasaini).**

4.2.1.1.1 Cost of toilets

In the area of study, a good number of the community members live below the poverty line where they spend $1.99/KES 200 or less in a day (County Government of Kitui, 2018). The community depends on casual work for income generation with a person earning $3 a day $3; also they have other needs to settle first like school fees for children, buying food, and health among other needs. Therefore, having a good toilet is almost a luxury and that is why they never have them, and if

they do they are temporary ones that are shallow. When it rains most of them are flooded or even carried away by the waters.

> *Their income is very poor because when you look at the houses they live in are temporary, it even gives you a hard time telling them to construct toilets, so such shows the person concerned has greater problems* **(KII_Female, 50 years).**

4.2.1.1.2 Community Perception of Toilets

In the Kasaini sub-location, most households lack toilets and it is based on the function expected to serve in the community. Most people think the toilet is meant to hide them when defecating and the forest serves that purpose and there is no cost of construction accrued to it, hence they prefer the easier way of using the forest.

> *Some people defecate in the bushes; they don't access the toilets, so we believe the water flowing into the earth dam or in the wells is dirty. When we talk to the CHVs in Kaseluni they tell us they have a hard time when telling the people to construct toilets because the people think the toilets are meant to hide them when they are defecating, so they opt to go to the forests, and never bother to build a toilet* **(KII_Female, 50 years).**

Open defecation is a habit that people grow up with within the study area, this confirms the theory of planned behaviour which postulates that every member of a community will act as per the perception of behaviour control. In this case, the community member does not have control over open defecation when the toilets are not there or are far away. Due to the long distances to the market or the water sources, people prefer to relieve themselves in the bush or on the farms instead of walking for long distances to access the toilets. Some of the homesteads lack toilets hence they have to either use their neighbors', if not so they use the bushes because it is not acceptable to walk into other people's homesteads at night unless it is an emergency since one might be confused with a witch.

Osiemo et al. (2019) state that even though water is key to human growth and survival, it has been faced with challenges of anthropogenic activities that influence its safety hence increasing incidents of water-related diseases. Open defecation is the highest form of transmitting pathogens that contaminate water causing waterborne diseases like diarrhea (Gwimbi et al., 2019). Unsafe water and poor sanitation are major causes of many deaths that are caused by diarrhoea especially if the sick person does not receive medical attention immediately. From the findings, it is clear that

defecation is a challenge to the community especially with the households that use water from earth dams and shallow wells.

Bisung et al. (2014) state that at the time of their study almost 748 million people were not exposed to improved water sources and an estimated 1 billion defecated in the open. In addition, the communities are not worried about the consequences thereof like diseases and unsafe water from unimproved water sources like earth dams, sand dams, and shallow wells as it is in the area of study.

4.2.1.2 Access to water from open shallow wells

The study findings indicate that most of the water sources apart from the boreholes are open and unimproved water points which make it more vulnerable to contamination. Most households in the area access water from the open shallow wells, since this water is cheaper and more accessible than that from improved water sources. In-depth interviews revealed that income-generating activities in the study area are fencing, construction, digging wells, and selling of water and firewood, alongside selling of farm products which is done once a year. On a good day, a casual worker will earn $3 which has to be divided among many needs including school fees, health, food, and water among other activities that need to be financed. After every need has been settled, at least water will get a small portion of like $ 0.5 which cannot enable an individual to access water from the improved sources. So they prefer accessing water from unimproved water sources like three days a week since most of them walk for 5km or even 10km to fetch water.

Plate 4: Community members fetching water and watering livestock at an uncovered shallow well

Water from the open shallow wells and earth dams is not safe since, when it rains, dirt from the forests flows into the water sources leading to contamination of the water. From observations, only a few shallow wells are covered, sealed, and cemented all around, others are covered with logs which leave open spaces. Most people water their livestock around the water sources and in most cases they soil the area so that dirt flows into the shallow wells when it rains. Spillovers from the drinking tray for cattle flow back into the well, which could also include cow dung deposited around drinking points closer to the wells. As shown in Plate 4.1 above, the people fetching water step on the wooden covers with shoes or with bare feet which might be contaminated with dirt from toilets or dust. Moreover, when the wells are not covered, the wind blows dirt into the wells which can pollute the water. Finally, rotten wood pieces fall into the wells, thereby affecting water safety.

> *As I add to what that man has said, most of our wells are not covered especially at Kwa Mbiti, in other places like Kasaini and Ngomano, I normally see them digging and making lids of the wells. If it's the dirt from the surrounding it will not get a chance to get in the well, but the ones at Kwa Mbiti are open, I am talking from my perspective because I have a well that is not covered. When the wind blows and dust raises that dirt will fall into the same well and affect the same water, so the water is not safe* **(FGD_Male, 65 years, Kitovoto).**

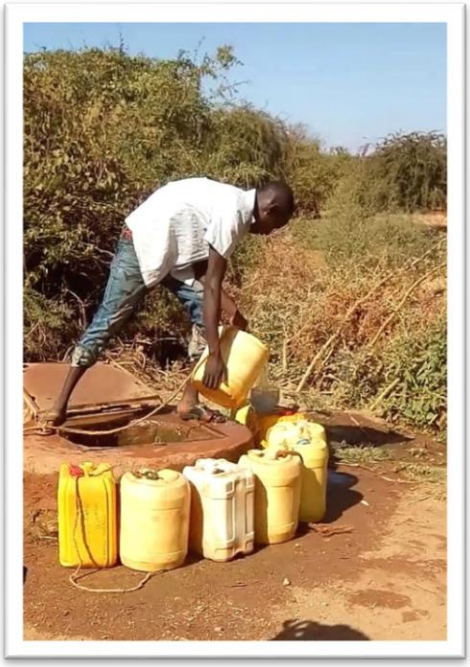

Plate 5: Fetching water at Kwa Mbiti shallow well with water spilling on the dirty feet and spilling over to the well.

At the shallow wells, when people are fetching water they step on the logs that cover the water points, then the water flows down from the feet of the person accessing water. At this water source, people do not remove shoes (Plate 5), so all the dirt flows with the water into the source hence affecting the water safety.

> *When people are fetching water from the shallow wells, some water from the jerrican we fetch drops off and pours on the feet of the person fetching the water which at times are dirty. The same dirt soils the water in the shallow well which might be clean* **(IDI_ Female, 40 years, Kitovoto).**

Plate 6: Green water collected at Mang'ulu rock catchment.

> *The water in Mang'ulu rock earth dam change color as the year proceeds and as the dry season continues, sometimes it turns green because of the dirt collected from the surrounding and dirt from the tree leaves* **(IDI_Female, 53 years, Kasaini).**

Kenya is a water-scarce country and, therefore, this forces citizens to draw water from unimproved water sources (Kurui et al., 2019). Waterborne diseases are caused by water from unimproved sources which houses pathogens that cause diseases (Gwimbi et al., 2019). These unimproved water sources include earth dams, unprotected wells, rivers, water vendors, and sand dams (Kurui et al., 2019). From the focus group discussions, it became clear that unimproved water sources are not covered, and because of that the water gets contaminated by any dirt either from dust, rain flows, wind, animals, or humans.

However, one may not be able to know when some dirt contaminates the water but uncovered water sources are at risk of holding unsafe water. Even though the community knows the water is unsafe, they still use the water due to water insecurity in the area. According to WHO (2019), the use of improved water sources with safe water ensures the well-being of the people, since people will access clean and safe water for their consumption. Accessing safe water is key to ensuring fewer illnesses and diseases that affect the normal activities of the community at large.

4.2.1.3 Stepping on the water sources and dipping Jerri cans into the water sources

Focus group discussions revealed that most people step on the water when collecting it, as shown in Plate 7 below, and this affects its safety in the long run. It was observed that some people bathe at the water points, maybe because of sweating or to remove dirt from the feet which, in the long run, affected water safety.

> *When people are fetching water from the earth's dam they step on the water, their shoes are dirty because they had to step on many dirty things like human feaces, dead animals, animal feaces, etc. on their way to the water source, the main problem is stepping into the water when fetching that changes the smell and even taste of water with time* **(FGD_ Female, 30 years, Kasaini).**

Plate 7: A woman fetching water stepping in the water and dipping a Jerri can at Mang'ulu Earth dam.

> *Yes, especially water at Mang'ulu earth dam is not good at all, this is because people misuse it, and some fetch water by stepping into the dam, while others deep the whole jerrican which is not cleaned into the dam* **(IDI_ Elderly Female, 60 years, Kasaini).**

When people access water, especially at the earth dams, they step in the water while at the same time dipping the Jerri can in the water. For most of the group-owned earth dams the members are warned against getting close to the earth dam with shoes on, and fined if they do so; they are supposed to step into the water with bare feet but which at times are dirty. In such cases, the only option of solving that problem is sanctioning the members but with the public earth dams, there are no prohibitions so anyone can do whatever they want.

When the mud at the earth dams is not removed, people step on it as they fetch water so it continues changing the color of the water, and also at some times it makes the water smell bad. Also, leaves from the trees drop into the water at the earth dams, and with time the water changes color to green and starts smelling bad over time **(FGD_Female, 40 years, Kitovoto).**

Plate 8: Community members operating a water ATM at Ikathima borehole.

However, water from the borehole is not affected by this activity because people draw from the tap into the Jerri cans which are then transported home for consumption. Sand dams are not readily available, although the few in the area are used to water livestock with minimal human consumption.

Focus group discussions revealed that most people step into in their shoes as they fetch the water. At the earth dams, people step into the water and, in most cases, in the mud left after the water dries up, which makes the water smell and also changes its taste. When this happens the community members leave the water source for livestock consumption. This was observed at some private earth dams in the Kasaini sub-location.

> *When people are fetching water from the earth's dam they step on the water, their shoes are dirty because they had to step on many dirty things like human feaces, dead animals, animal feaces, etc. on their way to the water source, the main problem is stepping into the water when fetching that changes the smell and even taste of water with time* **(FGD_Female, 30 years, Kitovoto).**

Safe water is a natural resource that should be available to everyone in the ecosystem for their efficient survival. Everyone needs to access sufficient safe water for drinking, cooking, personal cleanliness, and other activities that involve sanitation to uphold the dignity of the people (Olumana, 2018:165). Using unsafe water has highly influenced how people carry out their activities since when sick from waterborne infections most of their chores are suspended until they are well. By using water of poor quality, the community members' well-being is compromised. When the community understands the effects of its members' actions, then it will encourage them to act correctly to achieve what they are after. Knowledge of what affects water safety in the area will inform the members on how to come up with mitigating strategies that work best for each of the effects.

