ECONOMIC AND HEALTH COSTS OF POOR DRINKING WATER, SANITATION AND HYGIENE ON HOUSEHOLD LIVELIHOODS IN JINJA CITY, UGANDA

BY

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A DISSERTATION SUBMITTED TO THE DIRECTORATE OF RESEARCH AND GRADUATE TRAINING IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTER OF SCIENCE DEGREE IN WATER AND SANITATION ENGINEERING OF KYAMBOGO UNIVERSITY

APRIL, 2024

DECLARATION

I, Tumwesigye James, affirm that my dissertation, "Economic and Health Costs of Poor Drinking Water, Sanitation and Hygiene on Household Livelihoods in Jinja City, Uganda," is entirely original with no submissions to other universities to receive a degree. This dissertation utilized literature from journals and articles which was properly referenced and cited.

Sign…….

Tumwesigye James

Date: …….

APPROVAL

The undersigned certify that they have read and hereby recommend for acceptance by Kyambogo University a MSc dissertation titled **"Economic and Health Costs of Poor Drinking Water, Sanitation and Hygiene on Household Livelihoods in Jinja City, Uganda"** in partial fulfilment of the requirements for the award of a degree of Master of Science in Water and Sanitation Engineering of Kyambogo University.

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ABSTRACT

The largest tropical freshwater lake in Africa, Lake Victoria, provides both food and drinking water to the people of Jinja City and the surrounding area. However, increasing industrial waste and urban wastewater discharges have affected her water quality. This research was majorly aimed at determining the financial and health impacts of insufficient drinking water, sanitation, and hygiene (WASH) on household livelihoods in Jinja City. The specific objectives were: to assess the WASH conditions in Jinja; to determine the relationship between water quality, the ease of access to water sources and household livelihoods in terms of disease prevalence rates and to assess the effect of existing and improved sewer treatment techniques on household livelihoods. Data from 18 Key Informant Interviews (KIIs) and 285 household surveys were collected utilizing both qualitative and quantitative methods as part of the study's cross-sectional and descriptive research approach. The average WHO-acceptable water turbidity of 5 NTU (17 °C) was exceeded in every water sample test result, which is required for the survival and transmission of V. cholera. 66% respondents said that the incidence of water-related diseases had a significant influence on household livelihoods. The quality of water conditions was thus perfect for the spread of waterborne diseases including cholera, diarrhoea, typhoid, and others. Existing data shows that diarrhoea was a contributing factor in 3.4% of all fatalities between 2018–2019. Uganda spends about 1-2.5% of its GDP on WASH related diseases and an average household spends about shs 500,000 on water related diseases. Secondary data provided for Jinja from NWSC for Kirinya pond showed that some parameters like EC, BOD were not up to standard thus sewer treatment techniques are not so effective. There’s an urgent need to seek alternative but cheaper sewerage treatment techniques. Ugandan's livelihoods thus are significantly impacted by the economic and health implications of inadequate WASH. Health, water, and hygiene awareness campaigns should be carried out to make sure that those who frequent water sources adhere to the standard practices. Safe distances from water sources when digging pit latrines and proper wastewater disposal from industrial parks and factories.

Keywords: Economic and Health Costs, Poor Drinking Water, Sanitation and Hygiene, Household Livelihoods, Jinja City

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LIST OF ABBREVIATIONS/ACRONYMS

AHSPR	Annual Health Sector Performance Report
EED	Environmental Enteric Dysfunction
DALY	Disability-adjusted life year
FGDs	Focus Group Discussions
GDP	Gross Domestic Product
KIIs	Key Informant Interviews
MDGs	Millennium Development Goals
MLE	Maximum Likelihood Estimator
MoH	Ministry of Health
NEMA	National Environment Management Authority
NFA	National Forestry Authority
NGOs	Non-Governmental Organisations
NWSC	National Water and Sewerage Corporation
OLS	Ordinary Least Square Procedures
SAQ	Self-Administrated Questionnaire
SCBA	Social Cost-Benefit Analysis
STH	Soil-Transmitted Helminth
UBOS	Uganda Bureau of Statistics
UNICEF	United Nations International Children's Emergency Fund
USD	United States Dollar
VIPs	Ventilated Improved Pit Latrines
WASH	Water Sanitation and Hygiene
WfP	Water for production
WHO	World Health Organisation
WSP	Water and Sanitation Program

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DEDICATION

I commit this dissertation to my darling spouse, kids and my Parents whose establishment and motivation this accomplishment stands.

CHAPTER ONE: INTRODUCTION

1.1 Background to the study

Significant efforts have been made to increase access to sanitary facilities and clean water for a long time, primarily by governments, business entities, and outside development partners (Laura *et al.*, 2017). More than 25 of the 100 cities with the highest population growth worldwide are in Africa. It is anticipated that by the end of 2030, the continent's urban population would have increased by 58% (African Development Bank, 2024), with Sub-Saharan Africa being the least urbanized but fastest urbanizing area around the globe. Despite the impact this rapidly growing urban population in Africa is continuing to put on already overburdened social service delivery systems, the majority of people only need 7.5 liters of water per day in the majority of situations (WHO, 2017). Acute housing shortages, pollution, unchecked peri-urban development, poverty, and inequality have made the situation worse (World Bank, 2017).

As per the year 2022, 4.6 billion people had access to proper sanitation facilities. However, 1.5 billion people do not have access to well managed sanitation systems. Of these 419 million still perform open defecation and 44% of wastewater coming from households was emitted without treating it safely. Diseases have resulted such as diarrhoea. A total of 395,000 deaths for children under five years were registered in 2019 due to poor water, sanitation and hygiene (WHO, 2024).

The population of Uganda occasionally lacks access to drinking water despite the country's abundant surface and groundwater resources (Mutono *et al.,* 2020). It has been estimated that 3 out of 10 Ugandan households do not have a latrine, 8% of mothers with children under 5 have soap and water readily available for hand washing (UNICEF Uganda, 2022).

Uganda’s proposed expenditure on WASH is 1045 billion in the financial year 2023/24 (UNICEF Uganda, 2023). Costs which are brought about by poor WASH services include: loss in productivity that occurs when people are ill and need care and the time lost traveling between villages in search of water services (World Bank, 2015). About 8 million Ugandans don’t have admittance to safe drinking water and thus more than 4,500 young children below the age of five pass away every year from diarrheal diseases (World Vision International, 2021). A deeper

study into the economic and health costs of poor WASH on households' livelihoods in Jinja city was thus expedient.

1.2 Statement of the problem

In 2016, there were 1.9 million deaths and a loss of 123 million disability-adjusted life years (DALYs) due to diseases related to water, sanitation, and hygiene (WASH), accounting for 4.6% and 3.3% of all deaths worldwide, respectively (WHO and UNICEF, 2017). Nearly 830 000 of these deaths are caused by diarrheal disease. World Vision-Uganda (2021) revealed that over 4,500 children below the age of five pass away every year from diarrheal diseases due to polluted water and insufficient sanitation practices, and that an estimated 8 million Ugandans lack access to drinkable water. Only 8% of women in Uganda with children under 5 years have access of soap and clean water for handwashing (UNICEF Uganda, 2022) while 31% of the population has a handwashing facility with soap and water available at home (UN WATER, 2024). Despite unwavering efforts and significant financial investments in water and sanitation infrastructure by the government and NGOs, there are still significant gaps in the provision of improved water sources and the prevention of the financial and health consequences associated with subpar drinking water and sanitation. Additionally, hundreds of people continue to rely on contaminated water sources and lack adequate sanitary facilities and wastewater disposal systems. There is a chance that the number of WASH-related deaths in Uganda would rise if this problem is not handled right away. This study was conducted to close this gap, analyze its consequences on the economy and health, and provide affordable alternatives to current wastewater treatment methods to lessen these effects in Jinja City.

1.3 Objectives of the study

1.3.1 Main objective

The main objective of this study was to evaluate the financial and health effects of insufficient WASH on household livelihoods in Jinja City, Uganda.

1.3.2 Specific objectives

i. To determine the water quality and nature of sanitation and hygiene conditions in Jinja (Physico-chemical characteristics, sewer treatment techniques and Feacal cleanliness).
ii. To determine the relationship between household livelihoods (disease burden, high medical expenses) and water quality (Physico-chemical characteristics).

iii. To determine the relationship between household livelihoods (disease burden, high medical expenses), hygiene (personal hygiene, faecal cleanliness and handwashing with soap and sewer treatment techniques.

1.4 Research Questions

i. What are the conditions for sanitation, hygiene, and water quality in Jinja?
ii. What is the relationship between household livelihoods (disease burden, high medical expenses) and water quality (Physico-chemical characteristics)?
iv. What is the relationship between household livelihoods (disease burden, high medical expenses), hygiene (personal hygiene, faecal cleanliness and handwashing with soap and sewer treatment techniques.

1.5 Justification of the Study

Furthermore, SDG Goal 6 which is aimed to ensure availability and sustainable management of water and sanitation for all by 20230 (UN Uganda, 2024). It has been noted that millions of people have been and continue to be at risk of socioeconomic and health problems as a result of poor drinking water, sanitation, and hygiene. This WASH inadequacy also contributes to a high burden of illness on the worldwide population. Even though Jinja district is on the River Nile, the lack of adequate water infrastructure, such as tap water supply and proper hygiene and sanitation facilities, leaves much to be desired. Against this backdrop, the current study is being conducted to evaluate the financial and health effects of inadequate drinking water and sanitation on livelihoods in Jinja City to suggest potential solutions.

1.6 Significance of the study

It is significant to highlight that a thorough investigation of the negative consequences of inadequate drinking water and sanitation on livelihoods on the economy and health aids in changing people's attitudes regarding sanitation, hygiene, and educational practices. The results of this study will thus make significant contributions to the body of literature on developing programs and policies to counteract the negative economic and health implications of inadequate drinking water, sanitation, and hygiene. The study's findings will serve as information and a reference point for planners and policymakers as they work to mitigate the effects of poor drinking water quality and propose low-cost alternatives to current sewer treatment methods that will greatly enhance the sanitation in Jinja City's urban and rural settlements. Additionally, the findings of this research would give NGOs, community-based organizations, and other stakeholders including other researchers insight into how to conduct

additional research studies on water access and sanitation improvement that the current study might not have fully explored.

1.7 The scope of the study

1.7.1 Content Scope

The study was only able to evaluate three key variables: economic costs, health costs, and impacts on livelihoods of inadequate drinking water and sanitation.

1.7.2 Geographical Scope

The study was carried out in Jinja City specifically in Walukuba, Lubaga and Masese. Jinja district lies in the Eastern region of Uganda bordering Buikwe, Iganga, and Kamuli. The map in Figure 1.1, shows study areas in Jinja

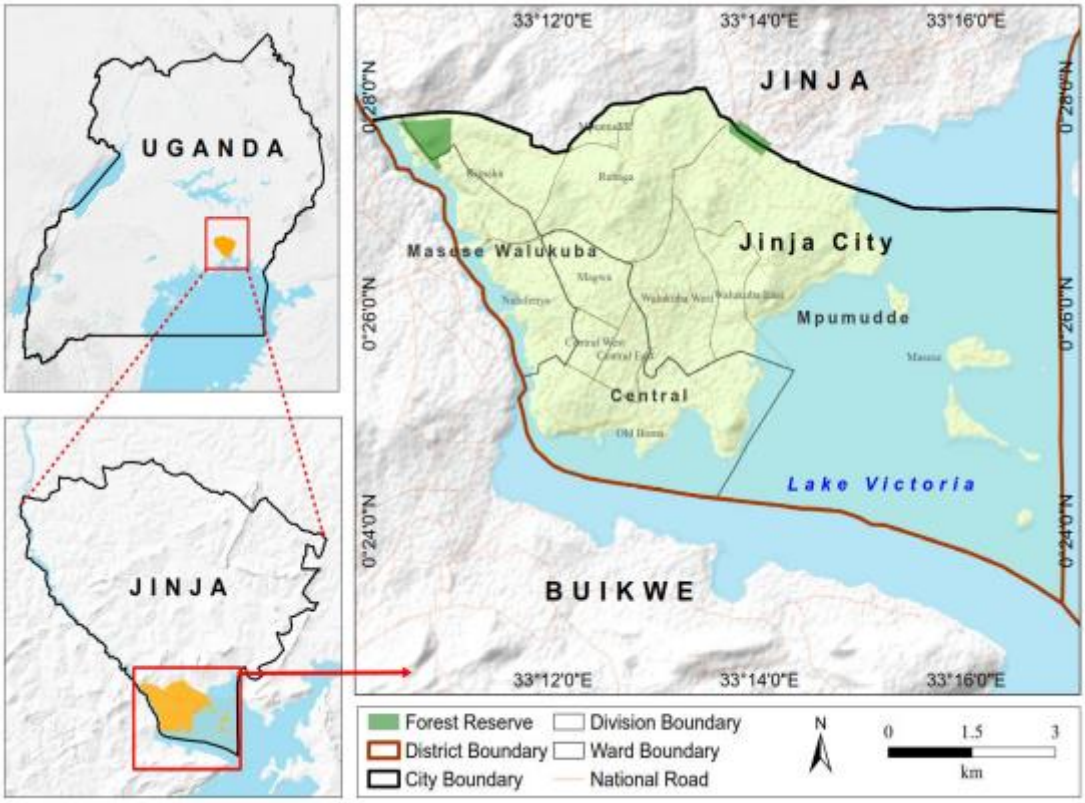

Figure 1. 1: Map of Jinja City showing Study Areas

1.7.3 Time Scope

The study done in just 11 months from January 2021- November 2021.

1.8 Conceptual Framework

The connection between the study's independent and dependent variables is shown in from various literature sources reviewed, the framework shows how various independent variables

(Disease prevalence rate, income, expenses and their effects on productivity, Trend of diseases by time and its effects, Life holder of people variations among different classes of the population and alternative cheap sewer treatment techniques) and how they influence the dependent variable (Effects on Household Livelihoods). The illustration of how to predict the antecedents of economic and health costs of poor drinking water and their effects on household livelihoods in Jinja City is given in Fig. 1.2.

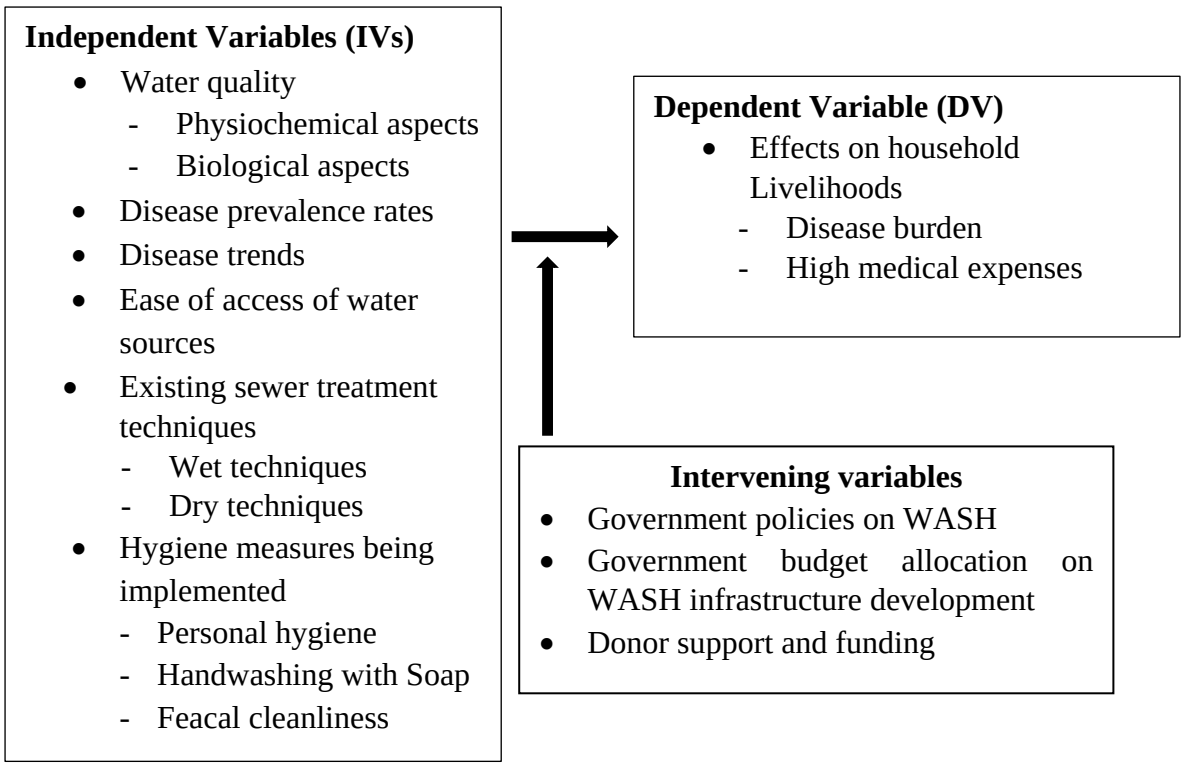

Figure 1. 2 Conceptual Framework

1.9 Chapter One summary

The problem statement, aims, importance, rationale, and conceptual framework of the investigation were all covered in the introduction to the study, which was provided in Chapter 1. This study sought to evaluate the economic and health cost of inadequate drinking water, sanitation, and hygiene (WASH) on household livelihoods in Jinja City, Uganda, with the following specific goals in mind: to evaluate the nature and quality of Jinja's WASH conditions; to assess the water quality and nature of sanitation and hygiene conditions in Jinja; to determine the relationship between water quality, the ease of access to water sources and household livelihoods and to assess the effect of existing and improved sewer treatment techniques on household livelihoods. This study's review of the literature is presented in Chapter 2.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter contains evaluated material from scholarly journals and internet sources. The literature review has been organized as par the study's specific goals, which are described in this article.