Fetching water by dipping Jerri cans in the water source highly affects water safety in the area. Nyaiko et al. (2015) state that there is a great relationship between human activities and the reduction of water safety since most of these activities are detrimental to natural resources, especially water. In most cases, the activities community members do thinking are safe are harmful to water safety.

4.2.2 Animal anthropogenic activities water risks

4.2.2.1 Animal defecation

From the unstructured observations, animals including cattle, dogs, and donkeys as well as wild animals defecate in the bushes and/or even around the water sources. In-depth interviews informed the study that the households own many herds of cattle which are watered at the water points. One household might own over 50 goats, 3 donkeys, and 10 cows which need to be watered and fed. They are left to feed themselves and sometimes they take themselves to the water points, especially during the rainy season when they go to the nearest earth dams and sand dams. Donkeys are

culturally acceptable animals for transporting water from water points to households or marketplaces. They are highly esteemed over other animals since they help with accessing water at far-off places. When fetching water donkeys are the only animals allowed around the water source for long and are watered at the water source especially if the other livestock are prohibited as is the case with private earth dams.

When the community members take livestock for watering and also to fetch water, the donkeys and the livestock defecate/urinate around the water source which in the long run affects water safety. When the feaces and urine get into the water sources they affect the colour and smell of the water which, in turn, informs that the water is not safe for consumption. In the case of a private earth dam, the owner leaves the water source for livestock consumption when the water becomes dirty and smelly. When there is no water at a close range from the household, most people will get dirty water and use a stone that clears the dirt but does not kill germs.

Plate 9: Livestock being watered at Kwa Mbiti Earth dam

> *We use donkeys to ferry water to our homes as earlier mentioned, these donkeys defecate and urinate around those water sources. In one way or another, the dirt ends up in the wells, either being washed off into the wells or wind blowing them into the wells. That's why I was saying if we rate the water, we use it is not clean* **(FGD_Male, 45 years, Kitovoto).**

The colour of the water turns green and it has a foul smell that shows that the water is not safe for human consumption. At some point, the households using the water have to abandon the water point until it dries up and then they clean the dirt as they prepare for the next rainfall. At times the households would fetch the same dirty water, and either boil or treat it with a stone called "Ivia ya ukuna kiw'u" (aluminum sulfate) which was used to clear the dirt. But the taste would be unbearable and so they would resolve to use other water points that have clean water for consumption.

> *When the livestock defecates at the earth dams, the faeces mix with mud, people step on it as they fetch water so it continues changing the colour of the water, and also at some point it makes the water smell bad. Also, leaves from the trees drop into the water in earth dams, and with time the water changes colour to green and starts smelling bad over time* **(Female FGD, Kitovoto).**

Capacity building and enlightenment to the community on how to water their livestock away from the water source would help keep the water safe and clean for consumption. The community should use a trough and adhere to watering the livestock away from the water source even with the private earth dams and shallow wells. Water is a very important resource that enhances every form of life on earth, and it is also a medium for disease transmission.

Water is a very important resource that enhances every form of life on earth, but it is also a medium for disease transmission. Therefore, enough safe water and efficient sanitation cannot be evaded since it is a factor that ensures a healthy community free of waterborne diseases for economic growth. People living in rural areas like in the study area use unimproved water sources that are exposed to the risks of contamination. It is, therefore, important to train the community on how to mitigate the effects of human activities on water safety until everyone understands the concept of safe water, hygiene, and sanitation.

4.3 Anthropogenic Activities and their influence on water safety at the Point of Transportation

Different water sources including earth dams, shallow wells, sand dams, and boreholes provide water for the people of the Tseikuru ward. All the water sources are a distance from homesteads apart from the private earth dams, and that is why water has to be transported to the point of

consumption. Water is transported mainly by use of donkeys, and minimally by use of carts or human backs if one does not own a donkey. Some households walk for 10 kilometers, while others walk for even 14 kilometers, especially when there is drought in the area. This explains why water has to be transported to the households.

> *The distance traveled to get water varies from one area to the other, like there are people who live out of the Masyungwa location and they still depend on water from Kwa Mbiti, some walk for 5 or 10 kilometers* **(FGD_Men, 45 years, Kitovoto).**

4.3.1 Use of unhygienic matter in container repair

Through unstructured observation, water in the Tseikuru ward is transported by donkeys or carts to the destination which could be the household, hotel, construction site, school, or even the hospitals in the area. In-depth interviews informed the study that when transporting water, at times the Jerri cans may fall and break. If this happens, the water collector will put sand or soil in the water to cover the hole so that the water does not spill off. The water at times changes colour due to the colour of the sand or soil, and this can also affect its safety since the soil might be contaminated by pathogens either from human or animal feaces which may lead to diseases if the water heater is not boiled or treated to curb such an eventuality.

> W*hen the jerrican breaks on our way home, we usually take some bits of sand and put it into the jerrican to avoid water pouring down, that way the water could have been fetched clean but it gets home dirt because the sand or soil is not clean* **(IDI_Female, 48 years, Kitovoto).**

Even though it does not solve the problem completely, it at least helps the person transporting the water time to fix the Jerri can when they get home. At times it might take a while since getting someone who can repair it might be some distance from the Jerri can's owner. That is why if the Jerri can is badly damaged the owner decides to get a new Jerri can altogether. Due to the domestic activities carried out at the household level like cooking, bathing, washing clothes, and drinking, among others, the availability of sufficient and safe water should be assured.

4.3.2 Use of unclean Jerri cans

Through focus group discussions, the study was notified that most people do not clean their Jerri cans for a period of two or even four months. When they are not cleaned a green layer form in the

Jerri can and this affects the safety of the water it is carrying. It is possible to put clean water into the Jerri can but the water gets contaminated by the dirt in the Jerri can. The same Jerri cans used for transportation are the same ones used for storage. This dirt that collects after using the water creates a mucous layer that contaminates the water if not cleaned.

> *Because of the environment and how the water is drawn and transported home. Also, the jerricans used to fetch water can contaminate the same water, a family can fetch water with jerricans for two or even more months without washing them so they form a green layer in the jerricans which is dirt. In most cases, we can fetch water while it's clean but when ferrying it home it gets contaminated* **(FGD_Male, 45 years, Kitovoto).**
>
> *Jerricans that carry water from the source are also dirty and can dirty the water, they have a green layer that attaches itself to the inside of the jerrican which changes the color and appearance of the water, therefore, one can get sick from taking such dirt without boiling or treating the water* **(FGD_Female, 64 years, Kitovoto).**

Often, the cleaning of Jerri cans and transportation facilities ensures the water transported is clean and safe for domestic use. Households without donkeys or carts and/or are new in the Tseikuru ward have to pay for them to get water. Moreover, the Jerri cans used by water vendors are not clean as cleaning them would take more time and this would affect their business. Most water vendors buy water from shallow wells and earth dam owners since they do not own the water sources. If a Jerri can go for $0.1 and they are fetching eight Jerri cans, then to clean the Jerri cans they have to add another Jerri can that would facilitate the cleaning, thus leading to the use of more money.

The World Bank (2018) explains how serious management of water resources and water transporting facilities is important to human health and the consumption of safe water which leads to healthy people. At times water from the water source could be clean but contaminated if not transported and stored in clean Jerri cans. However, this pollution only affects minimally households that have clean transport and storage facilities. Monitoring of water sources consistently as well as transportation and storage facilities, is an important exercise that should be done to ensure there are no effects of human activities on water safety (Nyakio et al. 2015). The safety of water is highly dependent on curbing or mitigating the effects of anthropogenic activities on it. An individual's intention to often clean Jerri cans will fulfill the need to have safe water for consumption.

4.3.3 Unsealed Jerri cans

The researcher observed that when carrying water home most Jerri cans lack lids. Therefore, the collector would get plastic bags (nylon) and/or leaves to cover the Jerri can and also to ensure water does not pour out on their way home. A key informant explained that plastic bags can be used also to tighten the lids that are made for other Jerri cans but because water has to be taken home, they use them to make the lids firm. However, people collect plastic bags beside the road on their way to the water source or around the water source. The in-depth interviews confirmed that these bags are contaminated with dirt or dust since some of them have been thrown away for a very long period. Before covering the lids, they are cleaned casually hence the dirt is not removed, thus affecting water safety when transporting the water home in the Jerri cans.

> *Because we lack water in the area, at times people visit the toilets or even defecate in the forests, but they don't wash their hands after that as per the sanitation regulations. When they seal the Jerri can lid on their way home the water can get contaminated* **(Male respondent, 48 years).**
>
> *Plastic bags are used as lids to cover the Jerri cans as they are transported home, the water from the water source may be clean but when the bags collected beside the road are used, they may contaminate the water* **(Female respondent, 31 years, Kasaini)**

From the focus group discussions, the study learned that people use hands that are not cleaned to seal the Jerri cans when the lids fall off on their way home Using dirty hands jeopardizes the safety of the water being transported home because most people do not wash their hands after using the toilets or defecating in the bushes or even after touching dirt. The community knows that their health is dependent on the consumption of safe water; however, they need to put the knowledge into practice by changing their behaviour of transporting safe water and maintaining the safety all along up to the storage and even to consumption.

The population is growing in every area in the world and this is correlating with the increase in anthropogenic activities that in most cases influence water and also environmental safety (Olumana, 2018: 164). Moreover, such activities should be dealt with to ensure there is safety in the existence of the ecosystem, which will help deter ill health and unsafe existence. Subsequently, the need to have sufficient water at the household level which is enough for domestic use and consumption should also increase the need to have safe water at the point of transportation as well as at the point of storage.

4.4 Water safety risks in storage practices

Focus group discussions informed the study that water in the Tseikuru ward is stored in plastic tanks (Plate 4.6) especially when it rains. Other households store the water in drums, pots, and Jerri cans used for fetching water. Due to the long distances the water collector is not in a position to fetch water twice or thrice in a day. There, therefore, is a skip method that is used by households fetching water from the shallow wells to ensure that every household has access to sufficient water that can last them a day or two. Those who access water from the boreholes still use the skip method because every time they use cash to access water for domestic use and livestock. Moreover, it is expensive for them to manage to do so every day.

Plate 10: Water tank used for water storage.

> *In storage, most women have found drums that can store water, when the donkeys reach home the woman will offload the jerrican ns they pour the way into the drums or tanks which they have for storage. Most of the storage facilities have lids, but even when it is covered the water is not safe for consumption. The part of storage is okay, others store water with the same jerricans they fetched water with. In most cases, the jerricans are covered, and the storage might be good but the water might be unsafe due to dirt from the point of collection or transportation* **(FGD_Male, 65 years, Kitovoto).**

> *We use the skip method whereby, when it gets drier, if I fetch today I will skip a day before I can come to fetch again. Also, if I have livestock today I will water them then I skip a day so that the other people can fetch water and water their livestock the following day* **(IDI_Female, 24 years, Kitovoto).**

Storing water in the home helps the people in that family to access and work on different activities, either financially or physically on days when they do not go to fetch water. For an individual to

store water in a safe place to ensure the water for consumption is clean, one has to have a habit and knowledge of the outcomes of unsafe water as explained by the theories of planned behaviour and reasoned action.

In most cases, it is common to have people store water in pots, jars, drums, buckets as well as other storage facilities depending on what the household can afford or maintain (Naliaka, 2014). Manga et al. (2021) state that a high percentage of the world's population needs to access, transport, and store water for domestic use and consumption since most of the water sources are a distance from the homesteads. If stored water is not handled properly, it might get re-contaminated at the household level during storage and use. Ideal storage of water ensures the safety of the household and the health of the members since from collection everyone has the intention of keeping the water safe for consumption.

4.4.1 Uncovered water storage facilities

From unstructured observations, some of the households have tanks constructed and/or bought to hold water when it rains and when one fetches lots of water. These tanks lack lids since the lids either broke or got damaged. Therefore, when the tanks are open, they endanger the safety of the water they hold. The dirt collected from the dust blown into the tanks and leaves falling off the trees creates a bad odour in the water, thereby forcing the households to abandon the water. In-depth interviews emphasized that the dirt collecting in such tanks contaminates the water collecting in the tanks from rains or the one poured into the tanks after collection from the water source.

> *When it rains and the tank is not covered and/or the tank is not cleaned the water collected is not clean, as it happened with me in the previous rainfall when water collected in our tank we opened the tank and let the water flow out because we were sure that water was not clean. That was confirmed when the tank was almost empty the water was deep green, showing that the tank had a layer of green dirt and there were also dry leaves from the nearby trees since the tank is not covered* **(Female respondent, 50 years, Kitovoto).**

Water should be stored in safe facilities as well as covered to ensure dirt does not get into the water. Every household should ensure they hold storage facilities that have lids to ensure that when water is poured into them, the dirt from outside does not contaminate the clean water.

4.4.2 Irregular cleaning of water storage facilities

The Jerri cans used to fetch water are supposed to be washed often to ensure the water they carry is clean and safe for consumption. The in-depth and key informants confirmed that cleaning of the Jerri cans and tanks does not happen in every one of the households. The interviews further confirmed what the theory of planned behaviour explains: cleaning of the Jerri cans is done by the household that knows the benefit of having clean and safe water. As shown by the findings, some people use the Jerri cans without washing them until they develop a green layer of dirt. This green layer contaminates the water. Some people wash them after a month or two while others leave them until they break to no repair then they throw them and buy new ones.

> *Water can be dirt even before it is poured into the storage facility, most people don't wash inside of the jerricans for a very long period when the jerricans are not cleaned they grow green stuff that is dirt and also the storage facility can grow the same if they are not cleaned* **(KII_Female, 50 years**).

It is believed that clean Jerri cans are highly dependent on the cleanliness of the owner and their value for hygiene; however, not everyone is keen on that. Women are the main water collectors in the area and some make sure they clean the Jerri cans used to fetch water and also the storage facilities. Storage facilities can also grow a green layer or have a foul smell due to the dirty residue at the bottom of the container. Cleaning them will help enhance water safety and ensure hygiene is upheld leading to healthy living and wellbeing.

> *Some jerricans are clean and others are not, it all depends on the owner because some wash the jerricans after a month or two, and others fetch water with them without washing them* **(FGD_Female, 35 years, Kasaini).**

At the point of collection for the borehole water, there is a storage tank used to store water after it is pumped by solar energy. The community accesses water from kiosks or reservoirs which draw water from the storage tank. Water cannot be accessed unless it is pumped and stored in the tanks before the fetching time. This storage facility is not cleaned in most cases; therefore, the dirt that collects at the bottom of the container can affect the safety of the water that is stored in it. The dirt might be caused by dust or some residue from the water or from the pipes that the water flows through. If left uncleaned the residue in the tank affects the water safety in the long run.

> *It might not be very clean because the tanks that hold the water when it is pumped from the borehole have dirt the same as the jerricans we use. These tanks are never washed so they*

might collect dirt in the process. The water from the borehole is not very clean but we take it as it is because it's better than the other **(FGD_Female, 34 years, Kasaini).**

Concerning safe water storage at the household level, the findings of this study support what Kirui et al. (2019) found, namely, that safe storage of water prevents microbial water pollution which causes waterborne diseases at the household level. If the community members would provide sufficient safe water, ensure hygiene, and enhance sanitation, especially in Kasaini Sub-location, water-related diseases would not be a major problem that needs to be dealt with.

4.4.3 Unhealthy handling of stored water

Water can be contaminated also by how the household members handle it especially when it is stored in an uncovered storage facility or when it is near the height which small children can reach. The findings indicate that children can drop dirty objects like spoons, sticks, and bowls into the storage facility which affects the safety of that water. In most cases, they access the storage facilities to fetch water the way they see others do, but in the process, they end up dirtying the water. At times they dip their dirty hands into the Jerri can that has water. The child's hands can be dirtied by touching their feaces or contaminated soil that contains pathogens which would pollute the water in the Jerri can. The water with time will change smell and taste and becomes unsafe for human consumption.

When we fetch water the children might dip dirty hands or throw dirty knives, sticks, etc., into the stored water hence dirtying it. We also at times fetch using dirty bowls or cups especially when we are washing the dishes, I think such can dirty the water **(IDI_Female, 40 years, Kasaini).**

Apart from children, adults also have dirty water in storage. The researcher observed that most adults would draw water from the drums or Jerri cans with dirty hands sometimes with soot especially when they are cooking. Other times when they are grinding millet to make porridge that they call *Mbithi*, which is uncooked porridge, their hands get dirty because, during the grinding process, one has to keep on adding water to the two grinding stones. Thus, when accessing water their hands can dirty the stored water. There were also cases where dirty jugs and bowls were used to fetch water from the storage facilities.

At times water is initially safe for consumption from the collection (Naliaka, 2014), but it can become contaminated by hands and cups that are dirty. Dirty containers dipped into the storage facility either to draw water or even when the kids are playing infects the clean water. The study findings agree with Kirui et al. (2019) on washing of hands to avoid waterborne diseases. Not washing hands affects water safety in a big way as the members of the household dip their hands in facilities used for storage to draw water for their daily activities. The washing of hands is poorly observed in the area of study, especially after visiting the toilet and doing other chores of the household. Household members avoid washing of hands before eating because water insecurity is rampant in the Tseikuru ward due to distances to the water source.

Water storage is a key issue that needs to be effectively dealt with, its hygiene will help the communities avoid using dirty and unsafe water which hurts their health. Storage of water is key, especially for households that do not have access to running water in their houses. It is important to make certain that whenever anyone is storing water they ascertain the hygiene of the process and the consequences to ensure water safety is assured throughout the process succeeding its collection. Safe storage of water at any level either at the household or community level, ensures there is prevention of water contamination which causes waterborne diseases (Kurui et al., 2019).

4.5 Effects of anthropogenic activities on water safety

4.5.1 Pathogenic Contamination of Water

In-depth interviews revealed that after it rains many people suffer from waterborne diseases since they use water from the nearest earth dams and sand dams that have contaminated water. The clinical officer confirmed that the community, especially children and some women, suffers from waterborne diseases including typhoid, amoeba, diarrhea, and stomach aches due to consuming unsafe water. These waterborne diseases are transmitted through various ways including consuming and using unsafe water. They can be fatal if left untreated for long or if there are multiple reoccurrences of the diseases. The unsafe water from earth dams and sand dams comes from the bushes where people and animals defecate. The dirt from the bushes contains pathogens that were transferred from either dead animals or from defecation.

> *People get sick when they take water from the water sources especially the earth dams immediately after the rains. Children and some women suffer from stomach problems and when they are diagnosed, they find out its waterborne diseases like typhoid and amoeba, though others get malaria due to the stagnant waters around, hence mosquitoes are rampant at that time* **(IDI_Elderly Female, 53 years, Kasaini).**

The study noted that anthropogenic activities have been influencing water safety for a while in the Tseikuru ward. Moreover, there have been trainings done by community health volunteers, clinical officers, and NGOs working in the area. The training has not borne as much impact as it was expected since most people are reluctant to put into practice what they are taught. The community was taught how to construct permanent toilets that will ensure cleanliness even in the bushes and farms. There are also teachings on how to have water and soap outside the toilets for washing hands after using the toilets. Despite the training on having water outside the toilets, an unstructured observation confirmed that few households put that into practice.