2.2 Existing WASH conditions in Africa

In a study which analysed environmental factors influencing endemic cholera risks in sub-Saharan Africa, a stratified model was done which showed a relationship that an increase in water provision led to a reduction in cholera risk from 4.2 % to 84.1 %. 9.8 % to 68.9 % reduction was noted when there was increased sanitation provision. This meant that water access, sanitation provision, rising temperatures, and increased rainfall were important factors which were contributing to endemic cholera incidence in the sub-Saharan region (Behzadian, et al., 2024). This model however did not highlight aspects of hygiene and its relationship to cholera spread.

A state of WASH conditions for countries in war torn areas of West Africa like Mali, Cote d'Ivoire, Senegal, Sierra Leone, Liberia and Nigeria was done. Women accessed better WASH services than and urban populations too than rural populations. Mali had the highest access to hygiene while Nigeria had the highest access to safe water. It was concluded that integrated WASH programmes with combined infrastructure development, behaviour change campaigns and community engagement should be encouraged to ensure peaceful and sustainable access to WASH levels (Aboah, 2024). This research however did not attempt to determine the relationship between existing WASH conditions and WASH related disease prevalence rates.

Gender perceptions on the spread of WASH diseases was explored in literature particularly in southwestern Uganda. The findings revealed that men who practiced farming thought that bilharzia is a lake-side problem and women performing activities like washing utensils were exposed to bilharzia easily. It was therefore important that interventions such as providing male and female toilets, carrying out gender-sensitive treatment campaigns, and encouraging decisions made by both genders would help curb the disease spread (Mugabi, et al., 2024). However, most of these findings too were people perceptions and not based on empirical data.

It was determined revealed that 24% of health facilities were found to have soap and water at water points, 38% had handwashing facilities at toilets and that hospitals had a toilet patient ratio of 1:63. It was concluded that more focus was supposed to be on sustainable provision of hygiene amenities like soap for handwashing particularly the high patient volume health care facilities (health centre IVs and hospitals) (Mulogo, et al., 2018). Although literature has information on WASH done on health facilities in South Western Uganda, not much has been done at the household level in Uganda.

2.3 Effect of water quality, the ease of access to water sources on household livelihoods in terms of disease prevalence rates

2.3.1 The disease prevalence rates and household livelihood

Investments in sanitation that adequately preserves human health would greatly benefit urban residents, especially those living in slums. Poor sanitation has a very large cost to the economy. Inadequate sanitation cost India about US$ 53.8Billion which was equivalent to 6.4% of India's GDP in 2006. This meant that a person annual impact amounted to US$ 48. In Cambodia the economic costs amounted to US$ 9.2 Billion a year in 2005 in Cambodia, Indonesia and Philippines. 79% of the premature mortality-related economic losses under health impacts (US$ 29billion) was due to deaths and diseases in children below five years. Diarrhoea in children below five years accounted for more than 47% of the total health-related economic impacts (Water and Sanitation Program, 2006). According to estimates, every dollar consumed on better water and sterilization created a fourfold return in the form of lower health care expenses. According to estimates made for India, the additional investment needed to achieve improved sanitation would open up new markets for goods and services (Kim *et al.*, 2016). Accordingly, emerging nations with increased access to water saw average annual growth of 3.7% as contrasted to developing nations with the same per capita revenue but limited access, which experienced yearly growth of 0.1% (WHO, 2015).

Each household lost around 409 rupees as a result of diarrheal sickness. Community under study suffered a total loss of 163,600 rupees or USD$ 3,635. To determine the socioeconomic conditions of each home, including their access to water and cleanliness, the researchers first carried out a random inspection of all households. A comprehensive longitudinal survey of all families afflicted by diarrheal illnesses was conducted after this for five weeks. It was

concluded that investing in better water and sanitation infrastructure was key since the cost of diarrheal infections is too expensive to ignore (Patel *et al.,* 2013).

As a way to ascertain the financial influences of malnutrition on Cambodian youngsters that are younger than five and expecting mothers. The value of the economic losses caused by malnutrition was estimated nationally by the investigators using a consequence model and the coefficient risk-deficit. According to the findings, malnutrition costs Cambodia's economy $266 million annually or 1.7% of GDP. To interrupt the existing cycle of rising mortality, bad health, and eventually decreased job performance, productivity, and profitability, the researchers urged the government to extend a variety of affordable, effective nutritional therapies (Moench *et al.,* 2016).

2.3.2 The diseases prevalence, personal hygiene by time and their effects on household livelihood

Esray *et al.,* (1991) investigated the impacts of various water supply, sanitation, and hygiene education programs using 144 papers in a meta-analysis. In comparison to water quality or quantity initiatives, they discovered that sanitation provision and hygiene education result in a median reduction in diarrheal occurrences that is approximately twice as large. They claimed that initiatives to enhance excreta disposal and water quality have a bigger overall benefit than those that focus just on improving water quality. Only when hygiene was better and water was optimally supplied could better water supply benefits materialize.

Estimates state that inadequate WASH caused 842,000 deaths from diarrhoea in 2012. This accounted for more than 50% of all diarrheal illnesses and was thought to be the cause of 1.5% of all disease problems, according to Prüss-Üstün *et al.* (2014). The WHO (2015) reported that treating water at the point of use and storing it within the home reduces the risk of diarrhoea disease by only 28%, compared to carefully controlling piped water from an improved point source.

Pruss-Ustun *et al*. (2014) approximate that poor sanitation and cleanliness are to blame for 4% of all mortality and 5.7% of all illnesses worldwide. According to the WHO (2015), over 1.5 million children below the age of five die each year as a result of poor sanitation. Services that

flush into a septic tank, pit latrine, vented pit latrine, pit latrine with a slab, or composting toilet are deemed to have "improved sanitation" for this study.

In a study on the uptake of community health entrepreneurs for febrile illness and diarrhoea in Bunyangabu district, a community perspective on services provided by Community Health Entrepreneurs (CHEs) for febrile illness and diarrhoea in rural Uganda was done. It was shown that CHEs play a considerable role in delivering primary healthcare including the provision of medication for fever and diarrhoea in the rural areas in which they are active (Hoeven , et al., 2024).

2.4 Sewer treatment techniques

Water and sanitation techniques can be divided into two parts, one with dry technique and the other with wet technique. The dry technique includes pit latrines, VIP, septic tanks and ecological sanitation. Dry sanitation is used in areas with little or limited water resources and is used in many African countries. The wet sanitation technique includes flush toilets and requires a continuous water supply and connection to a sewage system which is often used in Western countries.

2.5 Gaps Identified in the Literature

Several studies have been done on Lake Victoria. It has been noted that the water quality of Lake Victoria has been affected by amplified releases of municipal effluents and industrial wastewater. Limited literature however exists on what is the Economic and Health cost this contamination has on households' livelihoods in Jinja city, Uganda. This study is aimed at closing that gap.

2.6 Summary of Literature

Table 2. 1 Summary of literature review

S/N	Topic/Area	Source	Key Findings
1.	WASH investment	(Kim *et al.*, 2016).	Improved sanitation may demand greater investment, which might open up new markets for businesses.
2.	Health costs	Patel *et al.* (2013)	Diarrhoeal illnesses are too expensive to ignore.

The summary of literature is stated in Table 2.1. The proceeding chapter contains the methodology of the study.

CHAPTER THREE: METHODOLOGY

3.1 Research design

As part of the descriptive research approach for the study, both qualitative and quantitative methodologies were used to collect data. The descriptive design explains what is there and could assist in the discovery of new information and significance (Mugenda and Mugenda, 1999). A quantitative approach is the best type of design because it allows the researcher to gather information from a non-homogeneous entity and use structured data collection tools that fit a variety of experiences into predetermined response categories that are simple to compare, summarize, and generalize (Amin, 2005).

Using livelihood and economic assessment approaches including social cost-benefit analysis and cost-effective analysis, the study also determined the monetary and health consequences of ingesting contaminated water in Jinja City. In a cost-effectiveness analysis, the relative overheads and impacts of two or more courses of action are compared. In the health sector, a cost-effectiveness analysis was used to quantify the additional health outcomes linked to specific expenditures, with the direct use of resources from the health sector serving as the measure of cost. The cost-effectiveness of an intervention is calculated, according to the WHO (2015), by deducting US dollars from the number of cases, deaths, and disability-adjusted life years (DALY) that are avoided. Because it was an academic study with a constrained budget and time frame, this study solely used social cost-benefit analysis (SCBA), which has substantial issues when dealing with larger livelihood benefits.

"Social cost-benefit analysis" (SCBA) is the name of a paradigm that makes it possible to compare different treatments and obtain nuanced outcomes. On the choice of the best or most cost-effective option, it entails comparing the whole predicted benefits of one or more actions against the total expected costs, either explicitly or implicitly. In a full SCBA, all costs and benefits—whether or not they have a market price—must have values. The analyst must select a price (a shadow price) when there is no obvious market price or when the market price is considerably altered by a large public or private agency. The analyst must be open and honest about the assumptions used to determine the value of the shadow pricing.

SCBA was used to depict future costs and benefits of actions in present-day (year zero) monetary terms to deal with changing patterns of costs and benefits over time. The "present values" of the costs and benefits among different classes of people were calculated by applying

a rate of discount to costs and benefits accruing in the future, with Masese as the lowest earners, Lubaga as the middle earners, and Walukuba as the highest earners in Jinja City. This was done to account for the value of time. In addition, using the SCBA, the study was able to rank the costs of different interventions were done to improve access to safe drinking in Jinja City by producing ratios of benefits to costs. Most data that was used in SCBA was obtained from secondary data sources from the Jinja City water department.

3.2 Quality and nature of water, sanitation and hygiene conditions in Jinja

3.2.1 Testing of water samples from different water sources

The common places that are frequented by the locals to collect water, including the banks of the River Nile, the coasts of Lake Victoria, springs, and surface water (open wells), were utilized to gather the water samples. Thirty-eight samples were taken both during the wet and dry seasons to evaluate the physicochemical characteristics of the water and any health concerns that would affect Jinja City families' ability to support themselves. Throughout two lengthy research periods, one in the dry season (January 2021) and the other in the rainy season (November 2021), water extracted from these sources was studied. The results of these tests enabled a detailed examination of water quality features and identification of water consumption patterns. Similar to this, field meters from the Makerere University School of Public Health, such as the Tetracon 96A-4 meter, WTW oximeter for temperature and dissolved oxygen (DO), as well as WTW pH meter, were used to measure the pH, temperature, dissolved oxygen (DO), conductivity (CD), and turbidity of water samples. The summary of tests and procedures of testing the water quality parameters is provided in the appendix.

The data was cleaned, recorded, and kept in the spreadsheet. The right data were obtained from the internal memory of the Hach meters' HQ40d to repair errors in the recorded readings from water samples. Then, data was transferred from an Excel spreadsheet to SPSS version 20 for quick data analysis to provide means and standard errors of the means for the test outcomes. The results were then subjected to Turkey's Post Hoc test to see whether factors were statistically significant.

3.2.2 The nature of water, sanitation and hygiene conditions in Jinja

3.2.2.1 Study area and population

The investigation was carried out in Jinja City, which lies in the Eastern region of Uganda bordering Buikwe, Iganga, and Kamuli. The reason Jinja City was chosen is that it is one of the fastest growing cities, has a high level of new infrastructure development, including

buildings and roads that connect to various parts of Eastern Uganda at the same time, is situated at the source of the River Nile, but most of the households lack access to safe drinking water and proper hygiene. The study targeted households in Walukuba who are considered high-income earners, those in Lubaga who are considered middle-income earners and lastly, those in Masese who are considered as lower income by the city standards.

3.2.2.2 Sampling procedure

a. Sample Size Determination

Any research or inquiry where the objective is to infer information about the populace from a sample must include sample size determination, a method for determining how many observations to include in the sample (Singh and Masuku, 2014). From a total of 19,491 homes in Jinja city, in order to get the targeted households, households headed by children (aged 10-17) which is 109 were subtracted from actual households since the researcher selected study participants who were 18 years and above years to remain with 19,382 (UBOS, 2017). According to recognized and published tables (Singh and Masuku, 2014; Krejcie and Morgan, 1970), A sample size was determined using 384 households as the representative sample (see Appendix 1). Table 3.1 below provides a summary of the population categories that were chosen for the sample size.

Table 3. 1 Sample size determination

Category of respondents	**Target population**	**Sample size**
NWSC Officials in Jinja City	8	4
Jinja City health and administration officials	12	8
NGO and private partner officials	6	4
Water user committee members	12	8
Household Respondents	19,382	384
Total	**19,416**	**408**

3.2.2.3 Sampling Techniques

Alvi (2016) defines sampling as the procedure used to take a sample from a population. This is done mostly because it is hard to evaluate every component of a population during an inquiry; thus, a group of individuals or items is chosen for evaluation. To choose the research

participants, systematic and purposeful random selection approaches were utilized. When using purposive sampling techniques, sample units were chosen based on the goal. Only a few particular uses of this approach were reported (Singh and Masuku, 2014).

Additionally, a homogeneous population would adopt the systematic random sampling approach (Alvi, 2016). The initial element of the sample is chosen at random and the other units are chosen systematically in this sampling technique. R = N/n, sometimes referred to as the sampling interval, is the formula used when there are N units in the population and n units are to be picked. According to Singh and Masuku (2014), the starting number is taken at random from the rest of this R (Sampling Interval) to the previously determined number.

In a similar vein, Alvi (2016) emphasized that systematic random sampling, unlike simple random sampling, does not guarantee that every element would be included and that the sampling of the elements was based on predictable gaps in time between various houses. To choose the respondents who will take part in their investigations, these sampling strategies have been used in multiple studies (UBOS, 2017). In this study, the key informants were chosen using purposive sampling, while other categories for the quantitative procedures were chosen using systematic random sampling.

3.2.3 Data Collection Methods and Instruments

The investigator employed the following data-gathering techniques in this investigation. The following list of methods is used: (i) house survey; (ii) interview; (iii) focus group discussion; (iv) reconnaissance survey; and (v) document review:

a. Household Survey

In this approach, a self-administrated questionnaire (SAQ) was created and given to household respondents in Jinja city to get their opinions on the financial and health consequences associated with inadequate sanitation and drinking water in their neighbourhoods. This approach was utilized in the study because it allows for the fastest and least expensive data collection from a large population. Additionally, the questionnaire aids in information collecting that guarantees enough and reliable data are gathered, according to Mugenda and Mugenda, 2009.

b. Key informant Interview

The interviewing approach was used in the study because it produces extensive data and allows respondents to request clarification if necessary if they do not understand a question asked of them during the interview process. Additionally, thorough interviews provide prompt feedback. This approach involved face-to-face interviews between the investigator and carefully chosen key informants, including representatives from the NWSC, Jinja City authorities, NGOs, and water-related corporate partners. These respondents were chosen because it was believed that they would be knowledgeable and skilled about issues related to water and sanitation in the research region.

c. Focus Group Discussion

This method was used to gather information from carefully selected respondents especially water user committee members in Jinja. The method was guided by a focus group discussion guide to keeping the group focused on the issues under investigation while allowing various views and opinions of the respondents. The researcher conducted four (4) FDGs with men, women, youth females and youth males where each group contained 10 participants. The researcher moderated the discussion to ensure a coherent and focused discussion where all participants were encouraged to give their views and avoided a situation where few members dominated the discussion. In addition, the researcher trained a research assistant who assisted in taking notes during sessions and ensuring that no information was missed during discussions, the researcher asked the participants to allow audio recording and then transcribing the recorded FGDs into notes for easy report writing.

d. Reconnaissance surveys

By giving the researcher useful information, such as the location of water points, the varied ways to access water points, and the quantity and quality of water from various water sources in Jinja city, this technique included a quick assessment of the study region. Additionally, it involved observing and documenting socioeconomic and bio-physical traits that are connected to the financial and health effects of inadequate admittance to clean water and sanitation, and this information was crucial in completing the data obtained from surveys, interviews, and the review of secondary data (Pido, 2014).

e. Documents review

The information was gathered from the documentation on the local, national, and global levels that dealt with the consequences to the economy and public health of inadequate sanitation, drinking water, and sewer treatment options in Jinja City and the Jinja area. This information was gathered from internet sources, ministry water and environmental reports, NWSC Reports on water usage and sewerage disposal, unpublished research work, newspapers and journals.

3.2.4 Response rate

The study covered 209 respondents for quantitative data and 24 respondents for qualitative data (key informants). The researcher distributed 384 household surveys among household respondents and 285 were filled and returned out of 24 planned interviews with key informants, only 18 were successfully conducted as the remaining key informants were busy with other office duties and out of the office by the time of interviews. The information about the field work response rate is presented in Table 3. 2.

Table 3. 2 Response Rate

Categories	**Planned interviews**	**Actual done**	**Response Rate**
Qualitative (Key informants)	24	18	75%
Quantitative	**Questionnaires were given out**		
Household surveys	384	285	74%

The results in table 4.8 indicate that out of 24 planned key informant interviews, 18 appointments were fulfilled and interviews successfully conducted making a 75% response rate. For the quantitative data, out of 384 household surveys that were distributed, 285 questionnaires were answered correctly and completely, making a response rate of 74%.

3.2.4.1 Discussion

Therefore, the 74% average response rate for this study is excellent.