> *When it rains dirty water collects at the water sources and people access it hence they get sick of typhoid, diarrhea, amoeba, and stomach aches. There has never been an outbreak of cholera, but these others have been rampant, especially after the rainy seasons. This happens because most of the community members do not have decent toilets or sanitation facilities, hence the rainwater flows all the dirt from defecating animals and humans to the water sources* **(KII_ Male, 40 years).**

Through in-depth interviews and focus group discussions, the study revealed that when people are walking to their destination, they get pressed, and because the area they are in does not have public toilets they help themselves in the bushes. Kasaini location has few toilets because most people think that the government or the leadership in the area should help them in constructing the toilets. Tseikuru ward has a high dependency ratio and no one believes they can solve their problems by constructing toilets or ensuring clean water sources. This is because it has been an area with high support from donors and agencies. The lack of toilets has increased especially when it rains and the temporary toilets get destroyed and most people are not in a position to erect new ones due to low income. When people defecate in the bushes they create room for the consumption of unsafe water and the consequent waterborne infections.

> *I will talk about the Earth dam water, yes, we have toilets but I cannot walk for long distances to where there are toilets so I will just help myself in the bushes, either a short call or even a long call. Therefore, such dirt when it rains flows to the earth's dams, we drink that water then it leads to sickness and unsafe water* **(FGD_ Female, 45 years, Kasaini).**

However, the Sustainable Development Goals (SDGs) have Goal 6 which talks of how people should access safe and durable water as well as ensure sufficient sanitation and hygiene by 2030 (WHO, 2017). Safe water is a key need that should be provided, nations, regions, and areas should endeavor to ensure its availability to every individual, whether a child or an adult. The community requires capacity building and serial encouragement so that they can provide safe water and adequate sanitation for themselves and their households since donors and NGOs will always support them but leave in the long run. The private sector, including NGOs and donors, as well as the government should endeavor to include the community when doing any development in the Tseikuru ward. The inclusion will ensure the community members embrace the projects as their own which will also inform the maintenance and sustainability of the same.

4.5.2 Change of taste, odour, and colour of water

When earth dams, sand dams, or shallow wells get dirt from human and animal activities including defecation, over time the water changes its taste, colour, and odour. When this happens, households stop accessing water from these water sources. In such cases, the water source is abandoned for the others which have safe water depending on the taste, smell, or colour; the dirty water is left for livestock. People change to shallow wells that one has to pay for to access water. At the wells people use the seasonal payment method and if they access water from the boreholes it is the pay-as-you fetch method. It becomes expensive to access water since their income-generating ways are through casual work or selling of foodstuffs, which happens once in a while due to the rain patterns. This becomes a challenge since the area can stay for two or three years without rain, making access to water a real challenge.

> *The water in Mang'ulu rock earth dam change color as the year proceeds and as the dry season continues, sometimes it turns green because of the dirt collected from the surrounding and dirt from the tree leaves. At this time, we leave the water source for the livestock, then we start accessing water from the Ikathima borehole and Kwa Mwasi or Ngomano shallow wells* **(IDI_Female, 53 years, Kasaini).**

> *The water from the earth dam is free and when they dry up or the water starts smelling, we cannot continue using it, so we move to the boreholes and the shallow wells where we have to buy water for us to access it. Sometimes it is expensive but we have to ensure we get water for our domestic use* **(IDI_ Female, 43 years, Kitovoto).**

> *Water at Kwa Mbondo earth dam dries up in October and before it dries up, its quality is very poor, because it is thick and not safe for use but we still use it even when it smells bad and is dirty. The water also turns greenish. We have to boil it for drinking* **(IDI_ Female, 38 years, Kasaini).**

The change of odour, taste, and colour does not happen with water at the sources only, but even in the storage facilities if hygiene is not maintained. The in-depth interviews informed the study that children love playing with water and in most cases, they would dip dirty things like cups and spoons in the stored water. Dirt from the dipped things affects the safety of the stored water, which can affect the odour and taste of the water if it is left for a while. However, it is not just the children even adults draw water from the storage facilities with dirty hands using dirty jugs and this affects the safety of the stored water. These findings confirm what the theory of reasoned action explains, namely, that past experiences will inform one's actions. In this case, the households are used to fetching water with dirty bowls and jugs from the storage facilities, so they see nothing wrong here. When storage facilities are not cleaned they influence water safety too, since the dirt will affect the taste of the water, odour, and colour, although only at times.

> *Water from the earth dam and the shallow wells is not clear, in most cases it has a red residue so when we store water the dirt settles at the bottom of the jerrican. If we don't clean the jerrican then the same dirt affects the water poured into the storage facility. The residue might cause the color and taste of water to change* **(IDI_ Male, 40 years, Kasaini).**

Monitoring storage facilities often is of great significance since it highlights the implications of anthropogenic activities on the safety of water (Nyairo et al., 2015). The household members should be at the forefront in ensuring hygiene activities around the stored water for the sake of healthy living. The owner of the water sources, either a group or even a private owner, should enhance cleanliness around the water point and also take measures against any person who is against the set regulations. The person against the orders should be fined for misconduct around water facilities.

4.5.3 Low productivity

When the community or household members are unwell from waterborne diseases, they tend to be less productive in their daily activities, either farm work or even casual work, which also harms people's dignity, safety, and life achievements. However, some people use unsafe water since that is the only available option that they can survive on. Households prefer accessing water from earth dams since the water is free or they only have to offer labour to the owner of the water source. Since the earth dams are open, their water is unsafe especially immediately after the rains. Thus, consumption of this water without being treated causes diseases in the family. However, at this same time, people are expected to plant their seeds but which they cannot do when they are sick. They can only hire a different person to do their farm work which would not be possible due to their low incomes. In addition, pupils miss school due to illnesses caused by unsafe water, and this affects their well-being and education in the long run.

> *When people use the unsafe water accessed from the water sources, they get sick and that affects their daily activities. If one was supposed to go to work, they won't go because they're not feeling well. If the disease takes a while the employer might lay them down affecting the economic aspect of the family* **(KII_Male, 40 years).**

In the Tseikuru ward, households depend on casual work for them to at least feed, drink water, pay for school fees as well as cater for health needs, except for the permanently employed government staff. From the in-depth interviews there are mono-parented households where if the parent gets sick from the waterborne disease, he/she cannot provide for the family since they use hand to mouth way of subsistence. The daily income of a casual worker in the Tseikuru ward is KES 200 or KES 300 which is too low for them to facilitate all the needs that each household faces. The means of subsistence forces people to still do casual work even when sick to feed their children and access water.

> A*s a parent, my children have to feed whether I am sick or well, like now my husband is with another woman which means he doesn't provide for the family, so the whole weight is on me. Another woman's husband might be a drunkard so the little they get, is wasted with drinking, so the woman has to be responsible for the family. We have nothing else to do* **(IDI_ Female, 40 years).**

Unsafe water not only affects the well-being of the people but also their economic potential. This is because no one would access their income-generating activities when they are unwell or even dead (World Bank, 2019). When sick or dead due to waterborne diseases the nation loses manpower which deals with different sectors that make the nation productive. The households and the community, in general, should ensure hygienic ways of handling water and also avoid anthropogenic activities that affect water safety. Lack of sanitation, water, and hygiene has been a barrier to children's attendance at school (UNICEF, 2016), especially when they get sick from water-borne diseases which, at times, might be fatal. Better water sources also mean less expenditure on health as the community members are less likely to fall ill and incur medical costs and are in a better position to remain economically productive.

4.5.4 Unsafe water

When there is unhygienic handling of water at the collection, transportation, and storage points, then the community is exposed to unsafe water that affects their health in the long run. To the community health worker, there is no safe and clean water hence people live with the problem until they can access safe water which remains a goal to many people. Access to safe water and adequate sanitation is a challenge in the Tseikuru ward. In most cases, the communities are not in a position to solve the puzzle of providing safe water and adequate sanitation due to limited funds or even the incompetence of the leadership in the area.

> *In our area water safety has been a challenge since the community can only access water from earth dams, shallow wells, and sand dams at a cheaper price. We always think the borehole has clean water but not everyone can access water from the borehole every day since they feel it is too expensive for them if they have to water their livestock from the same water point* **(Male key informant, 57 years).**

Access to safe drinking water is an important human right although many people are deprived of this right because they only have unsafe water for consumption (Peiyue et al., 2017). Having safe water for consumption has been the opposite of what it is in reality (Bisung et al., 2014). This is because most people use unsafe water and live in areas where there is no adequate sanitation.

Adeosun et al. (2016) state that fresh water is important in the growth of every facet of society. However, water sources face risks every day due to human activities which affects the safety of

the water used for consumption (Kurui et al., 2019. Adequate and safe water supply helps enhance good health and also increases sufficient livelihood as well as well-being (Munyao, 2018). However, the research findings indicate that water safety in the study area has been negatively affected by anthropogenic activities.

SDG 6 advocates for communities to reduce as well as eliminate the activities affecting water safety, but it has not been easy with most people living in rural areas and also using unimproved water sources. Anthropogenic activities influence the quality of water greatly and this has been responsible for the waterborne diseases that people suffer from in the study area. Even though most people are aware of this problem, they have never put any effort into solving the problem. Many will ignore and do what they feel is good for them as a household or what they are used to. However, safety and well-being are key to everyone in the universe hence the need to adhere to the guidelines for safe water.

4.6 Mitigation strategies put in place to address the effects of anthropogenic activities that influence water safety

4.6.1 Water treatment practices

4.6.1.1 Boiling and water treatment

In-depth interviews demonstrated how households and the community at large mitigate the effects of anthropogenic activities on water safety since it has been a serious issue in their area. The key informants explained that water from the earth dams and sand dams is not clean and when the community takes it they get attacked by waterborne diseases. Catchment areas for the water sources are usually covered with human and animal defecation as well as other contaminants that affect water safety. When water is fetched from the water sources, households boil or treat the water using water guards before consumption. However, it is not everyone who follows the guidelines to the letter, most of the community members take it untreated since they feel it is okay with them. This confirms the theory of planned behaviour which explains that an individual will treat water if it is his/her normal behaviour but if not they will take it as it is since that is what they are used to.

> *People are advised not to take water raw without boiling or treating it, to avoid stomach waterborne diseases caused by pathogens from dirty water, one is advised to boil any water that they will take to avoid such ailments. In my case, I treat drinking water using a water guard. Also, mosquito nets should be in use especially when there is stagnant water with mosquitoes around to avoid getting sick* **(IDI_Elderly Female, 53 years, Kasaini).**

> *It's by boiling or treating the water with a water guard, although most people do not boil the water neither treat it apart from the people who have been diagnosed with typhoid or amoeba or stomach problems at least they will be keen to boil or treat the water. Others never bother, like now if I am thirsty and I pass through my neighbor's place they will give me unboiled water and I take it because I am very thirsty also when I get home very tired and thirsty I won't mind taking the water raw* **(FGD_Female, 40 years, Kasaini).**

Despite the Community Health Volunteers' work of training the community on hygiene and sanitation, most people think they are not responsible to anyone, hence the reason not to treat the water. The CHVs train people on how to boil drinking water, and how to treat and cover the storage facility to keep it clean to ensure the water used is safe for consumption. The community feels that their ancestors have been taking the water without treating it, and so they should not be forced to boil or treat the water since their bodies are used to the unsafe water. Others think that when the water is boiled it becomes tasteless and if treated by a water guard it has an unwelcoming smell. They feel the process is costly and not everyone has funds for buying the water guard.

> *I think I have already answered, nevertheless, they include, how to boil drinking water, how to treat drinking water, if one has a storage facility they should be covered, the same storage facilities should always be clean, I think that's all about water safety* **(KII_Female, 50 years).**

Moreover, there are cultural practices in the area of study that can expose the community to waterborne diseases. There is a porridge prepared by the people from the Tseikuru ward called *Mbithi* which is made of crushed millet and water. The water used is not boiled or treated and, in addition, the porridge is taken uncooked. This can easily expose the community to a great risk of water-related diseases. Since the community plants pearl millet, green grams, millet, sorghum, and other drought-resistant crops, this porridge is a quick fix for the households. However, it is a risk and if the community would incorporate treating and/or boiling the water before making the porridge, that would be part of keeping the community safe and healthy.

Safe water plays a significant role in preventing people from the outbreak of waterborne diseases. Diarrhoea has been among the first causes of death of children under the age of five (UNICEF, 2013) for a long period. If communities and households would put into place all measures concerning sanitation, hygiene, and safe water, then such diseases and deaths would be avoided (Wasonga et al., 2016). Water treatment and boiling should be accompanied by safe water storage measures to ensure there is no recontamination. For the community to avoid accessing unsafe water from the earth dams and the sand dams, they should endeavour to have large storage facilities which will help them store rainwater for a long time. However, rainwater might be a challenge to most members whose houses are thatched with grass. If the private sector and the government would help the community members to at least have a permanent house it would encourage rainwater storage.

4.6.1.2 Use of a local stone (aluminum sulfate) called 'Ivia ya ukuna kiw'u' for water purification

From observation and in-depth interviews, the study was notified that apart from boiling and treating the unsafe water for consumption, there is a 'stone' that is usually used to clean and desilt the dirty water. Although the water is not safe for drinking, the stone makes the water clear and one can boil or even treat it for human consumption. The stone is white and it is readily available at the local market. The water which collects in earth dams, sand dams, and shallow wells after the rains is not clear, and that is why people use the stone to make it clean. This cultural practice supports what the theory of planned behaviour explains, namely, that a person's behaviour will be determined by the outcome they expect from their actions. If the outcome is positive, especially when the household gets clean water, the behaviour of using the local stone will be practiced, unlike if there were no positive results.

Plate 11: The white stone (Ivia ya ukuna kiw'u) used to clean dirty and muddy water after the rains

> *Water from the earth dam is dirty and we use a purifying stone to clean the water for use. The only clean water is from the shallow wells. But earth dam water we just clean it with stone for domestic use like bathing and washing clothes, houses, and utensils. Water for cooking and drinking we get from the shallow wells and the boreholes.* **(IDI_Female, 50 years, Kitovoto).**

The research team decided to experiment with what the stone does to the dirty water to ascertain the explanation given. In one of the households, we requested for stone and dirty water for the test. Below is a picture showing what the water looks like, especially after the rains.

Plate 12: The researcher pours dirty water from an earth dam into a bowl to test how the stone clears the water.

In the picture (Plate 4.8) the water was poured into a bowl that would show the changes in the water. After that, the stone is put into the water for three to five minutes then the stone is removed to let the dirt settle at the bottom of the bowl or of the Jerri can. The stone is cut depending on the amount of water one would like to clean; if the water is in a jug or a bowl a small piece is cut, if the water is in a Jerri can then the stone will be bigger to ensure it cleans the water fast before use.

Plate 13: Stone in the dirty water to test how it changes and how long it takes to distill.

Plate 14: After two to three minutes water starts distilling.

After two to three minutes the water starts distilling and the dirt settles at the bottom of the bowl (Plate 4.10) or of the Jerri can if the person uses a Jerri can.

Plate 15: Clearwater.

One of the research teams held the bowl in a slanting manner (Plate 4.11) to show the changes that had taken place after the stone was removed since it took at most five minutes for the water to clear.

Plate 16: Distilled water after adding two more minutes to see the outcome.

Cleaning the dirty water with the stone does not kill germs, and that is why the water is used to wash clothes, wash house floors, and other household activities rather than for drinking. The stone should be cut into small pieces if the water is not much since its effects can affect food if the water is used for cooking. If anyone wants to drink the water which now appears clean, it should nevertheless be boiled or treated to make it safe for consumption. Households who use the stone and then take the water without treating or boiling it, face the same effects as those who did not administer anything on their water before consumption.

> *We use the stone for cleaning water for washing clothes. The stone doesn't kill germs in water, it only makes the water clear. If anyone wants to drink that water, they first should boil it after making it clear from the dirt* **(IDI_Elderly Male, 70 years, Kasaini).**

Safe water is an essential factor in the well-being of every community. However, the provision of cost-effective solutions that address hostile health effects that are caused by unsafe water and inadequate sanitation is a challenge to the rural areas which experience low income (Bisung and Elliot, 2014). The income each household has access to is geared toward facilitating the basic needs of that household, although at times the income is not enough. The community should have faithful and accountable communal group contributions that would have a rotational help to the

households that are members by providing whatever each household needs to enhance water safety and effective handling practices of water for the sake of each member's wellbeing.

4.6.2 Buying of bottled water and use of borehole water

From the in-depth interviews, the study learned that anybody who does not boil or treat water and values their health prefers buying bottled water. In addition, others prefer buying water from boreholes for drinking since they feel borehole water is safe for human consumption. The findings support what the theory of planned behaviour postulates, namely, that belief and overall evaluation of behaviour will inform the attitude towards the behaviour. Thus, for a household to access water at the borehole or buy bottled water for consumption will be informed by the belief that borehole and bottled water is safe. Water from the earth dams, sand dams, and shallow wells is used for other house chores such as washing house floors, and utensils and watering the livestock.

However, it is not everyone who prefers buying separate water for drinking because it is expensive. A bottle of water is bought at KES 30 or KES 20 from the shopping center, while water from the borehole goes for only KES 3 per 20-litre Jerri can. With the hot climate conditions in the area one bottle of water is not enough and, therefore, a 20-litre Jerri can is preferable although the boreholes are far away from the homesteads and contain saline water. In-depth interviews and focus group discussions suggest that the community prefers using earth dams, sand dams, and shallow well water because they hold fresh water even though it is not safe for human consumption. According to one respondent:

> *Water from the Ikathima borehole is clean and safe, unlike the water we get from the Kwa Mbondo earth dam, especially after the rains or before the earth dam dries up. When we have money we buy it for drinking but we cannot afford to buy it every time because it is expensive for us to buy every day* **(Male respondent, 53 years, Kasaini).**

The community members feel that people in charge of borehole water should lower the prices so that the water is accessible to every member of the community. Also, the government, together with the private sector, should come up with strategies for instilling a desalination machine at every borehole to ensure water collected by the community members can serve them to the best of their interests. To promote effective participation and strengthen issues about water safety the

government, private sector, civil society, and the community should be involved wholly (UNICEF, 2016).

4.6.3 Praying for water

In-depth interviews informed the study that it is a cultural practice for some community members to carry water to the church for purification and blessings. One takes a Jerri can, which is then prayed for by the Priest/Pastor then the water is used to sprinkle to the houses as well as drinking for blessings. At times people carry water in Jerri cans from the holy mountains and they believe the water is blessed, hence they take the water without treating it. Church members believe that God has the power to purify water from any impurities and that is why they are obliged to take the water to the priest or the pastor. They believe that even if the water was unsafe as long as the church leader prays over it then it is safe for human consumption as well as for other activities. One respondent explained this as follows:

> W*hen we bring water to the church, the Priest has to pray over it first before he sprinkles it on us. The Christians can even carry their water from home like 5 litres, for it to be blessed. Others carry 2 litres, then they use it at home for drinking or mixing with the water that is used at home or it is used by the faithful to sprinkle on their houses for blessings. People believe that when water is prayed for it ceases to contain germs or dirt; it is purified. Here people believe that others are jealous of them and can even bewitch them. So they sprinkle the water that has been prayed over on their houses to protect them from witchcraft. Others use it for bathing and in ways that are not known to anyone* **(Female respondent, 28 years, Kitovoto).**

However, due to the nature of the study, it did not test such kind of water to verify the claims, although the community members felt that it has been working for them all along. Water was also taken for prayers if the owner thought they were being bewitched especially if they got water from a new well or private earth dam where the owner is associated with witchcraft. Therefore, the blessed water was used to send away the evil spirits. In case a family had a series of cases of misfortunes, they believed they were bewitched. The visiting priest or pastor, needed to have the blessed water to keep off the evil spirits and bless the family beyond any negative effects from the enemy.

4.7 Health Seeking Patterns for Water Contamination Illnesses

4.7.1 Hospital and taking of herbs

When people are attacked by waterborne diseases like diarrhea, typhoid, and amoeba, they visit the hospital where they are diagnosed and treated according to the disease they are ailing from. If after visiting the hospital they do not feel better, they use the roots of a tree called *Katongatongi*, which they pound and make a concoction that helps in healing the stomach ache. According to one respondent in Kitoyoto:

> *Most people go to the hospital. I would say there is no other way of treating the disease, not unless one has stomachache without diarrhoea there is a tree root that can be used to treat the problem. The tree's name is "Katongatongi", which I have in my compound. One gets the roots, pounds them then soaks them in cold water, and then takes the concoction* **(Female respondent, 50 years, Kitovoto).**

Some community members prefer taking herbs depending on how they feel. They have mastered which herb to take and when to take it, and so use the particular herb for treatment in case of stomachaches. After a while, they feel better and then they do not ever visit the hospital for diagnosis or even to verify whether they are well or not. They feel that hospitals, clinics, and medicines came when they had already mastered their health-seeking behaviours and hence they do not wish to leave their way of life to incorporate the new ways of health-seeking behaviours. However, some undertake both after the first one has failed.