3.2.5 Data Analysis for objective one

a. Descriptive Data Analysis

The content analysis of the findings from all the data-collecting instruments, including the interview guide and the documentary checklist, was done using qualitative information from key informants. Verbatim quotes from the main responders served as additional examples for the analysis. Household surveys were edited and coded before being placed into the Statistic Package for Social Sciences (SPSS, version 20) computer program for quantitative data

analysis. To demonstrate household characteristics and demographic behaviour, the study used descriptive statistics. It primarily serves to contrast and compare various demographic characteristics and other socioeconomic factors that have an impact on health, sanitation, and drinking water. Tabulation and cross-tabulation, frequency, percentages, and computation of descriptive statistics like mean and standard deviation were some of the particular techniques used for data analysis. While descriptive statistics like frequencies, percentages, means, and standard deviations were used to assess the empirical data following the research's objectives, inferential statistics like correlation coefficients and regression were used to ascertain the statistical significance of the study variables.

3.3 Effect of water quality, the ease of access of water sources on disease prevalence rates on livelihood

A number of approaches have been used to achieve good water quality and reduce on disease prevalence rates and improve people's livelihoods. However, some water related diseases are still reportedly high in Jinja. Quantitative information about the population's demographics, such as the respondents' ages, genders, highest levels of education, main sources of income and water for households, distances between sources, perceptions of the cost of water among households, gender of the household head and the type of toilet facility, the accessibility of water washing facilities on latrines, and the availability of necessities at the household level, was determined.

3.3.1 Data collection

Data collection techniques, sampling and methods were obtained as indicated in section 3.2.2.

3.3.2 Data analysis for objective Two

3.3.2.1 Social cost-benefit analysis (SCBA)

The study obtained secondary data from the Jinja City water department and NWSC offices on different water projects, their costs and the time when such interventions were completed. Then using SCBA, the present value of benefits and costs of such interventions were calculated. One of SCBA's main benefits is that it can be used to assess public spending decisions to more effectively allocate limited resources by comparing all benefits to all costs in terms of the discount rate, discounted costs, and discounted total benefits; therefore, since data analysis revealed a benefit/cost ratio greater than 1, the study's findings were deemed to have social value.

3.3.2.2 Econometric Model Analysis

(i) Model Estimation Procedures

One of the study's primary goals is to investigate the financial and health effects or ramifications of Jinja City's poor sanitation and drinking water. By using a binary choice model to demonstrate the link between research variables and their statistical significance on family livelihood situations, it was possible to collect these measurements and parameters. When the dependent variable is completely observed, it indicates that the zeros are real zeros that accurately reflect the selection of the variables being studied. One can represent non-continuous explanatory variables as dummy variables and do non-linear regression analysis when this is the case.

When the dependent variable is binary, a binary choice model presupposes that people are offered a choice between two possibilities. Therefore, selecting one of the options would achieve a specific objective in a qualitative assessment with a particular set of attributes. Numerous techniques can be used to examine data with binary outcomes. When the error term is normally distributed, the maximum likelihood estimator (MLE), which employs ordinary least squares (OLS), beats the probit model, which necessitates the maximum likelihood method, asymptotically.

The probit MLE is consistent and hence more accurate if the error component is not normally distributed in y as opposed to the discriminant analysis estimator, which is inconsistent (Wooldridge, 2014). Ordinal least squares (OLS, from now on), the preferred approach of the estimate, may not be suitable due to the features of this dependent variable (Frazier *et al.*, 2020).

A thorough analysis of papers published in five prestigious management journals between 1980 and 2015 was done to support Probit models, and it was shown that around 47% of the studies include possibly false assumptions regarding the nature of zeros. According to the study, probit models may be used to address selection bias issues as well as potential homoscedasticity and normality violations in the residual distribution. Probit models assert that to properly comprehend the level of the variable when it assumes positive values, it is also necessary to comprehend the variables determining whether or not the observed dependent variable is censored.

According to Abebaw (2003), probit has an advantage over other models in the analysis of dichotomous outcome variables since it produces a meaningful interpretation and is incredibly versatile and simple to use mathematically. The probit model can provide an answer to the query regarding a small dependent variable. A binary value for Y is Y (0.1). According to Verbeek (2004), a typical normal distribution has the following characteristics for its density: a mean of zero, a variance of one:

$$Ø\ (€) = \frac{1}{\sqrt{2\pi}}\ \exp\ (-\frac{\epsilon^2}{2}) \quad \text{.....(1)}$$

Where Ø=cumulative standard normal distribution function

As noted in equation (1), then the general model expression can be as follows:

$$Y^* = \alpha + \beta X' + \varepsilon$$

.....(2)

with $\varepsilon|X \sim N(0; \delta^2)$ with $y = y^*$ if $y^* > 0$, and $y = 0$

Otherwise it is referred to as a latent variable when y is the relevant observable variable and y* is an unobserved variable. Three things are stated in Equation (2). First, X is predicted to have a monotonic influence on y*. Second, a normal distribution is followed by the residuals. Third, according to Dufour and Wilde (2018), the dependent variable is left-censored. A mathematical model is used to infer latent variables, which are different from observable variables, from other observed (directly measured) variables.

In this study, if Y* > 0 marginal economic and health costs of poor drinking water are greater than zero. Hence, the economic and health effects of poor drinking water and sanitation are more likely to increase household expenditure on accessing safe water, treatment of sick household members and increased health challenges that hinder household livelihoods. The vector of explanatory factors known as X' is intended to determine the indicators of household livelihood.

From equation (2), the determination of X' variables takes the following form:

$$p\{yi = 1\} = \phi(\beta x') \quad \text{.....(3)}$$

After identifying the factors that influence family livelihood situations, a probit regression function is used to demonstrate their functional organization, interdependence, and statistical

significance. The functional relationship between the dependent variable's determinants and its impacts on household livelihoods was presented by:

$\Pr\left(Y = \frac{1}{X_i}\right) = \emptyset(\beta_0 \quad + \quad \beta_1\text{Hygiene} + \beta_2\text{Awareness} + \quad \beta_3\text{pSoap} + \quad \beta_4\text{DistWater} + \beta_5\text{distHealth} + \quad \beta_6\text{hheWater} + \quad \beta_7\text{hhePealth} + \quad \beta_8\text{latrine} + \quad \beta_9\text{handWash} + \beta_{10}\text{wStorage} + \quad \beta_{11}\text{childFeac} + \quad \beta_{12}\text{shelves} + \quad \beta_{13}\text{wDisposal} + \beta_{14}\text{hheEducation}$ ……………………..……………………………………………(4)

Where the dependent variable Yi represents effects on household livelihood conditions influenced by various independent variables (disease prevalence rate, income, expenses and their effects on productivity, Trend of diseases by time and its effects, Life holder of people variations among different classes of the population, and alternative cheap sewer treatment techniques) measured in terms of the cumulative standard normal distribution function, hygiene and sanitation practice, awareness of dangers of poor drinking water, presence of primary detergent soap, distance to a water source, distance to a health centre, household expenditure on health, presence of latrine, hand washing facility, education level of the household head,………are determinants of the household livelihood conditions.

Additionally, the findings of the coefficients of 0, 1, 4, and 14 reveal that they can, respectively, reduce and enhance the likelihood of household livelihood situations. Table 3.2 lists the independent variables (disease prevalence rate, income, expenses, and their effects on productivity, trends in disease incidence and their effects, life expectancy differences among different classes of population, and alternative, inexpensive sewer treatment techniques) and how they affect the dependent variable (effects on household livelihoods), as well as the model code, variable type, and unit of measurement. Below, in Subsection II:

(ii) The summary of variables described in the Econometric Model

The summary of independent (disease prevalence rate, income, expenses and its effects on productivity, Trend of diseases by time and their effects, Life holder of people variations among different classes of the population, and alternative cheap sewer treatment techniques variables and how they influence the dependent variables (Effects on household livelihoods) are given in Table 3. 3.

Table 3. 3: Summary of variables description in the Econometric Model

No.	Name of the variable	Code in Model	Variable type	Unit of measure
1.	Hygiene and sanitation practices	hygiene	Dummy	1 if Yes, 0 otherwise
2.	Awareness of water contamination	awareness	Dummy	1 if Yes, 0 otherwise
3	Presence of primary detergent soap	psoap	Dummy	1 if Yes, 0 otherwise
4	Distance to a water source	distwater	Continuous	1 if Yes, 0 otherwise
5	Distance to a health centre	disthealth	Continuous	1 if Yes, 0 otherwise
6	Household expenditure on water	hhewater	Dummy	1 if Yes, 0 otherwise
7	Household expenditure on health	hhehealth	Dummy	1 if Yes, 0 otherwise
8	Presence of latrine at household	latrine	Dummy	1 if Yes, 0 otherwise
9	Presence hand washing facility	handwash	Dummy	1 if Yes, 0 otherwise
10	Water storage equipment at household	wstorage	Dummy	1 if Yes, 0 otherwise
11	Child faeces disposal	childfeac	Dummy	1 if Yes, 0 otherwise
12	Presence of utensils drying rack	Drying rack	Dummy	1 if Yes, 0 otherwise
13	Waste water disposal method	wdisposal	Dummy	1 if Yes, 0 otherwise
14	Household head education level	hheducation	Dummy	1 if Yes, 0 otherwise

3.3.3 Livelihood, Health and Economic Indicators

3.3.5.1 Definition of Livelihood indicators

These are a standardized list of indicators according to WHO which are associated with all types of livelihood interventions focused on improving admittance to providing safe drinking water and particularly for this study they will include the following:

(i) Gender of the respondents

The economic success of a particular household is significantly influenced by gender differences among families. Given that most women are involved in the unpaid work of making sure there is water at the family level, several empirical researches have shown that gender matters in identifying the issues that affect admittance to clean water and sanitation. As indicated by UBOS's 2012 Water and hygiene sector gender statistics Profile, 73.6% of families headed by men and 77.4% of families headed by ladies approached updated water sources, individually, while the average distance (kilometers) to the water source was no different for the two groups of households.

(ii) Family size

This is the number of people living in a certain home. This factor determines how likely it is that household size will raise the cost of water bills and medical care for people exposed to water-borne illnesses.

(iii) Age category of respondents

There is a continuity property for this variable. It is anticipated that as the family head ages, his or her talents and physical capacity to travel far in search of water sources and do daily activities would deteriorate.

(vi) Marital status of the respondents

Married people frequently shoulder a great deal of responsibility for the wellbeing of the family. In comparison to homes with married couples, who are responsible for providing for the requirements of their families as the primary breadwinners, it is believed that single people who are not married have less responsibility for covering water and health bills.

(v) Level of respondent Education

It assumed that households whose heads have high levels of education are in a position to understand and teach their family members how to keep proper hygiene and sanitation in and around their homesteads, be able to pay medical bills and meet water costs because most of the educated people have either form employment or engaged in gainful private enterprises compared to those who are illiterate whose options are limited in nature.

(vi) Distance to a water source and health centres

This continuous variable represents the time it took them to get from their habitation to the source/point/of water. One might infer from this that women and girls are more responsible than males for getting water. The study will be interested in determining how the proximity of health facilities and water sources impacts gender roles and home chores, and how this relates to the negative economic and health implications of Jinja City's inadequate sanitation and drinking water.

(vii) Presence of shelves at the household level

These shelves are used to keep household utensils clean before and after use. Therefore, it is assumed that households with such hygiene facilities have fewer incidences of water-borne diseases and their household expenditure on medical treatment is less compared to a household without such items.

3.3.4 Definition of Health Indicators

These are variables or quantifiable characteristics of the population, susceptible to direct measurements, that reflect the state of health of the persons in that community and particularly for the current study, these include; the occurrence of water-borne diseases or other health-related risks, costs of disease burden, time spent in hospital, distance to a health facility, availability and access to essential medical supplies among others.

3.3.5 Definition of Economic indicators

Economic indicators are both micro and macroeconomic measurements that are used to measure the current and future economic activity if the country. The current study will consider economic indicators in terms of the household level of income, employment among the study

population, type of household residence, available and access to hygiene and sanitation facilities like water sources, and latrine coverage among others.

3.4 Existing and alternative sewer treatment techniques and their effects on household livelihoods

Data from NWSC for wastewater analysis was reviewed. Furthermore, a descriptive analysis study on alternative cheap sewer treatment techniques that can be used in the community was done using questionnaires and Key Informant Interviews.

The questionnaire had respondents give their opinions on statements concerning the alternative cheap sewer treatment techniques that can be used in the community.

3.4.1 Data analysis for objective three

The opinions were subject to Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree) and results are presented using percentages, mean and opinions.

3.5 Quality Control

3.5.1 Introduction

Data collection tools and instruments should be valid and reliable. To ensure that they are reliable the following was ensured;

3.5.2 Validity

The degree to which an instrument achieves its stated aims determines its validity. The degree to which a research tool achieves its intended goals determines how valid it is. The fundamental tenet of qualitative research is that reliability, utility, and dependability are all facets of validity. Validity increases transparency and lowers the chance of researcher bias in qualitative research (Singh and Musuku, 2014). To verify the reliability of the research equipment, questions with defects were rectified before doing actual fieldwork. Pre-testing was done among homes in Jinja City parishes that were not deemed study sample regions. The validity test formula is provided below:

$CVI = n/N$

Where N is the total number of questions in the survey and n is the number of questions that have been determined to be legitimate. The instruments were deemed appropriate for use in research since they have a Content Validity Index (CVI) of at least 0.8, as shown in Table 3. 4.

Table 3. 4 Results of content validity for research tools

Raters	No of Items	Relevant	CVI %
Rater 1	23	20	86
Rater 2	10	9	90
Rater 3	10	8	72
Average % (CVI)			**82%**

As can be observed in table 3.3, a content validity Index generated was 82% and according to Amin (2005), the Content Validity must be grater or equal to 70% if the instrument is considered appropriate for data collection.

3.5.3 Reliability

If a measurement yields results that are consistent and have similar values, it is considered to be dependable (Amin, 2005). It evaluates the study's reliability, repeatability, correctness, and consistency. Zero dependability is 0, whereas perfect reliability is 1. The reliability coefficient varies from 0 to 1. To measure questionnaire items and acquire reliability results, test-retest reliability was used. A high-reliability rating, such as test-retest reliability's r = 0.98, shows that measurement errors are often few in research equipment and coefficients with yields of above 0.7 are considered adequate, and those with yields of above 0.8 are considered to be very good. According to Table 3. 5, the average reliability test score for this study was 0.84, which is considered to be extremely outstanding. The more alpha approaches 1.0, the better.

Table 3. 5: Reliability test results of research instruments

Study variables	Cronbach's Alpha
Disease prevalence rate, income, expenses and its effects	0.735
Life holder of people variation among community members	0.969
Alternative cheap sewer treatment techniques	0.875
Cost of poor drinking water in Jinja city	0.775
Average Cronbach Alpha coefficient for variables	**0.839**

3.5.4 Measurement of the variables

Respondents were asked to pick the best choice from a list of possibilities when questioned about their impressions of the impacts of coaching and training, rewards and payment, feedback and communication, as well as other study objectives. A five-point Likert scale, ranging from 1 (strongly Agree) to 5 (strongly Disagree), was provided in the questionnaire for each of the study's goals. The estimated mean and standard deviation of the Likert scale's five points, which ranged from 1 (strongly Agree) to 5 (strongly Disagree), are shown in Table 3. 6.

Table 3. 6: Five-point Likert scale codes and their interpretation

Description	Mean range	Scale codes	Interpretation
Strongly Agree	4.20-5.00	1	Very high
Agree	3.40-4.19	2	High
Neutral/undecided	2.60-3.39	3	Average
Disagree	1.80-2.59	4	Low
Strongly Disagree	1.00-1.79	5	Very low

(Source: (Joshi and Kale, 2015))

3.6 Ethical considerations

At every stage of the research project, research ethical considerations were noted, paying special attention to permission and confidentiality (Creswell, 2014; Robson, 2011). Every participant in this research gave their consent to participate. During data collection and analysis, anonymity was observed by utilizing questionnaire numbers rather than the respondent's name. To maintain participant anonymity in research, no information supplied by them should in any way identify them (Gilbert, 2011).

Additionally, throughout the study process, respondents' privacy and confidentiality were upheld, and no identities were noted or included in the final report. Any instances in which direct personal information was received were handled with the utmost discretion and privacy. In addition to being properly stored and kept private, questionnaires and field notes were only accessible by the researcher and statistician during data analysis.

3.7 Chapter Three summary

The study's methodology is described in Chapter 3 of the book. To collect data from 285 household surveys, 18 Key Informant Interviews (KIIs), and 18 Key Informant Interviews (KIIs), the study used a cross-sectional and descriptive research methodology. The research used a variety of methods to gather information, including home surveys, Key Informant Interviews, Focus Group Discussions (FGDs), reconnaissance surveys, desk/document checks, and laboratory water sample testing during both dry and rainy seasons. The presentation, assessment, and interpretation of the study's findings are covered in the next chapter.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter gives an examination of the research results in line with the study's unique goals. The results of the water sample analysis, the response rate, and the sociodemographic information of the respondents are all included in this chapter. Section two examines descriptive statistics, and Section three presents inferential statistics using Pearson correlation coefficients:

4.2 Quality and nature of water, sanitation and hygiene conditions in Jinja

4.2.1 Water Samples Test Results

The water samples tested were drawn from different water sources that included; the shores of Lake Victoria, River Nile banks, springs and surface water (open wells). The water samples were drawn during both dry (January 2021) and wet (November 2021) seasons to ascertain the physicochemical parameters and health risks posed on household livelihood in Jinja City. The sample test results are provided in Table 4. 1.