After being tested and diagnosed with a water-borne disease the doctor advises the sick person to ensure they boil or treat water before drinking it. Most of the community members adhere to the advice of the doctor up to the time they feel better and then stop immediately to do so. At the dispensary or clinics in Tseikuru ward, people are given water treatment pills or powder but most of them just keep the medication or even throw it away. One respondent put it this way:

> *Also, when you start having stomach problems, you go for testing, and when the doctor finds that you have either typhoid or amoeba you are advised to stop drinking the water from the earth dams and if you have to take it you are advised to first boil the water or you just drink the water from a borehole* **(Male respondent, 43 years, Kasaini).**

4.7.2 Native doctors

In other cases, when the illness persists the sick person visits a native doctor who treats people using the roots of a tree. Most community members visit the hospital for treatment but when they do not get better, they prefer going to the native doctors. Other people prefer going to the native doctors without visiting the hospital since they have faith that the herbs given will cure them. The community members know when to visit the hospital and when to visit the native doctor or even both if it is necessary. According to one key informant:

> *People are treated by the native doctors but not because of diseases caused by water. In most cases, people will go to the native doctor if they have suffered for a long period without getting relief. They have even gone to the hospital but the stomachache is not subsidizing; therefore, they result to native doctors since modern medicine is not working well for them* **(Female key informant, 50 years).**

Healthy lives will enhance the standards of living which will inform personal and collective growth in every society. It is the responsibility of each member of a household and a community to ensure the availability of safe and clean water in every household, whether urban or rural. Anything compromising the safety of water should be dealt with and settled for easy provision of consumable water for the well-being of the society at large.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

In summary, the study sought to assess the anthropogenic activities that influence water safety in the Tseikuru ward, Mwingi North Sub-County in Kitui County. These activities were observed at the points of collection, transportation, and storage; the effects of human activities on water safety; and the mitigation strategies used to address the effects of the anthropogenic activities on water safety in that ward.

Water safety in the Tseikuru ward is influenced by different anthropogenic activities. Both human-related activities and animal-related activities like grazing livestock around the water points affect water safety at the point of water collection. The cost of constructing toilets and the community's perception of toilets has led to many households lacking toilets, leading to open defecation, especially in Kasaini Sub-location. When accessing water from the public earth dams most people fetch the water while stepping on the water or dip their Jerri cans in the source both of which affect the appearance of water. In addition, animal defecation when animals are grazing or being watered has been influencing water safety around the water points. When the dirt is blown or washed into the water points, it changes the water's colour and smell.

Sealing Jerri cans with leaves, sand, and clay constitute water transportation pollutants. This is in addition to the regular use of uncleaned water containers. Stored water is contaminated by uncovered water storage facilities and irregular cleaning of storage facilities. Also, dropping of dirty objects, fetching of water with dirty hands, and use of dirty water collection jugs are the water storage unhealthy handling activities. In most households, water storage facilities are kept outside either with the same fetching Jerri cans or with drums or tanks. Dirt that settles at the bottom of the tanks, Jerri cans, and drums, changes the smell, colour, and taste of water, making it unfit for human consumption.

These activities alternatively influence water safety in each of the households. The use of open water sources has resulted in waterborne diseases especially immediately after the rainy season, which leads to low productivity of the community members. Change in taste, odour, and colour of the water makes it unsafe for consumption. Some households boil water before consumption while others treat it using a water guard. Others prefer taking it without any treatment since that is what

they were introduced to by their parents. In addition, doctors advise sick people to treat or boil drinking water, which most people drop immediately after getting well. The people who migrate to the place buy bottled water for drinking as well as borehole water for consumption.

5.2 Conclusion

Anthropogenic activities are key aspects that influence water safety in the Tseikuru ward, Mwingi North Sub-County. The study assessed the anthropogenic activities that influence water safety at the point of collection, transportation, and storage. The findings indicate that at the point of collection open defecation due to the lack of toilets in every household, community perceptions, and the cost of toilets, affect the safety of water especially due to runoffs after the rainy season. The theory of planned behavior explains that for a person to decide on what to do their decision is informed by different factors like past experiences and peer pressure. In that case, open defecation has been a normal thing because of the distances between homesteads and also the long distances to water points as well as the lack of toilets in most of the homes. Further, animal defecation at the water source causes a change in the colour, taste, and smell of water at the water points. In addition, dipping Jerri cans and stepping on the water when accessing them affects the safety of the water at the point of collection.

Due to the long distances to the water sources, most households use donkeys to transport water home or to the marketplace. The study found that in the process of transportation, water is contaminated by sand and leaves when they are used to seal broken Jerri cans. Also, green molds grow in transporting Jerri cans if they are not cleaned often, which affects the colour and smell of the water in the long run, making it unfit for consumption. Accessing water daily is not possible for most households due to distance; therefore, it has to be stored in either transporting Jerri cans or plastic tanks or drums. Uncleaned, unhealthy handling, and uncovered storage facilities were identified as how water is polluted. Most storage facilities are kept outside hence contamination happens especially if they are not covered.

Open water sources contain water from runoffs during rainy seasons. If such water is taken without being treated household members will suffer from waterborne diseases. In most cases, community members will take untreated water since it is their usual way of consuming water, thereby

supporting what the theory of planned behaviour postulates. The unsafe water if not treated or boiled causes waterborne diseases that affect the productivity of most people in the area. The study established that when sick, the members are not able to undertake their work, leading to low productivity immediately after the rain season. To address the effects of anthropogenic activities on water safety, the household boils, treats, prays, or uses a stone to clear the water, while some households buy bottled water or water from the boreholes for drinking. The knowledge and skills on how and why the community needs clean and safe water for their well-being will inform the actions taken to make the water safe for consumption as explained by the theory of reasoned action and the theory of planned behaviour.

Water safety is a key aspect in the fulfillment of SDGs, safe and clean water should be availed for a healthy nation. The study established that if every individual would agree to put into place the mitigating strategies to address the effects of anthropogenic activities, then they would use and consume safe water which would ensure healthy lifestyles.

5.3 Recommendations

The study recommends the following:

1. The community together with the government should reinforce ways that ensure a change of behaviour by most of the community members. Measures should be put into place to address open defecation, improve hygiene practices and promote drinking water safety as this will contribute to the growth and advancement of the society as well as their health.
2. Since water pollution does not occur in isolation, informal and formal levels of water governance need to integrate elements that minimize water pollution as part of addressing water insecurity in the community. This would mean holding water hygiene clinics as part of community engagement in safe and sustainable water consumption.
3. Further research on what hinders the community from practicing safe water handling practices to unearth the ideologies that do not support safe water handling.
4. The study recommends a feasibility study on an affordable mobile technology system that tests water quality

REFERENCES

Adeosun, F.I., Adams, T.F. & Amrevuawho, M.O. (2016). Effect of anthropogenic activities on the water quality parameters of the federal university of Agriculture Abeokuta reservoir. *International Journal of Fisheries and Aquatic Studies.* Vol. 4 (3) pg. 104-108

Ajzen, I. (1985). *From intentions to actions: A theory of planned behavior in J. Kuhl and J. Beckmann (eds), Action control.* (pp. 11-39). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-642-69746-3-2

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision processes.* 50,179-211

Ajzen, I. and Fishbein, M. (2005). *The influence of attitudes on behavior*. http://www.researchgate.net/publication/264000974

Akhtar, N.; Syakir Ishak, M.I.; Bhawani, S.A.; Umar, K. (2021). Various Natural and Anthropogenic Factors Responsible for Water Quality Degradation: A Review. *Water.* Vol. 13(19), 2660. https://doi.org/10.3390/w13192660

Ansari, Z.A & Matondkar, S.G.P. (2014). Anthropogenic activities including pollution and contamination of the coastal Marine environment. *The Academy of Environmental Biology*, India. Occup. Hlth. 14 (1 & 2) (2014) 71-78

Anyanwu, B.O., Ezejiofor, A.N., Igweze, Z.N., & Orisakwe, O.E. (2018). Heavy Metal Mixture Exposure and Effects in Developing Nations: An Update. *Toxics*. Vol. 4(6): 65.

Doi: 10.3390/toxics6040065

Babbie, E. & Benaquisto, L. (2010). *Fundamentals of social research*, 2nd ed. Toronto, ON: Nelson Education.

Bahadur, D.R., Ali, A., Bahadur, N.C., Behera, B and Ranjan, P.J. (2016). Access to safe drinking water and human health: empirical evidence from rural Bhutan. *Water science & technology. Water supply.*

Bain, R. Cronk, R. Hossain, R. Bonjour, S. Onda, K. Wright, J. Yang, H. Slaymaker, T. Hunter, P. Prüss-Ustün, A. and Bartram, J. (2014). Global assessment of exposure to fecal contamination through drinking water based on a systematic review. *Tropical Medicine & International Health*

Barbarios, F., Cetinkaya, C.P. (2014). Effects of Human Activities on water quality: A case study. Mogan & Eymir Basin. *Journal for water Basin management*. Vol.5: pg. 438-452.

Bernard, R.H. (2006). Research Methods in Anthropology: *Qualitative and Quantitative Approaches*, 6th ed. Lanham, MD: AltaMira Press.

Bisung, E., Elliott, S.J., Schuster-Wallace, J.c., Karanja, M.D. and Benard, A. (2014). Social capital, collective action and access to water in rural Kenya. *Social Science and Medicine*. Vol. 119: Pg. 147-154.

Bisung, E. and Elliot, S.J. (2014). Toward a social capital based framework for understanding the water-health nexus. *Social Science and Medicine*. Vol. 108: Pg. 194-200.

Bryman, A. (2012). *Social research methods*. 4th ed. New York, NY: Oxford University Press Inc

County Government of Kitui (2017). Planning for Sustainable Socio-Economic Growth and Development. *County Integrated Development Plan 2013-2017*. County Government of Kitui

County Government of Kitui. (2018-2022). *County Integrated Development Plan 2018-2022*.

Derara, C., Moa, M. & Abebe, B. (2018). Assessment of the quality of drinking water in storage tanks and its implications on the safety of urban water supply in developing countries. *Environmental Systems Research Journal.* Vol. 6: No.1

Dinka, M.O. (2018). *Safe drinking water: Concepts, Benefits, Principles and Standards.* Water challenges of an urbanizing world.

http://www.intechopen.com/books/water-challenges-of-an-urbanizing-World.

Edokpayi J. N., Rogawski E. T., Kahler D. M., Hill C. L, Reynolds C., Nyathi E., Smith J. A., Odiyo J.O., Samie A., Bessong P., Dillingham R. (2018). Challenges to Sustainable Safe Drinking Water: A Case Study of Water Quality and Use across Seasons in Rural Communities in Limpopo Province, South Africa. Water (Basel). *National Library of Medicine*. Vol.10(2):159. doi: 10.3390/w10020159.

Fishbein, M. (2000). *The Role of theory in HIV Prevention*. AIDS care.

Fishbein, M. (2008). Theory of Reasoned Action. *The International Encyclopedia of communication*. https://doi.org/10.1002/9781405186407.wbiecro17. Viewed on 25/04/2020.

Glanz, K. Rimer, B. AND Viswanath, K. (2008). *Health Behavior and Health Education Theory, Research and Practice, 4th ed.* San Francisco CA: John Willey & Sona, Inc.

Griffin, R.J., Neuwirth, K. & Dunwoody, S. (1995) Using the Theory of Reasoned Action to Examine the Impact of Health Risk Messages. *Annals of the International Communication Association,* 18:1, 201-228, DOI: 10.1080/23808985.1995.11678913

Gwimbi, P., George, M. and Ramphalile, M. (2019). Bacterial contamination of drinking water sources in rural villages of Mohale Basin, Lesotho: Exposures through neighborhood sanitation and hygiene practices. *Environmental Health and Preventive Medicine*. Vol 24; 33.

http://www.kenyacountyguide.co.ke/kitui : Accessed on Feb 18, 2019

https://www.nema.go.ke/images/Docs/Legislation%20and%20Policies/Environmental%20Act%20(EMCA1999)%20.pdf Accessed on November, 2018

https://www.nema.go.ke/index.php?option=com_content&view=article&

Accessed on November, 2018

Inyinbor.A.A, Adebesin, B.O., Oluyon, A.P., Adelani-Akande, T.A., Dada, A.O & Oreofe, T.A. (2018). *Water pollution: Effects, Prevention and Climatic Impact, water challenges of an Urbanizing World*. MatJaz Glava: Intechopen. Doi: 10.57772/intechopen.72018

Issaka, R.Z., Abdallah, M.H. & Abiwu, N. (2015). Impact of household storage tanks and practices on quality rainwater stored in central Gonja District, Ghana. *The International Journal of Engineering and Science*. Vol. 4, Issue 10. Pg. 58-66

Kasprzyk, D. and Montano, D.E. (2015). Theory of reasoned action, theory of planned behavior and the integrated behavioral model. *Health behavior: theory, research and practice*. pg. 95-124. San Francisco, CA, US: Jossey-Bass.

Khan, B. A., Cheng, L., Khan, A. A., & Ahmed, H. (2019). Healthcare waste management in Asian developing countries: A mini review. *Sage journals*. Vol. 37 (9). https://doi.org/10.1177/0734242X19857470

Koshland Science Museum (2018). *Safe drinking water is essential*. National Academy of Science. www.koshland-science-museum. Org

Accessed on 10th April 2019

Kothari, C.R. (2004). *Research Methodology: Methods and techniques*, 2nd ed. Belmont: Thomson Wadsworth

Kumar, K. (1989). *Conducting Key Informant Interviews in Developing Countries*. A.I.D. Program Design and Evaluation Methodology Report No: 13. http://ww.slidesshare.net/achintbt/usaid-tips-series

Accessed on 22nd January 2021

Kurui, E.J., Ogendi, G.M. Moturi, W.N. and Nyawanga, D.O. (2019). Household water handling practices in the Arid and semi-arid lands in Kenya. *The relevance of Hygiene to Health in Developing Countries.*

Thai-Hoang, L., Thong, T., Thai Loc, H., Trang Van, P.T., Phuong Thuy, P.T., and Thuoc, T.L. (2022). Influences of anthropogenic activities on water quality in the Saigon River, Ho Chi Minh City. *Journal of Water and Health*. Vol. 20 (3), 491-504. Doi: 10.2166/wh.2022.233

Liyanage, C.P. & Yamada, K. (2017). Impact of Population Growth on the water quality of natural water Bodies. *Sustainability*. Doi: 10.3390/su9081405

Manga, M., Ngobi, T. G., Okeny, L., Acheng, P., Namakula, H., Kyaterekera, E., Nansubuga, I., & Kibwami, N. (2019). The effect of household storage tanks/vessels and user practices on the quality of water: a systematic review of literature. *Environmental Systems Research*, 18 (2021). https://doi.org/10.1186/s40068-021-00221-9

Meride, Y. & Ayenew, B. (2016). Drinking water quality assessment and its effects on resident's health in Wondo Genet campus, Ethiopia. *Environment Systems Research*. Vol. 5 pg.1

Munyao, M.J. (2018). *Water pollution in a Riparian Community: The case of River Athi in Makueni County, Kenya.* South Eastern Kenya University

Naliaka, B. (2014). *Factors influencing safe water and sanitation practices on community health in Kenya: A case of Kajiado Central District*. University of Nairobi

Ngechu. M. (2004). Understanding the research process and methods. *An introduction to research methods*. Nairobi: Acts Press

Nguyen, Q.A., Luc Hens, MacAlister, C., Johnson, L., Lebel, B., Tan S.B., Nguyen, H.M., Nguyen, N. and Lebel, L. (2018). Theory of Reasoned Action as a Framework for Communicating Climate Risk: A Case Study of Schoolchildren in the Mekong Delta in Vietnam. *Sustainability*. Vol. 10, **https://doi.org/10.3390/su10062019**

Nyairo, W.N., Owuor, P.O. & Kengara, F.O. (2015). Effect of anthropogenic activities on the water quality of Amala and Nyangores tributaries of River Mara in Kenya. *Environmental Monitoring and Assessment*. Volume 187, Number 11. ISSN 0167-6369

Olumana, M.D. (2018). *Safe drinking water: Concepts, Benefits, Principles and Standards. Water challenges of an urbanizing World.* Pg. 163-182. http://dx.doi.org/10.5772/intechopen.71352 accessed on 09/04/2019.

Onuoha, P.C., Alum-Udensi, O. & Nwachukwu, I.I. (2018). Impacts of Anthropogenic Activities on Water Quality of the Onuimo section of Imo River, Imo State, Nigeria. *International Journal of Agriculture and Earth Science.* Vol. 4 No.4

Osiemo, M.M., Ogendi, G.M., & M'Erimba, C. (2019). Microbial Quality of Drinking Water and Prevalence of Water-Related Diseases in Marigat Urban Centre, Kenya. *Environmental Health Insights.* Vol. 13. doi: 10.1177/1178630219836988

Pradinaud, C., Northey, S., Amor, B., Bare, J., Benini, L., Berger, M., Boulay, A.M., Junqua, G., Lathuillière, M.J., Margni, M., Motoshita, M., Niblick, B., Payen, S., Pfister, S., Quinteiro, P., Sonderegger, T., Rosenbaum, R. K. (2020). Defining freshwater as a natural resource: A framework linking water use to the area of protection natural resources. *Environmental Protection Agency*. Vol. 24(5):960-974.

Peiyue, L., Tian, R. Xue, C. & Wu, J. (2017). Progress opportunities and key fields for groundwater quality research under the impacts of human activities in China with a special focus on Western China. *Young Scholars in Earth & Environment Sciences*. Vol. 24 pg. 224-234

PLAN 2013-2017. *Planning for Sustainable Socio-Economic Growth and Development*. Kitui County 2015. http://cog.go.ke>downloads>category. Accessed on February, 18, 2019.

Ratemo, M.K. (2018). Impact of Anthropogenic activities on water quality: The case of Athi River, Machakos County, Kenya. *Journal of Environmental Science, Toxicology and Food Technology*. Vol. 12: (4) pg. 01-29

Sweetman, C. & Medland, L. (2017). *Introduction: gender and water, sanitation and hygiene, Gender & Development,* 25:2, 153-166, DOI: 10.1080/13552074.2017.1349867

Tagoe, N.D. & Mantey, S. (2017). Mapping the effects of anthropogenic activities in the catchment of Weija Reservoir using remote sensing techniques. *Ghana Mining Journal*. Vol. 17, No. 2, pg. 6-11

Thai-Hoang, L., Thong, T., Loc, T.H., Van, P.T.T., Thuy, P.T.P. & Thuoc, T.L. (2022). Influences of anthropogenic activities on water quality in the Sagion River, Ho Chi Minh City. *Water and Health*. Vol. 20 (3) pg. 491-504

UNICEF. (2020). *Strategy for Water, Sanitation and Hygiene 2016-2030.* New York: UNICEF.

United Nations (2015). *The Millennium Development Goals Report.* New York: United Nations

United Nations. Goal 7: *Ensure Environmental Sustainability*. 2013.

Uwimphuwe, M. Reddy, P. Barrat G. and Bux, F. (2014). The impact of hygiene and drinking water in Masaka, Rwanda. *Journal of Environmental Science and Health.* Vol. 49, pp 4434-4440

Wasonga, J., Okowa, M. and Kioli, F. (2016*).* Sociocultural Determinants to Adoption of Safe Water, Sanitation, and Hygiene Practices in Nyakach, Kisumu County, Kenya: A Descriptive Qualitative Study Job. *Journal of Anthropology*. Volume 2016, Article ID 7434328, 5 pages. Hindawi Publishing Corporation Journal

Weber, H. & Sciubba, J.D. (2019). The Effect of Population Growth on the Environment: Evidence from European Regions. *European Journal of Populations.* Vol, 35(2):379-402.