4.2.1.1 The mean physicochemical characteristics of water samples

Table 4. 1 The mean physicochemical characteristics of water samples

Water source	**pH**	**Temp (^{0}C)**	**DO (mg/L)**	**CD (µS/cm)**	**Turb (TNU)**	**No of samples**
WHO Standard	**6.5-8.5**	**-**	**> 5**	**-**	**0-5**	
L. Victoria	6.80 ± 0.42	18.9 ± 0.53	6.04 ± 0.62	193.23 ± 45.93	67.11 ± 17.74	30
R. Nile	6.94 ± 0.10	28.21 ± 0.66	5.21 ± 0.46	140.82 ± 22.01	54.62 ± 28.46	3
Springs	6.19 ± 0.15	24.87 ± 0.36	4.65 ± 0.48	276.46 ± 45.46	41.71 ± 8.84	2
Open wells	9.03 ± 0.17	34.1 ± 0.88	3.50 ± 0.23	55.99 ± 7.75	116.16 ± 56.56	3

At the points where people were fetching water, for example at Masese landing site (10) - (majority of Masese residents pick water from here). Masese NWSC water treatment plant

(10) - (majority of Walukuba residents pick water from here). Towards the source of the Nile 10- (majority of Lubaga residents pick water from here) At River Nile they were 3 points near the source. This is because 500 meters from the source it would be another district called Buikwe yet our focus was Jinja. Springs were only 2 these were in Masese and Walukuba. There was no spring in Lubaga. Open wells were only 3. Lubaga was near the Kimaka senior army command. Masese near BIDCO, Walukuba too.

The results in Table 4. 1 of revealed that, except for turbidity, the bulk of the mean physicochemical water characteristics of the water sources were within the WHO's recommended water safety range. The results indicated that water samples from open wells and springs, respectively, had pH values of 9.03 and 6.19, which were outside the WHO-recommended safety range.

In the same manner, the results showed that water samples from L. Victoria had dissolved oxygen levels of 6.04mg/L, which were beyond the WHO-recommended safety threshold. There were significant variations in water temperature, with samples taken from open wells having the greatest temperatures (34.1 °C) and those taken from L. Victoria having the lowest temperatures (18.9 °C). Additionally, the findings demonstrate that there were variations in the amount of dissolved oxygen, with Lake Victoria showing the greatest level (6.04 mg/L) and open wells having the lowest level (3.5 mg/L). Specifically, for Lake Victoria, Physico-chemical parameters were tested and the results are shown in Table 4. 2**Error! Reference source not found.** and Table A. 2.

Table 4. 2 Physico-chemical parameters of water samples along the Lake Victoria (sampling period: October to November 2021)

Physico-chemical parameter	Min	Max	Mean	Lower 95 % CI	Upper 95 % CI	NEMA standards	No of Samples
Temperature (°C)	18.1	34.3	26.4	26.1	26.8	20.0–35.0	30
pH	5.9	9.3a	7.2	7.1	7.3	6.0–8.0	30
EC (µS/cm)	104.7	1320	574.6	538.1	611.2	1500	30
Total alkalinity (mg/L)	28	550	240.5	222.1	255.8	800	30
TSS (mg/L)	6	3100	198.7a	140.8a	240.7a	100	30
BOD5 (mg/L)	2	425.7	91.4a	82.7a	90.0a	50	30
COD (mg/L)	5	322.1a	257.4a	211.3a	300.5a	100	30
Total phosphate (mg/L)	0.01	84.1a	9.5a	8.7	13.3a	10	30
Orthophosphate (mg/L)	0	26.2a	5.2a	4.5	5.9	5	30
Ammonia-N (mg/L)	0	50.8a	21.2a	19.6a	22.5a	10	30
Nitrate-N (mg/L)	0	1.5	0.2	0.15	0.25	10	30

All parameters tested were meeting the NEMA Standards.

4.2.1.2 Discussion

Except for turbidity in Table 4. 2 results showed that the majority of the water sources' mean physicochemical water characteristics fell within the WHO's recommended water safety range. The outcome showed that water samples taken from springs had a pH of 6.19 below the WHO-recommended safety range while water samples taken from open wells had a pH of 9.03 outside of it, respectively. WHO, 2016 reports that discusses how various pathogens, including Giardia lambda, Cryptosporidia, and V. cholera, use high water turbidity to resist the effects of water treatment chemicals and cause illnesses that are transmitted through water is another source of support for the study's conclusions. Therefore, high water turbidity may encourage the growth of potentially harmful algae blooms.

Additionally, the findings of water samples showed that the majority of water source sites had low conductivity rates, except for spring water samples, which had the greatest conductivity rates at 276.46 S/cm and the lowest from samples taken from open wells at 55.99 S/cm. The bulk of the water sources had water turbidity levels above the WHO recommended level, with open wells recording the highest levels at 116.16 TNU and springs recording the lowest levels at 41.71.

When the aforementioned data were placed via Turkey's post hoc test on the lake and river sites, it was discovered that there were statistically significant variations for all water physicochemical properties. L. Victoria recorded the highest temperature (28.21 °C), while the River Nile recorded the lowest (18.9 °C), as shown in Table 4. 2.

The possible causes of pollution could be the effluent from industries around Lake Victoria which is not treated such as leather tanning industries, textile industries. Poor Solid waste management with evidence of plastic bottles dumped on the shorelines of the lake. Poor sewer system from the city council. The combined waste and sewer systems and runoff which lead directly into the lake. Septic tanks also opened during rains and this worsens the situation. Fish farming caused pollution due to farmers pouring fish food in the cages directly to the lake.

Except for turbidity, the majority of water variables (pH, temperature, dissolved oxygen, and conductivity) were statistically significant, comparable to the comparison of data from springs and open water wells for the wet and dry seasons. These findings are in line with those made by Campell *et al.* (2003), who drew attention to the fact that some industrial firms in Jinja continue to discharge sizable amounts of untreated effluents into the Nile, Walukuba, and Kikenyi rivers, as well as into the city's wetlands, Lake Victoria, and other waterways. These bodies of water have become nutrient-richer and have less dissolved oxygen in them as a result of the buildup of dangerous chemicals in biomass and sediments.

The findings above are following those of research conducted by Verschuren *et al.* in 2002, which showed that human activities have continued to have a detrimental effect on the Lake Victoria shoreline in the Jinja Municipality. Therefore, it is not unexpected that wetland degradation has caused Lake Victoria's water quality to gradually shift. They discovered that the impacts of these activities over the past few decades included increasing nutrient and

chlorophyll-a concentrations, declining oxygen levels in deeper water, decreased biodiversity, and increasing quantities of dangerous organic compounds.

The water sample test results from the study show in Table A. 3 and Table A. 4 show that the surface water sources and springs in Jinja are appropriate for drinking and other domestic applications. The bulk of the city's water samples tested did not match the WHO's standards for drinking water quality in terms of the principal physicochemical factors, making them unsafe for human consumption. Additionally, all surface water sources and springs that were analyzed exhibited turbidity levels that were higher than the WHO-recommended threshold of 5NTU although homes in the research areas used the same water for domestic reasons like drinking. According to the study, there were differences in the other physicochemical properties (pH, temperature, dissolved oxygen, and conductivity) between research sites on the same lake and between the various water sources.

The majority of sources (mostly those with turbidity) had mean water physicochemical qualities that were outside of acceptable ranges, and all but a small number of sources (particularly springs and open wells) had pH and dissolved oxygen levels that were outside of the WHO-recommended limits. Consumers of these water sources who did not adhere to WHO drinking water criteria might be exposed to the harmful effects of polluted water, including cholera and other waterborne infections. The present study's findings suggest that high water turbidity may encourage the survival and spread of infections, such as the V. cholerae bacteria that lead to cholera epidemics and ill health. High water turbidity makes water disinfection more difficult by necessitating more chlorine. The rising demand for chlorine for water disinfection can be costly and challenging to maintain continuous supply since Uganda and many other developing countries need and receive more donor assistance.

The majority of the water sources and springs that were examined met WHO requirements for drinking water in terms of conductivity, dissolved oxygen, and temperature. However, the mean amounts of dissolved oxygen in water samples from open wells were lower than what the WHO advises for drinking water. To guarantee that everyone has access to safe drinking water, research may focus on water sources that exhibit important physicochemical characteristics outside of the WHO drinking water range. The various water sources (lakes, rivers, springs, and open wells) have statistically significant differences in the physicochemical properties of the water.

Additionally, as acidity is frequently associated with an increase in the solubility of dangerous heavy metals (such as lead, arsenic, and others), it could be required to test the water for metallic pollution. Heavy metal pollution of water results in illness because of ongoing exposure to heavy metals, which accumulates over time and manifests too late for treatment to be effective. The findings of this study also demonstrate that the water quality of springs, deep sources (lakes and rivers), and open water sources varies. The higher quality of deep-water sources compared to surface sources may be due to the minimal industrial input pollution.

The results of the aforementioned study back up Chau *et al.* (2015), who stressed that residents of communities with inadequate water supply were forced to find local sources of drinking water on their own. Rural areas are particularly affected since residents there must collect water from wells, ponds, springs, lakes, rivers, and rainwater collection to meet residential needs. It is shown that individuals commonly consume untreated water from various sources. However, these alternative sources of drinking water are frequently subjected to point and non-point sources of pollution, and they are frequently contaminated with excrement, claim Chigor *et al.* (2013).

The study's findings concurred with those of Diouf *et al.* (2014), who stressed that contaminated drinking water is the primary source of diarrheal illness, which was blamed for more than 700,000 recorded child fatalities under the age of five in 2011. Diarrhoea is a significant factor in infant mortality in poor nations.

4.2.2 Characteristics of the respondents

4.2.2.1 The respondents' age group

Important to this study was information about the age groups of respondents. This is because age determines a lot how an individual perceives and interprets issues that influence their daily work performances, especially their skills and experience in tourism marketing. In most cases, mature employees are considered to be more committed to their work and have more experience in tourism marketing as compared to their counterparts who are recruits and graduates of the Organisation. The study results on the age of respondents are given in Table A. 8 to Table A. 10. The majority of the respondents 124(60%) were age range of 31-39 years, this was followed by those in the age bracket of 40-49 years with 42(20%), 23(11%) for those were age range of 20-30 years and lastly, those who were in the age range of 50 years and

above with only 8%. This implies that most of the respondents were considered to be mature and the information provided could be trusted as accurate to generate this field report

4.2.2.2 Gender of the respondents

It was important for this study to consider information about the gender of the respondents since gender roles and responsibilities in society affect both men and women differently especially when it comes to carryout of the domestic chores like fetching water, collecting fire wood, cooking and taking care of young ones. It is common sense that when it comes to matters of fetching water, women and youth are expected to participate more than men because of traditional connotations attached to such domestic chores. The results on the gender of respondents are summarised in Table A. 8 to Table A. 10.

The study results in Table A. 8 to Table A. 10. indicated that the majority of the respondents were females 148(52%) while 137(48%). were males. This may imply that females were more willing to participate and most of them were present at home compared to men who prefer being with fellow men outside the home environment.

4.2.2.3 Marital status of the respondents

The respondents' marital status was crucial to the study because it affects one's level of performance and degree of dedication to the job. After all, married individuals have more duties at home to take care of before going to work than single people do. These home duties cause one to spend less time working, which eventually lowers their level of productivity. Table 4.8 provides the study's marital status findings.

The study findings in Table A. 8 to Table A. 10. indicate the majority of the respondents (55%) were married while 32% of them were still single, 7% of them were separated or divorced and lastly, 6% of them were widowed. The implication is that married people especially women and youth are the ones at the centre of ensuring water for domestic chores is readily available among the households.

4.2.2.4 Education level of Respondents

Important to this study was information highest level of education obtained by the household respondents because this determines a lot of how people conceptualize and understand matters that affect their daily routines and activities in life including access to and availability of clean drinking water in their respective communities and villages in Jinja City. The study results on the education level of respondents are presented in Table A. 8 to Table A. 10.

The study results in Table 4.8 indicated that the majority of the respondents 151(53%) had attained a secondary level of education, 97(34%) had obtained a tertiary (Diploma) level of education, 20 (7%) had a Master's Degree, 17(6%) had degree level of education and lastly, 12(4%) had primary level of education. This implies that the majority of respondents had the necessary skills and knowledge to provide accurate data for the study under investigation.

4.2.2.5 Main sources of household income/livelihoods

Important to this study was the source of income for the household as income levels determine the ability to pay and meet the costs of the most necessities for the family. The study results on the main source of household income are summarised in Table A. 8 to Table A. 10.

The results in Table A. 8 to Table A. 10. revealed that the majority of respondents (52%) mentioned business/self-employment as their main source of household income, followed by agriculture (crop products) with 28%, agriculture (both crops and animals) with 8% and monthly pay and agriculture (animals only) with 6%. The main reason for having the majority of respondents having business or self-employment as their main source of income could be because the study targeted mainly from Masese and Lubaga areas of Jinja City which are mainly occupied by low-income households.

4.2.2.6 Household head category and main source of water

The results compared the household head category (male and female-headed) and the main sources of water for domestic use. When the results were triangulated, it was revealed that the majority of male-headed households (37%) were getting water from public taps as compared with 40% of female-headed families. The results indicate that over 60% of male-headed households as compared to 63% of female-headed households were not getting their water from the tap (considered unsafe water sources). This may be attributed to the fact that most men can

afford to pay for water bills as compared to their female counterparts who may prefer cheap water sources. The results on the household category and main source of water are provided in Table A. 8 to Table A. 10.

4.2.2.7 Household head category and distance to water source type

The results on household head category and distance to water sources which were categorised as "improved" and "not improved" indicated that on average, 74% of the male-headed households had access to improved water sources, as compared to 77% of the females headed households. In addition, results revealed that on average, the majority of respondents moved between 0.5-2.9 km to access improved water sources as illustrated in Table A. 8 to Table A. 10.

Further, the information obtained during FGDs with female participants revealed that on average, a jerrican (20Litres) of water in Jinja city costs three hundred shillings (Ugx 300/=) and on worst days when water is scarce, especially during dry seasons, the price of a jerrican of water can cost you one thousand (Ugx 1000/=) as provided by water vendors and a household needs at least two Jerricans of water. During the dry season, most water taps were out of running water, hence most community members resort to buying water from vendors done bicycles or Boda Boda and those who can't afford this cost, endure long journeys and sunny hours to access water yet on average, a household needs at least three jerricans of water daily for domestic use. The results on how the respondents' perceived cost of the water in Jinja City is given in Table A. 8 to Table A. 10.

As indicated in Table 4.8, the majority of the respondents (49%) reported that the costs of water among households in Jinja City are moderate, however, about 20% of the respondents still perceive water access and availability to be very expensive for the community members. These results are supplemented by qualitative data from KIIs and FGDs which revealed that water access challenges vary among communities in Walukuba, Lubaga and Masese divisions in Jinja City. Residents in Walukuba revealed that water access was not a major challenge as most households can access tap water and in Lubaga challenge is relatively and but Masese residents are most affected as most access water from an unsafe water source contaminated by industrial wastes, disposal of domestic and municipal waste including garbage, excreta and liquid household waste.

4.2.2.8 Household head category and type of toilet facility used

The results on the household head category and type of toilet facility used indicated that the majority of the respondents in male-headed households (49%) used a covered pit latrine private as compared to 45% of female-headed households, followed by 35% of female-headed households mentioned that they were using sharing covered pit latrine as compared to 30% among the male-headed households as summarised in Table A. 8 to Table A. 10.

In addition, the findings on the availability of water washing facilities on latrines revealed that the majority of the respondents (51%) had water washing facilities at their latrines but never had a soap, followed by 29% of them who had water washing facility and soap and 12% of them reported not having washing facility at their latrines. The results on the availability of water washing facilities on latrines are summarised in Table A. 8 to Table A. 10.

The study findings on the availability of essential items at the household level revealed that the majority of respondents (46%) had water storage equipment at the household level, 18% of them had utensil drying racks and 13% of them had child faecal disposal as summarised in Table A. 8 to Table A. 10.

4.2.3 Results of Econometric Modeling

The probit model was used in the study to determine the determinants of household livelihood circumstances' parameters. The key determinants of the probit model included; Hygiene and sanitation practices, awareness of dangers of poor water, presence of primary detergent soap, distance to a water source (km), distance to a health centre (km), Household expenditure on water month, Presence of children faeces near household, Presence of latrine at household, presence hand washing facility, water storage equipment at household, presence of utensils drying rack, wastewater disposal method and household head education level. The test results for key variables, Code in Model, observations, mean, standard deviation, minimum and maximum unit of measure are presented in Table 4. 3.

Table 4. 3: Key variables for Econometric Model

Name of the variable	Code in Model	Obs	Mean	Std. div	Mini	Maxi
Hygiene and sanitation practices	hygiene	285	.95	0.20	0	1
Awareness of water contamination	awareness	285	.66	0.47	0	1
Presence of primary detergent soap	Psoap	285	.74	0.43	0	1
Distance to a water source (km)	distwater	285	2	0.54	0	3
Distance to a health centre (km)	disthealth	285	5	0.34	3	15
Household expenditure on water month (UGX)	hhewater	285	20,000	0.50	10,000	50,000
Presence of children's faeces near household	latrine	285	.20	0.40	0	1
Presence of latrine at household	handwash	285	.84	0.35	0	1
Presence hand washing facility	wstorage	285	.80	0.39	0	1
Water storage equipment at household	childfeac	285	.66	0.47	0	1
Presence of utensils drying rack	Drying rack	285	.42	0.49	0	1
Waste water disposal method	wdisposal	285	.18	0.38	0	1
Household head education level	hheducation	285	1.7	1.10	1	5

Additionally, the maximum likelihood estimation of the probit model revealed that hygiene and sanitation practices, knowledge of the risks of unclean water, the presence of primary detergent soap, the proximity of a household to a water source (in kilometers), the proximity of a household to a health center (in kilometers), the household's monthly water expenditure, the presence of children's faeces close to the household, the presence of a latrine at the household, the presence of a handwashing station, the presence of water. The key determinants of household livelihood for Probit Model Results are summarised in Table 4. 4.

Table 4. 4: Probit Model Results on Household livelihood conditions

YI Household livelihood	**Coef**	**Std err**	**P> |Z|**
Variables			
Hygiene	1.54***	.58	0.008
Awareness	.47**	.25	0.064
Psoap	.98***	.26	0.000
Distwater	.48**	.32	0.051
Disthealth	.37**	.24	0.062
Hhewater	.65**	.31	0.054
Latrine	-.34*	.35	0.384
hand wash	-.66**	.36	0.043
Wstorage	-.13**	.26	0.654
Child faeces	.73***	.23	0.001
Drying rack	.-.84***	.26	0,001
Wdisposal	.06*	.23	0.978
Ventilate	-.16*	.22	0.460
HH head edu	.55**	.26	0.030
Constant	**-16**	**069**	**0.016**

Number of obs	=285
LR chi2(14)	=50.46
Prob> chi2	=0.0000
Pseudo R2	=0.2364
Unrestricted Log likelihood	=-101.30
Restricted Log likelihood	=-99.00

*** p<0.01, ** p<0.05, * p<0.1

Ceteris paribus variables—also known as constant variables—are what make LR with constant variables work when the Xi's are zero. Only the explanatory factors can account for the impact without constant terms. The results of the Marginal Effect after Probit for significant model variables are presented in Table 4. 5.

Table 4. 5: Marginal Effect Results after probit for significant model variables

Household livelihood	dy/dx	Std. err	P> |Z|
Hygiene	.54***	.15	0.001
Awareness	.34**	.12	0.047
Psoap	.36***	.10	0.000
Distwater	.21**	.10	0.041
Disthealth	.31**	.11	0.032
Hhewater	.23**	.11	0.034
Latrine	-.11*	.10	0.295
hand wash	-.23**	.11	0.034
W storage	-.36***	.10	0.001
Child faeces	.26***	.07	0.001
Drying rack	.34***	.10	0.001
wdisposa	.04	.11	0.660
Ventlate	-.0.5	.07	0.456
HH head edu	.20**	.09	0.034

As shown in Table 4. 4 and Table 4. 5 the study's findings showed that households' practices of sanitation and hygiene education are significant at a 1% level of significance and have a positive impact on lowering household expenses for paying medical bills for water-borne illnesses like diarrhoea, cholera, and typhoid, among others. This is because households who embrace good hygiene habits, including washing their hands with soap and water, and hygiene education lower the health risks. When families utilize latrines, the risk that they would contract an illness caused by a water-borne agent is reduced by 54%, while other factors remain constant.

One of the elements that influence a family's welfare is the household head's level of education, and the study's results show that this factor is significant at a 5% level of significance and has a bad relationship with diarrhoea reduction. This is because it's likely that the families' level of education will help them see the benefits to their health that could result from having access to clean water, proper sanitation, and hygiene education practices. The study's findings indicate that having some degree of education had a positive impact on how the family behaved in terms of maintaining good water and hygiene (151/285 or 53% had secondary education).

Knowledge of water pollution during storage: The study's results indicate that this is one of the most important elements impacting household health. It has a positive effect on lowering the incidence of pneumonia and diarrheal illness and is statistically significant at 5%. Water-related diseases (household livelihoods) are decreased by 34% when a family's members have received training in capacity building and health campaigns that provide them with the necessary skills to be aware of water contamination during storage and other constant variables.

The study's findings revealed that the presence of the drying rack is a factor in determining home wellbeing. It is statistically highly significant at 1% and has a detrimental impact on reducing diarrhoea. If all other factors remain the same, respondents who said that their homes have drying racks meant the possibility of a 34% decrease in water-borne illnesses. The study found that because most families lacked access to either water, soap, or both, hand-washing facilities did not affect the prevalence of diseases associated with drinking water. Due to the majority of them being found to be inoperable and possibly having been installed during the COVID-19 pandemic outbreak when the government was emphasizing the installation of such facilities among households, which were later abandoned, the presence of hand washing facilities did not guarantee that households would use them properly.

4.3 The relationship between water quality, the ease of access to water sources on household livelihood in terms of disease prevalence rates

4.3.1 Disease prevalence rate

The relationship between water quality, the ease of access to water sources on household livelihood in terms of disease prevalence rates was obtained using questionnaires with a 5 Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree) and results are presented using percentages, mean and opinions as indicated in Table 4. 6

Table 4. 6: Disease prevalence rate, expenses and its effects on livelihoods

Items on disease prevalence, income expenses and their impact	**SA**	**A**	**N**	**D**	**Mean**	**Opinion**	**Std**
High disease incidences in the community due to inadequate safe drinking water.	20%	54%	15%	11%	4.15	Agree	1.24
Water-related diseases are on increasing due to contamination from faeces.	20%	48%	10%	22%	3.82	Agree	.978
Increased recorded cases of Diarrhoea as the result of inadequate safe drinking water.	12%	57%	14%	17%	3.87	Agree	.976
Water borne diseases are more common among urban poor than rich households.	5%	74%	13%	8%	4.06	Agree	1.41
Diarrhoea has serious financial costs on household	10%	51%	11%	28%	3.81	Agree	.872
In this community, people are at risk of getting soil-transmitted helminth (STH).	22%	59%	15%	4%	4.08	Agree	1.43
Inadequate access to safe water led to productivity losses due to long time illness	22%	46%	15%	17%	3.92	Agree	.878
Water borne diseases have increased household expenditure on health care.	20%	59%	12%	6%	4.12	Agree	.972
Grand mean					**3.98**	**Agree**	

Table 4. 7: Weighted mean for Likert scale

Weighted mean	Opinion	Weight
4.2-5	Strongly agree	5
3.4-4.19	Agree	4
2.6-3.39	Uncertain	3
1.8-2.59	Disagree	2
1-1.79	Strongly disagree	1

(Source, (Abd-Elfattah, 2008))

As indicated in Table 4. 6, the majority of the respondents were in agreement with statements or items provided on disease prevalence, income expenses and its impact, based on weighted means in Table 4.11. The grand mean of 3.98 shows respondents were in agreement that disease prevalence rate and expenses affect livelihoods.

Further, the qualitative information from FGDs and KIIs revealed that in Jinja the common water-borne diseases which members have suffered in the last 12 months included; typhoid, cholera, dysentery, worms, scabies, river blindness, and Diarrhea among others. These water-borne diseases have had serious socio-economic and health impacts on general people's livelihood as youthful and energetic people spend most of their productive time nursing their sick families and less time is left to work and contribute to the economic welfare of the family.

Additionally, according to information from KIIs and representatives from the NWSC Jinja Branch, several industrial enterprises in Jinja release sizable amounts of untreated effluents into the Nile, Walukuba, and Kikenyi rivers, as well as into the city's wetlands and Lake Victoria. As a result, the water loses dissolved oxygen, nutrient enrichment occurs, toxic chemicals build up in biomass and sediments, fish deaths occur, and other problems arise. One important source pointed out that in support of these findings:

> *"Much of the challenges we face right now here in Jinja is as the result of the destruction of wetlands because wetlands are very important in many respects: they recharge groundwater aquifers, protect the shore lines from wave action, clean polluted water and act as nutrient traps"*

The shoreline of Lake Victoria within the Jinja Municipality boundary, which has long served as filters for nutrients and contaminants that originate from the catchment area and has thereby

protected the water quality of Lake Victoria, has come under pressure from increased human activities, according to information obtained from KIIs. The degradation of wetlands caused by human activities such as the expansion of industrial parks and factories, the felling of trees, and soil erosion from lakeshore farming has gradually changed the quality of the water in Lake Victoria and the nearby water sources. This is demonstrated by rising nutrient and chlorophyll-a concentrations, declining biodiversity, oxygen loss in deeper water, and a rise in hazardous chemical compounds.

In the same way, qualitative information from FGDs with youth revealed that increased population and insufficient soil infiltration capacity to absorb wastewater with high organics content usually cause overflow of pit latrines and septic tanks, which wastes end up into surface water drainage networks and cause contamination to streams and rivers. Most respondents blamed the high prevalence rates of water borne related diseases on poor pit latrines and septic tanks in Jinja City which have significantly contributed to the contaminated groundwater sources. It was revealed that during the rain seasons, pit latrines are affected due to a rise in the water table, which also decreases groundwater infiltration capacity and inadequate sewage and drainage system.

Further, information obtained revealed that most participants were aware of ways or strategies of stopping the spreading of water-borne related diseases where they mentioned that the most effective way is through hand washing with soap after the toilet visit and before food eating. However, on a sad note, it was observed that most households (51%) visited during the household survey did not have a soap where a water washing facility was available and but other households lacked both hand washing facilities (no water, soap or toilet paper) and this challenge points to lack or ignorance about the importance of domestic hand washing practice.

The aforementioned study's findings are in line with those of WSP, (2012), which discovered that Uganda loses an estimated US$8.1 million yearly because of a lack of access to water and sanitation. Each person who utilizes open defecation is estimated to spend about 2.5 days a year trying to find a private spot to crap, which results in huge financial losses. Women bear a disproportionate share of the expense of caregiving because they frequently spend more time with small children, sick relatives, or elderly loved ones. Similar to this, US$147 million is wasted annually owing to premature mortality, of which 23,000 Ugandans, including 19,700

children under 5, die from diarrhoea each year—nearly 90% of which are directly related to inadequate WASH.

4.3.1.1 Discussion

The results of the study also support the conclusions of the World Bank's (2015) Economic Study on Uganda, which found that inadequate sanitation and hygiene cost the Ugandan economy 380 billion shillings (US$ 177 million) annually, or 1.1% of the country's Gross Domestic Product (GDP). This corresponds to a yearly average of Shilling 11,800 (US$ 5.5) per person or Shilling 22,300 (US$ 10.4) per person without access to basic services. The negative health impacts of inadequate sanitation and water supply, the expense of treating these health issues, the loss of productivity that comes when people are ill and others must provide for them, and the time required to get services all contribute to these costs.

Related to the above, the study findings revealed that the majority of the respondents (44%) believed that there is always drug stock out while 21% of them indicated that health care services are expensive and 17% indicated that drugs are available but they cover few diseases as the results are summarised in Figure 4. 1

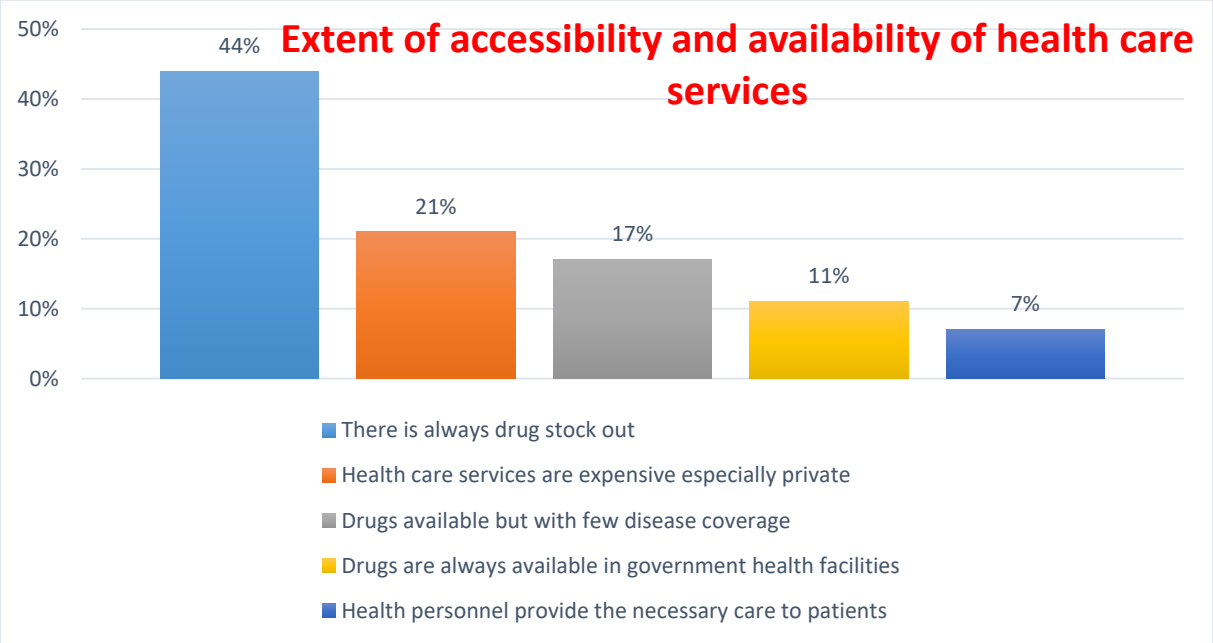

Figure 4. 1: Extent of accessibility and availability of health care services

In the same way, the information obtained from FGDs with men, women and youth revealed that on average, a household in Jinja city spends between 100,000-500,000 UGX in meeting

health medical bills due to water-borne related diseases annually. Qualitative information from KIIs with Jinja City health officials indicated that most people suffer from gastrointestinal infections caused by bacterial pathogens and it includes diarrhoea. Some major bacterial pathogens are Vibrio cholera which causes cholera; Shigella species as well as some Salmonella species which causes dysentery; E. coli (Enteropathogenic) which causes dysentery-like infections; Salmonella typhoid which causes typhoid. Acute enteritis in humans is primarily caused by Campylobacter, Helicobacter and Arcobacter, where Helicobacter pylori have also been implicated in causing stomach ulcers. Information obtained revealed that treatment for such infections is very expensive and most lower government health facilities hardly offer medication for such infections when it is not detected and treated in early stages, it may have long life-threatening health effects for the population.

Related to the aforementioned, information received from health officials stated that having a safe sanitation system with no leaks and contamination of the soil or water happens is one key preventive against wastewater bacteria. The wastewater should not be released directly into the environment since the pathogens pollute and provide a health risk to both adults and children as well as to animals because they can carry some infections, which results in their recycling in the environment.

The study findings on the perceived cost of health care services regarding the treatment of water-borne diseases revealed that the majority of the respondents (52%) regarded cost as expensive, followed by those who mentioned that the costs a very expensive (28%), moderate (13%) and lastly those who considered the costs to be cheap (7%) as given in Figure 4. 2.

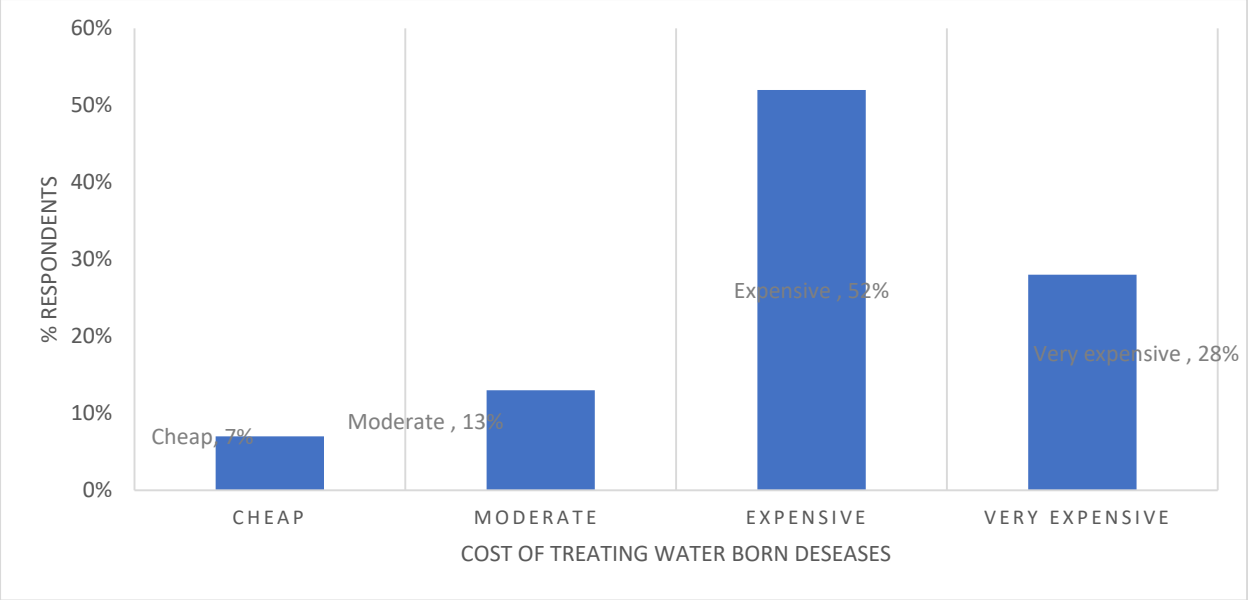

Figure 4. 2: Perceived cost of Health Care Services

The aforementioned findings are consistent with those of the Asian Development Bank report from 2014, which showed that the government's recurring costs for treating 458,828 patients with water- and vector-borne diseases in South Tarawa in 2012 totalled A$7.4 million, excluding administration and support services. The same research showed that 29,606 cases, or 7% of all cases treated by clinics and hospitals in the nation, involved water-borne diseases.