World Bank (2018). *The World Bank Annual Report*. Washington DC: World Bank

WHO/UNICEF (2011). *Drinking water equity, safety and sustainability: Thematic report on drinking water.* WHO/UNICEF. 2011

WHO/UNICEF. (2012). *Progress on Sanitation and Drinking-Water: 2012 Update*. Geneva, Switzerland: WHO/UNICEF; 2012.

WHO (2014). *Water-related diseases*. http://www.who.int/water sanitation health/diseases/en/.

Accessed Feb 2019

WHO (2017). *Safely managed drinking water - thematic report on drinking water.* Geneva, Switzerland: World Health Organization; 2017.

WHO/UNICEF (2017). *Progress on Drinking Water, Sanitation and Hygiene*. Geneva, Switzerland.

WHO (2019). *Water, Sanitation and Hygiene*. Geneva

WHO (2019). *Drinking water Newsletter*. Geneva

WHO (2019). *Drinking water World Health Organization Newsletter*. www.who.int. Accessed on 16/12/20.

Wutich, A., Budds, J., Eichelberger, L., Geere, J., Harris, M. L., Horney, A. J., Wendy J., Norman, E., O'Reilly, K., Pearson, A. L., Shah, S.H., Shinn, J., Simpson, K., Staddon, C., Stoler, J., Teodoro, M. P. and Young, S. L. (2017*). Advancing methods for research on household water insecurity: Studying entitlements and capabilities, socio-cultural dynamics, and political processes, institutions and governance*. https://doi.org/10.1016/j.wasec.2017.09.001 2468-3124/_ 2017 Elsevier B.V. All rights reserved.

http://www.who.int/phe/events/wha_66/flyer_wsh_water_borne_disease.pdf?ua=1. *Preventing waterborne disease Ensuring safe drinking water.* Accessed Feb 2019

Yang Fu and Wenyan, W. (2018). Behavioral informatics for improving water hygiene practice based on IoT environment. *Journal of Biomedical informatics*. Vol.78, Pages 156-166. Http://doi.org/10.1016/j.jbi.2018.11.006

Zhou, L., Appiah, R., Boadi, E.B., Ayamba, E. C., Larnyo, E. & Antwi, H.A. (2022). The Impact of Human Activities on River Pollution and Health-Related Quality of Life: Evidence from Ghana. *Sustainability*. 14, 13120. https://doi.org/10.3390/su142013120

Zoellner, J., Krzeski, E., Harden, S., Cook, E., Allen, K., & Estabrooks, P. A. (2012). Qualitative application of the theory of planned behavior to understand beverage consumption behaviors among adults. *Journal of the Academy of Nutrition and Dietetics*, *112*(11), 1774–1784. https://doi.org/10.1016/j.jand.2012.06.36

APPENDICES

Appendix I: - INFORMED CONSENT FORM

ANTHROPOGENIC ACTIVITIES AND THEIR INFLUENCE ON WATER SAFETY IN TSEIKURU WARD, MWINGI NORTH SUB-COUNTY.

INVESTIGATOR: Faith Mbithe Wambua

Introduction.

I am **Faith Mbithe Wambua** from the Institute of Anthropology, Gender and African Studies, University of Nairobi, conducting a study on **ANTHROPOGENIC ACTIVITIES AND THEIR INFLUENCE ON WATER SAFETY IN TSEIKURU WARD, MWINGI NORTH SUB-COUNTY.**

Purpose

The study pursues to explore anthropogenic activities and their influence on water safety in Tseikuru ward, Mwingi North Sub-County.

Procedure

If you agree to participate in the study, you will be of help in answering different questions on the study topic. You will answer question on what are the anthropogenic activities that influence water safety in the area, how is water collected, transported and stored, does it get contaminated by our different activities which we carry out around such occasions and what are the effects of these human activities on water safety and how best they can be solved to ensure water is safe to everyone and for survival of all. The study findings will help inform the community, the ward and the county government on the best way to curb such cases of water contamination.

Benefits

There will be no immediate assistance from the study, however, the findings will be given to the area chief, the ward administrator, Sub-County director in the Ministry of Water and any other body that works in the community to provide safe water. The findings on the anthropogenic activities and their influence on water safety will inform even the community on how they can do their best to use and access water safely without having to contaminate it making it unsafe for human consumption leading to poor health of the people.

Confidentiality

Your privacy will be maintained at all times. There shall be no mention of names or identifiers in the report or publications which may arise from the study.

Compensation

There will be no reimbursement for your participation in the study.

Voluntariness

Your contribution in the study is voluntary. If you choose not to participate, you will not be forced. You are also free to will also be free to pull out from the study at any time. Therefore, I kindly request your full cooperation.

Persons to contact

If you have any questions regarding the study, you can contact Faith Mbithe Wambua through telephone number 0713165995. You may also contact my supervisor Dr. Dalmas Omia of the Institute of Anthropology, Gender and African Studies at the University of Nairobi- telephone number 020-2082530

Your participation in the study will be highly appreciated.

APPENDIX II: IN-DEPTH INTERVIEW GUIDE

SECTION 1: Social demographic information

1	Age	18-30..... 30-50..... 50 and above…….
2	Gender	Male..... Female..... Other specify……
3	Occupation/Profession of parent(s)/guardian(s)	Formal…… Informal……. Business/Self-employed……. Unemployed…… Other specify……
4	Name of sub-location	Kitovoto……. Kasaini……..

SECTION 2: Anthropogenic activities and the influence on water safety.

1. Where do you fetch water in the area? Is water safe for consumption in each of the different water sources (earth dams, sand dams, boreholes and shallow wells)?
2. What are the anthropogenic activities practiced in the area that affects water safety?
3. How are people carrying out different activities at the point of collection at the water sources?

4. How is water transported from the source? What are the anthropogenic activities that influence water safety at the point of transportation? Do you think how water is transported is safe?
5. What are the anthropogenic activities that influence water safety at the point of water storage?
6. Do you think how people store water is safe for their health? Why?

Theme 2. Effects of anthropogenic activities on water safety

1. What are the known effects of unsafe water in the area?
2. What are other causes of unsafe water apart from anthropogenic activities?
3. Has there been an organization teaching on water safety? Which one? How did they carry out their training and how effective was the training?
4. Are there cases reported on the effects of these contaminated water? If any explain.
5. Which diseases are caused by unsafe water? How do people access health care, are there other ways of treatment apart from professional health care?

Theme 3: Mitigation measures on the effects of anthropogenic activities on water safety

6. In case water is unsafe, is there a way people clean it? How? Do you think it is safe after the procedure? Is there a cultural/religious practice of water purification?
7. What are some of the teachings taught on water safety either by Community Health Volunteer (CHV) or clinical officers? Do the teachings help people?
8. How best and suitable do you think can solve such a situation in a fit and acceptable way for everyone?

THANK YOU FOR PARTICIPATION.

APPENDIX III: KEY INFORMANT INTERVIEW GUIDE

Theme 1. Anthropogenic activities and the influence on water safety

7. Where do you fetch water in the area? Is water safe for consumption in each of the different water sources (earth dams, sand dams, boreholes and shallow wells)?
8. What are the anthropogenic activities practiced in the area that affects water safety?
9. How are people carrying out different activities at the point of collection at the water sources?
10. How is water transported from the source? What are the anthropogenic activities that influence water safety at the point of transportation? Do you think how water is transported is safe?
11. What are the anthropogenic activities that influence water safety at the point of water storage?
12. Do you think how people store water is safe for their health? Why?

Theme 2. Effects of anthropogenic activities on water safety

9. What are the known effects of unsafe water in the area?
10. What are other causes of unsafe water apart from anthropogenic activities?
11. Has there been an organization teaching on water safety? Which one? How did they carry out their training and how effective was the training?
12. Are there cases reported on the effects of these contaminated water? If any explain.
13. Which diseases are caused by unsafe water? How do people access health care, are there other ways of treatment apart from professional health care?

Theme 3: Mitigation measures on the effects of anthropogenic activities on water safety

14. In case water is unsafe, is there a way people clean it? How? Do you think it is safe after the procedure? Is there a cultural/religious practice of water purification?
15. What are some of the teachings taught on water safety either by Community Health Volunteer (CHV) or clinical officers? Do the teachings help people?
16. How best and suitable do you think can solve such a situation in a fit and acceptable way for everyone?

THANK YOU FOR PARTICIPATION

APPENDIX IV: FOCUS GROUP DISCUSSION GUIDE

Theme1. Anthropogenic activities and the influence on water safety at the point of collection, transportation and storage...

1. Where do you fetch water? Explain how you fetch water from the different sources (earth dams, borehole, sand dams and shallow wells)?
2. How is the quality of water in the different water sources you access water from?
3. What are some of the activities that affect water quality?
4. What are the anthropogenic activities practiced in the area that affects water safety?
5. How are people carrying out different activities at the point of collection at the water sources?
6. How is water transported from the source? What are the anthropogenic activities that influence water safety at the point of transportation? Do you think how water is transported is safe?
7. Do you store water? What are the anthropogenic activities that influence water safety at the point of water storage?
8. Do you think how you store water is safe for your health? Why?
9. To what extent do you think water safety is affected by anthropogenic activities?

Theme2. Effects of anthropogenic activities on water safety

1. What are the known effects of unsafe water in the area?
2. What are other causes of unsafe water apart from anthropogenic activities?
3. Has there been an organization teaching on water safety? Which one? How did they carry out their training and how effective was the training?

Theme 3: Mitigation measures on the effects of anthropogenic activities on water safety

1. In case water is unsafe, is there a way you clean it? How?
2. What are the teachings taught by Community Health Volunteers and clinical officers about water safety?
3. Do you think it is safe after the procedure?
4. What do you think can solve the issue?

THANK YOU FOR PARTICIPATION

APPENDIX V: UNSTRUCTURED OBSERVATION CHECKLIST

Observe the following:

Observation	**Activities**
1. How people fetch water	
2.Activities around water sources	
3.How is water transported	
4.How people purify water for consumption	