4.3.1.2 Pearson correlation between disease prevalence, income expenses and effect on household livelihoods

To determine whether there was statistical significance between disease prevalence, income expenses and effect on household livelihoods, the information on the testing relationship between these two study variables was obtained using inferential statistics using SPSS. Table 4.12 provides an overview of the Pearson correlation findings.

Table 4. 8: Correlation results for disease prevalence and effect on livelihoods

Correlation coefficients			
		Disease prevalence & income expenses	Effect on household Livelihoods
Disease prevalence & income expenses	Pearson correlation	1	.745
	Sig. (2-tailed)		.000*
	N	285	285
Effect on household Livelihoods	Pearson correlation	.745	1
	Sig. (2-tailed)	.000*	
	N	285	285

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

The Pearson correlation results in Table 4. 8 depict a strong positive correlation (r = .745) between disease prevalence & income expenses and the effect on household livelihoods in Uganda, taking Jinja City as a case study. The results further revealed a significant statistical relationship between the two study variables given that the p-value (p=.000) is less than recommended significance at 0.01.

To determine the strength of the relationship between these two study variables, the coefficient of determination (r^2) has been computed as follows: That is r^2 = (0.745x0.745) x 100 = 56%. This implies that a percentage increase in disease prevalence & income expenses causes an increase in household livelihood expenditure to meet the costs of water-borne related diseases and vice versa., Hence, 44% not captured may account for other factors that influence household livelihood other than disease prevalence and income expenses.

4.3.2 Trends of Water-related Diseases and their effects on the community

The study findings on each of the statements made about the trends of water-related diseases and their effects among the community were obtained using questionnaires with a Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree) and results are presented using percentages, mean and opinions as indicated in Table 4. 9.

Table 4. 9: Trends of water-related diseases and their effects on the community

Items on disease prevalence, income expenses and their impact	**SA**	**A**	**N**	**A**	**Mean**	**Opinion**	**Sd**
Disease trends in Jinja have increased due to poor and un protected water sources.	10%	73%	6%	11%	4.13	Agree	.958
Diseases from the contaminated water have worsened the costs of household treatment.	8%	80%	2%	10%	4.16	Agree	1.25
In the past 12 months, at least one member of my family experienced Diarrheal disease.	25%	63%	6%	6%	4.14	Agree	.998
Trends in the cost of treatment for water diseases have gone high in my household.	7%	78%	6%	9%	4.21	Agree	1.17
In the last 12 months, a member of my family was admitted as a result of poor drinking water.	7%	30%	10%	53%	3.68	Agree	.636
Trends in health care services related to water, hygiene and sanitation have increased.	15%	60%	10%	16%	3.97	Agree	.926
Repeated episodes of diarrhoea and chronic helminth infections are common.	4%	65%	4%	27%	3.96	Agree	.938
Grand mean					**4.03**	**Agree**	

As indicated in Table 4. 9, the majority of the respondents were in agreement with statements or items provided on disease prevalence, income, expenses and their impact based on weighted means in Table 4. 7. The grand mean of 4.03 shows respondents were in agreement that disease prevalence rate, income, their expenses affect the community.

The above results are supplemented by qualitative information from KIIs and FGDs which revealed that rapid population growth and urbanization in Jinja are already creating an overwhelming strain on the existing water infrastructure services including sanitation services. Providing sanitation services, especially for the poor who are living outside the City master

plan like illegal settlements in wetlands or slum areas has contributed a lot to spoiling water quality and increasing the health risk for human beings from water pollution. The information obtained from KIIs with health officials indicated that water-borne related diseases like Cholera, Diarrheal, and Typhoid have directly, and indirectly via malnutrition (and its consequences for other diseases such as respiratory infections and malaria) are all leading causes for increased cases of children morbidity in Jinja City. The situation is worsened by high costs associated with health-seeking behaviour including consultation, medication, and transport and in some cases, sick people end up being hospitalized which places a heavy burden on household incomes yet most families, especially in low-income areas like Masese, members struggle to meet necessities for their families.

Related to the above findings, one official from NWSC, Jinja branch had this to say on health issues affecting the local population due to poor and unsafe drinking water:
"Indeed, escalating deterioration of water and sewer systems has continued to weaken our ability to provide safe drinking water and essential sanitation services for the current and future generations. Most of the materials used like pipes have a life span, they need to be checked more often to identify ones with damage and leaks so that they can be repaired or replaced in time. As many pipes crumble and leak, it often becomes a very expensive water and sewer problem to address and this results in an unacceptable risk to human health and the environment."

In the same way, information obtained from KIIs with the Jinja City water department revealed that the government of Uganda through local governments has been instrumental in ensuring that District/City staff is equipped with the necessary skills, and knowledge, to provide water and sanitation facilities, support communities in operations and maintenance of community water sources by forming community water user committees in addition to the promotion of appropriate technologies and approaches for urban and rural water supply and sanitation.

Qualitative data also showed that Jinja City has taken steps to assure the availability of hygienic sanitation facilities based on management responsibility and ownership by the user households as well as sustainable safe water supplies within easy reach. This has been made possible by guaranteeing the fair implementation of cost-effective, sustainable water and sanitation infrastructure for local populations through the planning, budgeting, and resource allocation participatory processes to District LGs. This has been made possible by ensuring that the local

community has appropriate access to Water for Production (WfP), which aims to develop and utilise water resources for productive usage in crop irrigation, livestock, aquaculture, industries, and commercial activities.

In addition, the information from KIIs with health officials on strategies to avert health risks emanating from poor water quality revealed that good hygiene and hand washing are one of the best protections against infections and sickness. The information indicated most people tend to have health problems in areas with insufficient water because hygiene is a matter of water access for the households, if there is a sufficient amount of water it can be used to also for hygiene, besides food and water consumption. They mentioned that community members need to be trained on the proper handling of vegetables and fruits, washing them with water before food preparation and consumption is a good way to avoid pathogens and maintain safe health. In support of these findings, one health official noted:
"In our communities, people hardly commit time to attend and participate in health camps and campaigns, they think it is a waste of time since they are not paid allowances at the end of such health campaigns yet it is only through these channels of communication that people can gain skills and knowledge of preventing and reducing health-related challenges……., water is not a problem, the way people utilize it is a problem."

In addition, information revealed that there are several reasons for the outbreak of water-borne diseases like cholera, diarrhoea and the most important reason was poor hygiene, unsafe disposal of excreta and wastewater, but also the level of education in the household head, quality of the water and the water source. They mentioned that one way to reduce and eliminate hand-mouth diseases routes proper hygiene is important where the transmission of the microorganism can be taken care of by hand washing with soap, never eating anything raw before washing it with boiled safe water and cooking and boiling water if it is unsafe before household consumption.

Related to the above, health officials indicated that another effective and best approach to reduce the burden of high cost incurred in meeting health care services costs is the use of promotional materials and other handbooks for hand washing, proper and accurate water handling and use. This can also be possible by providing health, water and sanitation information through newspapers, radio programs, theatre performances, and workshops to

inform the citizens about how to practice and maintain good and healthy hygiene regarding water use to avoid persistent water-related sickness in their communities.

4.3.2.1 Discussion

The results of the aforementioned study are consistent with those of Fregonese *et al.'s* (2017) study, which showed that inadequate water, sanitation, and hygiene (WASH) practices are linked to less-than-ideal child growth in sub-Saharan communities. According to research findings, improving WASH conditions have been linked to better child anthropometrics in various studies (van Cotton *et al.,* 2018; Spears *et al.,* 2013), according to results from WHO (2020). Cumming (2016) supports the results of the aforementioned researchers that persistent helminth infections and recurrent diarrhoea might impair nutritional absorption, which can result in undernutrition.

According to Prüss-Üstün *et al.'s* (2014) study, the majority of diarrhoea deaths occur in children under the age of five and in low-income nations due to the extremely poor quality of the drinking water, which causes recurrent bouts of diarrhoea cases. In a similar vein, Kim et al. (2016) found that diarrhoea illness is the greatest cause of death in sub-Saharan Africa and the second-largest cause of morbidity and mortality among children under the age of five in both low- and middle-income nations. Diarrhoea illness has an impact on a child's nutritional condition, with related health and socioeconomic effects.

4.3.2.2 Pearson correlation between trends of water-related diseases and effects on household livelihoods

Inferential statistics were used to gather data on the test findings between these two research variables, and the Pearson Correlation Coefficient was calculated to see whether there was statistical significance between the two study variables. Table 4. 10 lists the Pearson correlation results.

Table 4. 10: Results between trends of water-related diseases and effect on livelihoods

Correlation coefficients			
		Trends of water-related diseases	Effect on Household Livelihoods
Trends of water-related Diseases	Pearson correlation	1	.816
	Sig. (2-tailed)		.000*
	N	285	285
Effect on household Livelihoods	Pearson correlation	.816	1
	Sig. (2-tailed)	.000*	
	N	285	285

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

The Pearson correlation results in Table 4. 10 indicate a strong and positive correlation (r=.816) between trends of water-related diseases and their effect on house livelihoods in Jinja City. In addition, the study results revealed that there is a significant statistical relationship between these two study variables as reflected by p-value (p=.000) which is less than the recommended significance level of 0.01. To determine the strength of the relationship, the coefficient of determination (r^2) was computed as follows: That is r^2 = (0.816x0.816) x 100 = 66%. This implies that holding other factors constant, a percentage change in trends of water-related diseases leads to a 66% increase in household expenditure or a decrease in household livelihood wellbeing and vice versa.

4.3.3 Life holder of people variation among community members

The study findings on each of the statements made about the Life holder of people variation among community members were obtained using questionnaires with a Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree) and results are presented using percentages, mean and opinions as indicated in Table 4. 10.

Table 4. 11: Life holder of people variation among community members

Items on life holder of people variations	**SA**	**A**	**N**	**D**	**Mean**	**Opinion**	**Sd**
The low quality of water infrastructure such as tap water supply impact negatively livelihoods of people	10%	67%	10%	13%	3.95	Agree	.847
Practicing proper hygiene and sanitation can reduce the disease burden among households	18%	61%	8%	13%	3.97	Agree	.839
Adequate clean water is an essential prerequisite for household economic improvement.	18%	48%	19%	15%	3.84	Agree	.966
Poor water quality causes many diseases but this varies among different economic classes.	23%	50%	18%	10%	3.98	Agree	.976
Inadequate access to safe drinking is caused by frequent breakdowns in water infrastructure.	13%	71%	3%	13%	4.15	Agree	1.27
Poor sanitation increases the risk of faecal-oral transmission exposing children to pathogens.	5%	64%	19%	13%	3.96	Agree	.935
Grand Mean					**3.97**	**Agree**	

The majority of respondents, as shown in Table 4. 10, agreed with the assertions or suggestions made on variances in life expectancy based on weighted averages in Table 4. 7. The grand mean of 3.97 shows respondents was in agreement that Life holder of people varies among community members.

The results of the aforementioned study are supported by data from KIIs and FGDs, which showed that enhancing water quality at the point of household use and consumption has the

potential to shield members of the household from water-borne illnesses like diarrhoea, typhoid, and cholera.

According to information from KIIs with the city water department and NWSC, which is related to the aforementioned, the community's use of water and sanitation services may depend on whether or not they stand to directly benefit from taking part in the operation and maintenance of water sources. Most individuals believe it is not their responsibility to preserve excellent water quality if they are not elected to a water user group. To assess the use of water services, Jinja City has made an effort to compile data on the number of male and female private operators of piped water systems, owners of water and sanitation construction companies, and operators of water and sanitation services in urban areas.

4.3.3.1 Discussion

In support of the above study findings, one top official from the NWSC Jinja branch had this to say on the interventions to improve the quality of water available in the study areas.

"To avert future water-related challenges, we need to work on issues of mind change and also shift in the way we manage urban water systems. This paradigm shift must be based on several key concepts of urban water management, namely that: water is a cycle and hence we must consider interventions over the entire urban water cycle; we must reconsider the way water is used (and reused), and we must promote the greater application of natural systems for water and wastewater treatment."

4.3.3.2 Pearson correlation between life holder of people variation and effect on household livelihoods

Using inferential statistics, it was possible to determine the testing connection between these two research variables and determine if there was statistical significance between them by computing the Pearson Correlation Coefficient. Table 4. 12 displays the findings of the Pearson correlation.

Table 4. 12: Results between life holder of people variation and effect on household livelihoods

Correlation coefficients			
		Life holder of people variation	Effect on Household Livelihoods
Life holder of people variations	Pearson correlation	1	.694
	Sig. (2-tailed)		.000*
	N	285	285
Effect on household Livelihoods	Pearson correlation	.694	1
	Sig. (2-tailed)	.000*	
	N	285	285

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

The Pearson correlation coefficient results in Table 4. 12 indicate a moderate and positive correlation (r=.694) between the life holder of people variation and the effect on household livelihoods in Jinja City. In the same way, inferential statistics indicated a significant statistical relationship between the study two study variables as indicated by p-value (p=.001) which is less than the recommended significance level (0.01).

To determine the strength of the relationship, the coefficient of determination (r^2) was computed as follows: That is r^2 = (0.694x0.694) x 100 = 48%. This implies that holding other factors constant, life holder of people variation influences household livelihoods by 48%, meaning a percentage increase in independent variable results in a percentage increase in household expenditure to meet water, health and other household necessities. Hence, the life holder of people variation accounts for less percentage as compared to the other two independent variables.

4.3.4 Effects of poor drinking water on household livelihoods in Jinja City

The study findings on each of the statements made about the effects of poor drinking water on household livelihoods (dependent variable) in Jinja City were obtained using questionnaires with a 5 Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree) and results are presented using percentages, mean and opinions as indicated in Table 4. 12.

Table 4. 13: Items on effects of poor drinking on household livelihoods

Items on effects of poor drinking on livelihoods	**SA**	**A**	**N**	**D**	**Mean**	**Opinion**	**Sd**
Poor quality water infrastructure such as broken taps for water supply negatively livelihoods.	10%	73%	6%	11%	4.128	Agree	.9681
Practicing poor hygiene and sanitation behaviours increase the disease burden among households	9%	79%	2%	10%	4.116	Agree	1.245
Poor access to drinking water increases medical health service bills for households	25%	63%	6%	6%	4.142	Agree	.9872
Children are more likely to be exposed to diseases through faecal-oral transmission when there is poor sanitation.	15%	60%	16%	10%	3.967	Agree	.9263
Disease trends in Jinja City have been reduced because of improved water sources.	4%	65%	4%	27%	3.919	Agree	.9358
Diseases from the contaminated water have worsened the costs of household treatment.	9%	60%	11%	20%	3.919	Agree	.9557
In Jinja City at least, one member of the household experiences Diarrheal causing infections annually.	10%	73%	6%	11%	4.148	Agree	.9781
High-cost trends related to treatment for water-related diseases among households in the last year.	9%	80%	2%	10%	4.216	Agree	1.249
Grand Mean					**4.07**	**Agree**	

As indicated in Table 4. 13, the majority of the respondents were in agreement with statements or items provided on the effects of poor drinking on household livelihoods based on weighted means in Table 4. 7. The grand mean of 4.07 shows respondents was in agreement that poor drinking water affects household livelihoods.

The above findings are supplemented by qualitative data from FGDs with youth which revealed that most youth especially females expressed worry and fear in the period when water is scarce in Jinja City where they resort to fetching water from Lake Victoria and River Nile yet this water is fit for domestic use and drinking since it is not treated. In support of these results, one female participant in FGD in Masese had this to say:

"*In our communities, insufficient water means that most youth especially boys will move around without bathing but it is different for girls once puberty hits and this has the largest impact on female children. Girls will need water to keep themselves clean and avoid contracting STIs associated with poor sanitary facilities including latrines*."

The qualitative data from FGD with youth revealed that most school-going children especially girls have largely been impacted by poor hygiene resulting from insufficient availability of safe and clean water among households. This has forced some girls out of school because they spend much of their morning and evening hours (Rush) moving over long distances to look for water sources. The lack of viable school days and education will hinder the next generation of Ugandan females from breaking the pattern of unequal opportunities for meaningful work. They recommended that to expand water connectivity and coverage from the national grid or NWSC scheme, the Jinja City government should collaborate with other stakeholders. When women and children have access to clean water, their homes will be healthier, their cleanliness will be better, and their chances and potential as school-age children will increase.

4.3.4.1 Discussion

The findings discussed above are in line with Alaerts and Kaspersma's (2009) recommendation that initiatives for institutional and capacity development in water-related development should take into account a multi-dimensional approach involving four interrelated levels: individual, organizational, enabling environment, and civil society. Additionally, they suggested that institutions be strengthened, instruction be given, and residents be informed about the value of and how to use water.

4.3.4.2 Top Causes of Mortality in Jinja

According to statistics from July 2018-June 2019 (Jinja Referral Hospital, 2023), the cases of Diarrhoea (a water-related disease) were 455, and the death reported was 18, representing a fatality rate of 4% and 3.4% of total deaths as shown in Table 4. 14. This agrees with what was discovered from the field data that trends of water-related diseases and their effects affect the community negatively as show in graphs on Figure 4. 3 and Figure 4. 4.

Table 4. 14 Top causes of mortality July 2018-June 2019

S/N	Disease	Case	Death	Percentage of deaths (%)
1	Malaria total	1653	65	12.3
2	Malaria Confirmed (Microscopic &RDT)	1654	25	4.7
3	Anaemia	1075	87	16.4
4	Pneumonia	901	49	9.3
5	Injuries: Road Traffic Accidents	681	16	3.0
6	Septicemia	661	33	6.2
7	Injuries: (Trauma due to other causes)	667	10	1.9
8	Other Neonatal Conditions	573	41	7.8
9	Premature baby (as a condition that requires mgt)	490	73	13.8
10	Diarrhoea - Acute	455	18	3.4
11	Gastro-intestinal disorders (non-infective)	466	1	0.2
12	Neonatal Sepsis 0-7days	339	28	5.3
13	New TB cases diagnosed: Clinically Diagnosed	332	29	5.5
14	Hypertension (Old cases)	339	8	1.5
15	Respiratory Infections (Other)	313	2	0.4
16	Severe Malnutrition (SAM): Without oedema	288	22	4.2
17	Sickle cell Anaemia	285	6	1.1

18	Measles	274	5	0.9
19	Hypertension (Newly diagnosed Cases)	210	11	2.1
	Total	**11656**	**529**	

(Source: (Jinja referral hospital, 2023))

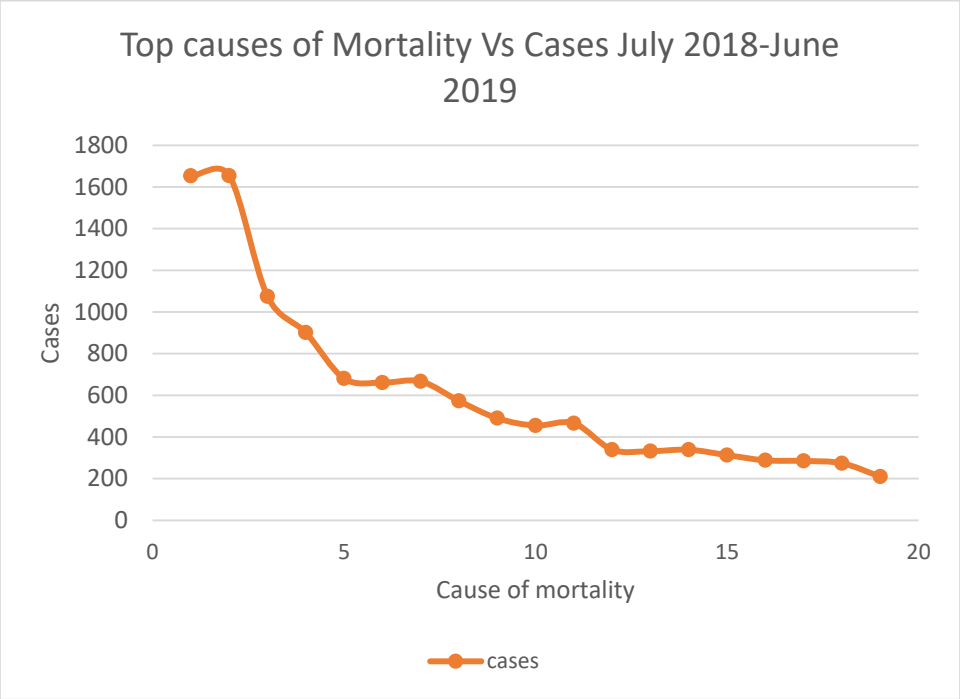

Figure 4. 3 Top causes of Mortality vs Cases

On horizontal axis, number from 1 to 19 indicate the diseases as show in table 4.18

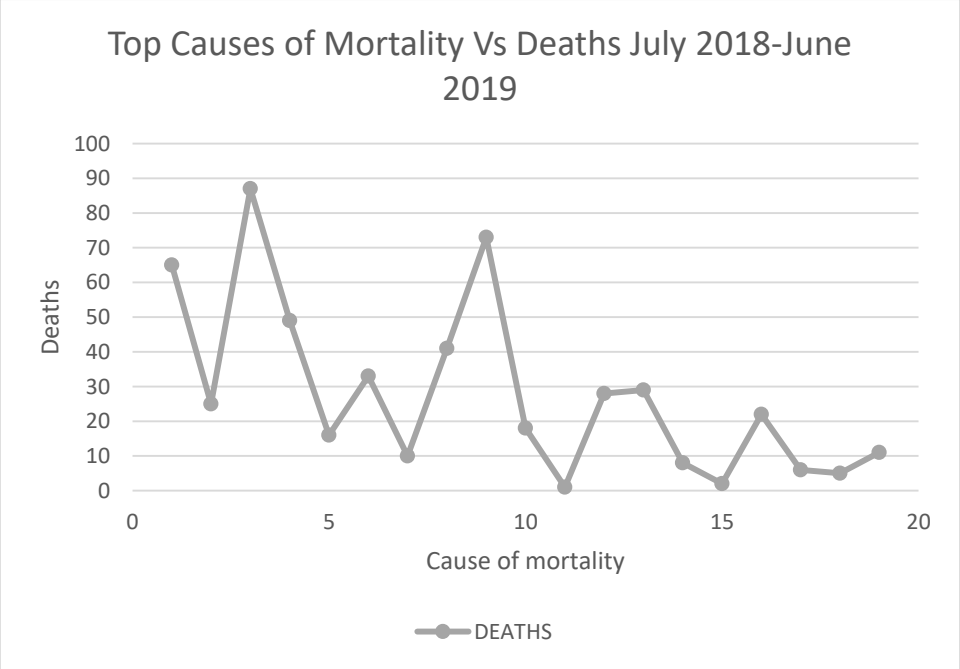

Figure 4. 4 Top causes of Mortality Vs Deaths

On horizontal axis, number from 1 to 19 indicates the diseases

4.4 Effect of existing and alternative cheap sewer treatment techniques on household livelihoods

As seen in objective two, water quality, the ease of access to water sources has significant effect on disease prevalence rates, disease trends, income, expenditure, productivity. It is thus important to assess the effect of existing sewer treatment techniques on household livelihoods and also explore cheaper sewer treatment techniques used by locals. Sewer coverage in Jinja is 25%. 25% use septic tanks, 50% use pit latrines while in Kampala sewer coverage is 6% which is still demanding (USAID, 2014). There is need to explore alternative cheaper sources of sewer treatment employed by locals in treatment of wastewater.

Data was obtained from NWSC for treated wastewater for Kirinya and Kimaka ponds for the years 2020 and 2021 as indicated in tables 4.18, 4.19 and 4.20.

For Kirinya ponds, in June 2020, except for COD, the parameters which were passing the standards were EC, Alkalinity, TSS, BOD, Total phosphorus, Ortho-phosphates, Ammonia Nitrogen, and Feacal Coliforms, Table 4. 14

4.4.1 Wastewater analysis results for Jinja

From the available records, it was discovered that data from 2019 to 2021was most critical as shown in Table A. 5, Table A. 6 and Table A. 7.

4.4.2 Questionnaire analysis results

Data was also obtained from questionnaires which were issued. The study findings on each of the statements made about the alternative cheap sewer treatment techniques that can be used in the community were obtained using questionnaires with a Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree) and results are presented using percentages, mean and opinions as indicated in Table 4. 15.

Table 4. 15: Alternative cheap sewer treatment techniques that can be used in the community

Items on alternative cheap sewer treatment techniques	SA	A	N	D	Mean	Opinion	Sd
Improved cheap alternative treatment techniques have several economic benefits to the local population	20%	71%	6%	3%	4.22	Agree	1.24
Effective treatment of water using affordable techniques can reduce health care costs.	20%	62%	11%	7%	3.99	Agree	.889
Government support in providing alternative cheap water treatment can reduce disease and cost burden.	8%	60%	12%	20%	3.87	Agree	.899
Household knowledge and tools for ensuring safe drinking water is a very important aspect.	5%	82%	5%	8%	4.13	Agree	.984
Waterborne diseases are caused by poor maintenance of water treatment and distribution systems.	6%	65%	12%	17%	3.98	Agree	.857
Insufficient financial resources and poor management leads to unclean safe drinking water.	10%	73%	9%	8%	3.96	Agree	.968
Grand Mean					**4.02**	**Agree**	

As indicated in Table 4. 15 the majority of the respondents were in agreement with statements or items provided on cheap sewer treatment techniques based on weighted mean values in Table 4. 7. The grand mean of 4.02 shows respondents was in agreement that alternative cheap sewer treatment techniques can be used in the community.

Recommendation

Cheap sewer treatment use of, Instream wetland, moringa oleifera systems, Aeration weirs and adsorption/ Bio-oxidation process are one of the cheap treatments that can be applied easily in local communities. Instream wetland treatment on the existing drains that offers an efficient, inexpensive and simple treatment with efficiency of 71% and 85% on apparent color and turbidity removal.

Some of the locally available ways of preserving clean water for drinking at the household level mentioned included; solar and electric ultraviolet (UV) purification units, disinfection, ceramic filters and ultra-filtration systems but most of these techniques are used in institutions like schools hotels hospitals which use large quantities of water and some average household, especially in Walukuba division where some residents can afford the cost of buying and installing such water systems. However, in resource-constrained households, water for drinking is only preserved through boiling and this boiled water sometimes develops a bad odour when takes a long in a container without being consumed in time. In addition, firewood or charcoal used to boil water sometimes makes it smell smoke and distorts the original quality and test of drinking water.

In addition, the information from KIIs with NWSC officials revealed that pertaining keeping using cheaper sewer treatment technology or techniques, pit latrines are the most common sanitation technique in Jinja City, especially among slum dwellers and those in low-income laying areas. These are easy to dig and construct and an average household can afford the costs involved in putting such sanitation facilities. The sanitation building often contains walls and doors, and the dig-hole or constructed area is 1-3 m^3. The pit latrine can last some years since if it is used by more than one household it will last a shorter time.

Construction materials required for pit latrines consist of ordinary bricks, clay, and tree poles because of this simple construction technique used in pit latrines, in some households, their foundation is often fragile and can be life-threatening, especially for children and other vulnerable groups like the elderly. Due to their nature, some women prefer moving to long distances away from such facilities to ease themselves for fear of contracting UTIs because of poor hygiene most where a pit latrine is being used by more than one family. About the provision of cheaper but effective techniques for sewer treating, information obtained through

KIIs with officials from NWSC revealed that in the study area, people in the community make use of septic tanks are often stationed outside and below the ground.

4.5 Chapter Four Summary

Chapter Four contains the presentation, analysis and interpretation of the findings of the study. For the quantitative data, out of 384 household surveys that were distributed, 285 questionnaires were filled, making a response rate of 74%.

The qualitative data from FGD with youth revealed that most school-going children especially girls have largely been impacted by poor hygiene resulting from insufficient availability of safe and clean water among households. This has forced some girls out of school because they spend much of their morning and evening hours (Rush) moving over long distances to look for water sources. The next generation of Ugandan girls will be prevented from ending the cycle of uneven opportunity for meaningful work as a result of the lost number of possible school days and education. Diarrhoea (a water-related disease) was 455, and death reported was 18.

From wastewater analysis results, for Kirinya ponds, in June 2019 for example, except for COD, the parameters which were passing the standards were EC, Alkalinity, TSS, BOD, Total phosphorus, Ortho-phosphates, Ammonia Nitrogen, and Feacal Coliforms. This shows that sewer treatment techniques are not so effective.

About the provision of cheaper but effective techniques for sewer treating, information obtained through KIIs with officials from NWSC revealed that in the study area, people in the community make use of septic tanks are often stationed outside and below the ground. The proceeding chapter contains the conclusions and recommendations of the study.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The study's results and suggestions are presented in the following chapter.

5.2 Conclusions

In terms of critical physicochemical water properties, the study found that the water sample results for drinking and other study's domestic usage locations were dangerous. These water sources have favourable physicochemical properties that allowed for the propagation of several waterborne illnesses, such as cholera, diarrhoea, and typhoid, among others. Additionally, all water sample test results were above the WHO-recommended mean water turbidity of 5NTU (17 °C), which is necessary for V. cholera survival and transmission. These results justify the 4% case fatality rates and 3.4% of total deaths caused by acute diarrhoea in the year 2018-2019. This shows that if WASH services are improved, the health of the children will be improved.

The study discoveries revealed that the greater part of the respondents agreed with statements on trends of water-related diseases and this was the most important variable (66%) that influenced the dependent variable (household livelihoods), holding other factors constant as indicated by the person correlation coefficient test results. In addition, the majority of the respondents (56%) agreed on disease prevalence that influenced the household livelihoods lastly, most of the respondents agreed with the assertions made about Life holder of people variation among community members and this variable contributed 48%.

From the secondary data provided for Jinja from NWSC for Kirinya pond, some parameters like EC, BOD were not up to standard. This shows that sewer treatment techniques are not so effective thus the need to seek alternative but cheaper sewerage treatment techniques is expedient.

Although the problem of toilets is important, the safe removal of human waste and various domestic wastewater is a crucial component of good sanitation. Sanitation and good family hygiene extend well beyond the issue of toilets. Therefore, maintaining good personal, family, and cultural cleanliness and practices is essential if adequate sanitation is to be assured beyond the availability of actual restroom facilities, since they by themselves will not be able to address the issue. The idea that initiatives like encouraging cleanliness, educating the public about

water and waterborne illnesses, sanitation, and immunizations are essential to ensure that proper health is reached.

Additionally, even though boiling water is practical and advised by technical recommendations since it eliminates turbidity and kills microorganisms, there are problems with poor compliance because these populations lack access to firewood and charcoal, which are the primary sources of energy for cooking. Therefore, it is important to encourage alternate safe water delivery methods that use specific filters like decanting and sand filters and flocculation agents that do not use heat energy to reduce high-water turbidity and remove germs.

The mere provision of hard infrastructure like hand washing water facilities, construction of latrines, water storage facilities, and wastewater disposal among others as indicated in variables included in the econometric model is not a “silver bullet” solution for water problems in local communities, these infrastructures need to be combined with building capacity and awareness creation to make a sustainable impact on reducing water-related diseases and improve household livelihoods among communities in Walukuba considered as high-income earners, Lubaga as middle-income earner and Masese as lower income earners in Jinja City. This is in agreement with public health measures which should be put in place to avoid diseases such as educational programs, and recommending policies.

5.3 General Recommendations from the study

There is a need for health, water and hygiene awareness campaigns to ensure that people who stay around water sources follow the standard procedures and distance of digging pit latrines and ensure proper wastewater and other waste materials disposal from industrial parks and factories which have been found to contaminate water bodies. This can be possible by developing water-borne related disease profiles and most affected areas which presents a unique opportunity for timely budgeting and action-oriented responses.

It was found that as urbanization and socioeconomic activity in Jinja's industrial sector expanded, so did the number of nutrients and pollutants entering Lake Victoria and other water sources, further degrading the water's quality. As a result, solutions for more environmentally friendly products that are also more affordable must be introduced. Examples include on-site waste separation and reduction and effluent recycling.

The model's findings demonstrate that one of the crucial factors determining family welfare is hand washing with soap. The majority of the other Sustainable Development Goals (SDGs)—especially those that prioritize lowering child death, attaining universal primary education, combating diseases, and advancing gender equality and women's empowerment—rely on having admittance to better water and sanitation systems as well as improved hygiene practices like hand washing. As a result, society must embrace a new viewpoint on washing hands with soap.

There is also an urgent need for the workers at industrial sites to have improved and required training, as well as for the treatment facilities to receive proper maintenance. Because the people of the catchment area use resources and produce pollution at the same time, a wide multidisciplinary strategy must be emphasized in the environmental management plan for Jinja.

To decrease the time spent going to obtain water, the Jinja City NWSC branch must provide data on water depending on the percentage of men and women who use different water technologies. Data should also demonstrate how alternative water technologies are usable and feasible for different types of water users, including People with Disabilities (PWDs) and other disadvantaged populations.

The urban water cycle has to be constructed and maintained with the proper infrastructure. Protecting the infrastructure used to clean and transport the water (including the sources, treatment facilities, and distribution networks) is crucial for warranting the safety of drinking water and reducing the costs associated with insufficient drinking water.

5.4 Policy recommendations from the study

Policies regarding disposal of effluent from factories should be revised and updated to be more stringent to limit pollution of water bodies like Lake Victoria. The effluent should be pretreated before being released into the water bodies.

5.5 Recommendations for further study

It is necessary to perform more research to undertake a sanitary survey (a thorough examination of the complete mechanism for transferring water from the source to the mouth, especially water from springs to detect potential issues and alterations in drinking water quality).

Since Uganda is located in the tropics where sunlight is abundant, more research is needed to examine the use of solar energy (solar water purifiers) as a cheap alternative method of preserving water for domestic purposes among urban and rural households. This is because methods like cooking with firewood, charcoal, or electricity were proving to be expensive in the long run. Another study can be conducted to establish the effects of rapid urban Population growth and urbanization on water infrastructure development in urban cities in Uganda.

5.6 Study Strength

The study offered several advantages. The first step was to analyze the physicochemical properties of water from water sources throughout two periods (the dry and rainy seasons), using a cross-sectional and descriptive study design that combined qualitative and quantitative methods. The validity of the study's findings was enhanced as a result of the design's decreased risk of mistakes from one-off assessments. Second, the results were typical of the water sources in the research districts because they included a wide range of water sources, including lakes, rivers, open wells, and springs from various water sources in Jinja City.

Third, the use of reliable tools calibrated field meters, a Tetracon 96A-4 meter for conductivity, a WTW pH meter for pH, a WTW oximeter for DO and temperature, and a WTW pH meter for pH assessed the values quickly and accurately. Forth, the purposive selection of Jinja City with mushrooming industries and factories, and rapid urban population growth was an important aspect in examining the impact of waterborne related diseases and their effects on household livelihoods. This indicated that the findings had a greater chance of being applied by stakeholders aiming to increase admittance to safe water and avoid the spread of water-borne illnesses.

5.7 Study limitations

This research evaluated the effect of inadequate drinking water and sanitation (WASH) on livelihoods in Jinja City, Uganda, at a specific moment in time. The reason for this is the dearth of panel data required for a dynamic examination. The reliability and representativeness of the outcome evaluated throughout time may have been hampered as a result, in one way or another. Panel data may be used to perform longitudinal research, which can help solve these issues.

Additionally, even though the study found that the study area had favourable conditions for water-borne illnesses like cholera, typhoid, and diarrhoea (higher than recommended mean water turbidity and temperature of above 17 °C), the study was unable to document the cause-and-effect relationship between water and V. cholera because it is a disease that most commonly affects Ugandans. Therefore, more research utilizing relevant techniques is advised to establish such correlations.

Thirdly, only the five essential physicochemical water features, known as Vital Signs, were examined in water samples, although many other factors, such as nitrates, copper, lead, fluoride, phosphates, arsenic, and others, have an impact on the survival and health of living organisms. Therefore, more research on these other factors that this present study did not examine is needed.

5.8 Chapter Five Summary

The study's results and suggestions are presented in Chapter 5. According to the findings, Jinja City, Uganda's livelihoods are significantly impacted by the economic and health implications of inadequate drinking water, sanitation, and hygiene (WASH). The study recommended the need for health, water, and hygiene awareness campaigns to make sure that those who frequent water sources adhere to the recommended practices and keep a safe distance when digging pit latrines, as well as to ensure proper wastewater and other waste materials disposal from industrial parks and factories. Additionally, there is a pressing need for enhanced and mandated training of the staff at industrial sites as well as for adequate upkeep of the treatment facilities. References and appendices are included in the following sections.

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APPENDICES

Appendix I: Table of Sample Size determination

Table A. 1 Sample Size Determination

N-----n	N-----n	N-----n	N-----n	N-----n
10-----10	100-----80	280-----162	800-----260	2800-----338
15-----14	110-----86	290-----165	850-----265	3000-----341
20-----19	120-----92	300-----169	900-----269	3500-----346
25-----24	130-----97	320-----175	950-----274	4000-----351
30-----28	140-----103	340-----181	1000-----278	4500-----354
35-----32	150-----108	360-----186	1100-----285	5000-----357
40-----36	160-----113	380-----191	1200-----291	6000-----361
45-----40	170-----118	400-----196	1300-----297	7000-----364
50-----44	180-----123	420-----201	1400-----302	8000-----367
55-----48	190-----127	440-----205	1500-----306	9000-----368
60-----52	200-----132	460-----210	1600-----310	10000-----370
65-----56	210-----136	480-----214	1700-----313	15000-----375
70-----59	220-----140	500-----217	1800-----317	20000-----377
75-----63	230-----144	550-----226	1900-----320	30000-----379
80-----66	240-----148	600-----234	2000-----322	40000-----380
85-----70	250-----152	650-----242	2200-----327	50000-----381
90-----73	260-----155	700-----248	2400-----331	75000-----382
95-----76	270-----159	750-----254	2600-----335	100000-----384

(Source: Krejcie and Morgan (1970:608) in Amin (2005))

Where N= Population size and n= sample size required

Appendix II: Interview Guide for KIIs

1. How are old are you?
2. What is your marital status?
3. What is level of your education?
4. What are main sources of water in this place?
5. Do you think these sources of water are safe for drinking?
6. Do you think people in these areas have adequate access to safe water sources?
7. On average, how much is a jerrycan of water in this area? (**probe if this cost is expensive or not**)
8. What are some of the common water borne diseases?
9. Do you think people get easy access when to medical access when they have water borne diseases? (**probe for the distance to health facilities, availability of medical services and cost of meeting medical bills**)
10. Do you think people are aware about ways through which proper hygiene is kept among households? (**probe for availability of waste disposal, drying rack, storage for water for during, if they always boil water for drinking and if community construct and keep latrines clean**)
11. To what extent is the disease prevalence rate, income, expenses and its effects on productivity in terms of low, middle- and high-income areas?
12. Suggest ways or measures how water borne related diseases can be prevented and treated in this area?
13. What are the trend of diseases by time and its effects among lower, middle and high income areas in Jinja City?
14. What is the life holder of people variations among lower, middle- and high-income areas in Jinja City?
15. What are the alternative cheap sewer treatment techniques compared to the covey treatment in Jinja City?

THANK YOU FOR YOUR TIME AND COOPORATION

Appendix III: Questionnaire for household members in Jinja City

Dear Respondent;

My name is **Tumwesigye James**, currently conducting fieldwork for data collection for compiling a dissertation for the award of an MSc in Water and Sanitation Engineering of Kyambogo University titled **Assessing the Economic and Health Cost of Poor Drinking Water and Sanitation on Livelihoods in Uganda: A Case Study of Jinja City.** Am kindly requesting your assistance in answering the questions provided in the questionnaire. The answers provided shall be treated with auto most confidentiality and for only academic purposes. Thank for your time in advance.

Section A: Demographic characteristics

1. **Age of the respondent** (*use codes below and tick appropriate options*)

Age brackets of respondents	**Codes**
18-25 years	1
25-32 years	2
32-39 years	3
39-46 years	4
46-50 years	5
50 and above	6

2. **Sex of the household head** (*use codes provided to tick the correct option*)

Sex/gender of the household head	**Codes**
Male	1
Female	2

3. **Sex of the respondent** (use codes provided to tick correct options)

Sex/gender of the household respondent	**Codes**
Male	1
Female	2

4. **Marital status** (use provided codes below to tick the correct options)

Marital status of the respondents	**Codes**
Single	1
Married	2
Separated/divorced	3
Widow	4

5. **Education level of respondents** (use provided codes below to ick correct options)

Education qualification of the respondents	Codes
None formal	1
Primary	2
Secondary	3
Tertiary (Certificate/Diploma	4
University degree	5

6. **Source of income/livelihoods** (use codes below to tick right option)

Source of income for the respondents	**Codes**
Monthly pay/ salary	1
Business /self-employed	2
Agricultural (Animal products)	3
Agricultural (crop products)	4
Agricultural both animals and crops	5
Others (**specify**)	6

7. **Household head category** *(use codes provided below to tick right option)*

Category of the household head	**Codes**
Male headed	
Females headed	
Child head	

8. How many people live in this household?.....
9. How many boys and girls in this household?.....
10. Among boys and girls, who participate mostly in fetching water for domestic use?

.....

.....

.....

.....

11. What could be reasons for your answer in QN 10 above?

.....

.....

.....

.....

12. **Category of residential area** (*use codes provided below to tick right option*)

Urban	
Semi-urban	
Slum dweller	

13. **Water source near household** *(use codes provide to tick appropriate options)*

Water source near household	**Codes**
Private taps	1
Public taps	2
Bore-hole	3
Protected well/spring	4
River	5
Vendor/Tanker trunk	6
Rainwater	7
Other **(specify**)	8

14. **Quality of water source (use codes to tick appropriate options)**

Quality of water source	**Codes**
Improved water source	1
Not improved	2
Not sure	3

15. **Distance to water sources** *(use codes to tick appropriate options)*

Distance from household to water sources	
0 Km	1
0.1-0.5 km	2
0.5-1 km	3
1.01-2.9 km	4
3+ km	5

16. How much is a jerrican (20Ltrs) of water in this community?

.....

.....

17. How do you rate the price of jerrican of water in this community (*use codes below*)

Rating options	**Codes**
Cheap	1
Moderate	2
Expensive	3
Very expensive	4

18. What are some of the challenges do face in accessing safe water in these areas?

.....

.....

.....

.....

.....

.....

19. What measures do you think can be done to solve such water challenges?

.....

.....

.....

.....

.....

20. **Sanitation and hygiene in the area (***Type of latrine used in the household)*

Category of latrine used at the household level	**Codes Provided**
Covered pit latrine private	1
The covered pit latrine shared	2
Uncovered pit latrine	3
VIP latrine private	4
VIP latrine shared	5
Flush toilet private	6
Flush toilet shared	7
Bush /open area	8
Other (specify)	9

21. **Availability of water washing facility on latrines** (use codes to tick appropriate options)

Availability of water washing facility in the latrine	**Codes**
No	1
Yes, without water	2
Yes, without soap	3
Yes, with water and soap	4

22. Availability of other essential items at household (use codes Yes=1, No=2 to tick)

Essentials items at the household level	**Codes (Yes)**	**Code (No0**
Water storage equipment at household	1	2
Child feaces disposal	1	2
Presence of utensils drying rack	1	2
Waste water disposal method	1	2
Household head education level	1	2

Section B: Disease prevalence rate, income, expenses and its effects on productivity

23. Use the following 5 Likert scale codes to tick the best alternatives on this study objective (strongly agree=1, agree =2, neutral =3, disagree =4 and strong disagree =5)

Items on disease prevalence, income expenses and their impact	**SA**	**A**	**N**	**A**	**SD**
There are high disease incidences in the community due to inadequate safe drinking water	1	2	3	4	5
Water-related diseases in the community are on increasing due to contamination from faeces or other pollutants	1	2	3	4	5
There are increased recorded cases of Diarrhea as the result of inadequate safe drinking water.	1	2	3	4	5
Waterborne diseases are more pronounced among urban poor like children than it is among rich households.	1	2	3	4	5
Diarrhoea as a result of inadequate access to safe drinking water has serious financial costs on household	1	2	3	4	5
In this community, there is a possibility of people being at risk of getting soil-transmitted helminth (STH) infections.	1	2	3	4	5
Inadequate access to safe drinking water in this community has led to productivity losses as people are bedridden and seeking healthcare.	1	2	3	4	5
Waterborne diseases have increased household expenditure on health care and treatment.	1	2	3	4	5

24. What are some of the common water-borne diseases at least a family member has suffered from in the last 6 months?

    .....

    .....

    .....

25. Did a member of the family seek for medical health care services to treat the sickness?

    ……

    ……

    ……

26. How do you rate access and availability of health care services in these areas? (*use codes to tick appropriate options*)

Health care diameters	**Codes**
Drugs are always available in government health facilities	1
Drugs are available but with little disease coverage	2
There is always drug stock out	3
Healthcare services are expensive, especially for private	4
Health personnel provide the necessary care to patients	5

27. How much money did you spend on medical healthcare services in the past 12 months?

    ……

    ……

    ……

28. How do you rate the price of health care services? (*Use codes provided to tick the most appropriate options)*

Rating health care services in areas	**Codes**
Cheap	1
Affordable	2
Moderate	3
Expensive	4
Very expensive	5

Section C: Trends of water-related diseases and their effects on the community

29. Use the following 5 Likert scale codes to tick the best alternatives on this study objective (strongly agree=1, agree =2, neutral =3, disagree =4 and strongly disagree =5)

Items on disease prevalence, income expenses and their impact	**SA**	**A**	**N**	**A**	**SD**
Disease trends in Jinja have reduced because of improved water sources.	1	2	3	4	5
Diseases from the contaminated water have worsened the costs of household treatment.	1	2	3	4	5
In the past 12 months, at least one member of my family experienced Diarrheal causing infections.	1	2	3	4	5
Trends in the cost of treatment especially for water-related diseases have gone high in my household.	1	2	3	4	5
In the last 6 months, at least one member of my family was admitted as a result of poor drinking water.	1	2	3	4	5
Trends in health care services related to water, hygiene and sanitation have increased.	1	2	3	4	5
Repeated episodes of diarrhoea and chronic helminth infections have nutrient absorption among children in this community	1	2	3	4	5

30. If you compare the past two (2) years and now, do you think the spread of waterborne diseases has reduced or increased?

    .....

    .....

    .....

31. Give reasons to support your answer choice in QN 28

    ……

    ……

32. What are some of the measures that can be used to reduce the effects of water-borne related diseases?

    ……
    ……

Section D: Life holder of people variation among community members

33. Use the following 5 Likert scale codes to tick the best alternatives on this study objective (strongly agree=1, agree =2, neutral =3, disagree =4 and strongly disagree =5)

Items on life holder of people variations	**SA**	**A**	**N**	**D**	**SD**
The low quality of water infrastructure such as tap water supply impact negatively livelihoods of people	1	2	3	4	5
Practicing proper hygiene and sanitation can reduce the disease burden among households	1	2	3	4	5
Adequate water and sanitation are essential prerequisites for household economic improvement.	1	2	3	4	5
Poor water quality causes many diseases but this varies among different economic classes in Jinja town.	1	2	3	4	5
Inadequate access to safe drinking is caused by a frequent breakdown in water infrastructure affecting lifestyles.	1	2	3	4	5
Poor sanitation increases the risk of faecal-oral transmission exposing children to pathogens and infectious diseases that lead to loss of lives.	1	2	3	4	5

34. Do you have a water user committee in this area responsible for keeping water sources clean and protected?.....

35. What are the critical roles played by those water user committees?

    ……
    ……
    ……

36. Do you think water availability and access affect rich and poor residents in the same way in this community?.....

37. Give reasons to support your answer in QN 36

……

……

…….

Section E: Alternative cheap sewer treatment techniques that can be used in the community

38. Use the following 5 Likert scale codes to tick the best alternatives on this study objective (strongly agree=1, agree =2, neutral =3, disagree =4 and strongly disagree =5)

Items on alternative cheap sewer treatment techniques	**SA**	**A**	**N**	**D**	**SD**
Improved cheap alternative treatment techniques have several economic benefits to the local population	1	2	3	4	5
Effective treatment of water using affordable techniques can reduce health care costs.	1	2	3	4	5
Government support in providing alternative cheap water treatment can be a very important step in reducing disease and cost burden among households.	1	2	3	4	5
Providing households with knowledge and tools on how an important step in ensuring the safety of drinking water	1	2	3	4	5
Much of water-related issues are the result of neglected maintenance of water storage, treatment, and distribution systems.	1	2	3	4	5
Insufficient financial resources and poor management leads to deterioration in the availability of safe drinking water.					

39. Mention some of the locally available ways of preserving clean water for drinking at the household level.

……
……
……
……

40. What are some of the challenges in using such methods of preserving water clean for drinking?

……
……
……
……
……...

41. What do you think can be done to provide cheap but effective methods or techniques of treating water for drinking in this community?

……
……
……
……
……..

Section F: Effects of poor drinking water on household livelihoods

42. Use the following 5 Likert scale codes to tick the best alternatives on the cost of poor drinking water in Jinja City (Strongly Agree = 1, Agree = 2, Neutral = 3, Disagree = 4 And Strongly Disagree = 5)

Items on effects of poor drinking on livelihoods	**SA**	**A**	**N**	**D**	**SD**
The low quality of water infrastructure such as tap water supply impact negatively livelihoods of people	1	2	3	4	5
Practicing poor hygiene and sanitation behaviours increase the disease burden among households	1	2	3	4	5
Poor access to drinking water increases medical health service bills for households	1	2	3	4	5
Poor water quality causes many diseases and this affects the economic productivity of the people in Jinja City	1	2	3	4	5

Inadequate access to safe drinking is caused by a frequent breakdown in water infrastructure affecting lifestyles.	1	2	3	4	5
Poor sanitation increases the risk of faecal-oral transmission exposing children to pathogens and infectious diseases that lead to loss of lives.	1	2	3	4	5
Disease trends in Jinja city have been reduced because of improved water sources.	1	2	3	4	5
Diseases from the contaminated water have worsened the costs of household treatment.	1	2	3	4	5
In Jinja City at least, one member of the household experiences Diarrheal causing infections annually	1	2	3	4	5
Trends in the cost of treatment for water-related diseases have gone high among households in the last year.	1	2	3	4	5

END

THANK YOU FOR YOUR TIME AND COOPORATION

Appendix IV: Determination of Chemical/Biological Parameters in Water

Measurement of Dissolved Oxygen and Temperature

Oximeter was used to measure Dissolved oxygen of the samples

Procedure

- The meter was switched on and it performed self-test.
- 100ml of test sample was measured and put into a plastic beaker
- The DO sensor was immersed into the test sample in a beaker.
- The meter displayed measured parameter (DO) concentration in mg/l as well as temperature as ^{o}C.
- The display flashed until a stable measured value was availed in about 20 seconds.

Measurement of Ortho phosphates

Determined using ascorbic acid method, where Ammonium molybdate and antimony potassium tartrate react in an acid medium with phosphorous to form an antimony - phospho-molybdate complex. This complex is reduced to an intensely blue colored complex by ascorbic acid. The colour is proportional to phosphorous concentration in a given sample.

Reagents: combined reagent and ascorbic acid was used during the tests, combined reagent contained a mixture of Sulphuric acid, potassium antimony tartrate and Ammonium molybdate which was prepared as shown below.

- 70ml of conc Sulphuric acid was diluted with 500ml of distilled water
- 1.37g of P0tassiium antimony tartrate was dissolved into 400ml of distilled water
- 20g of Ammonium molybdate was dissolved into 500ml of distilled water and
- 1.76g of Ascorbic acid powder was dissolved into 100ml of distilled water'

Procedure

- The sample was filtered using 0.45 micro meter what man filter papers and the filtrate was used as test sample.
- Blank sample was prepared by measuring 25ml of distilled water
- 25ml of standard phosphate was also measured and finally 25 ml of test sample or filtrate was measured also
- 3ml of combined reagent was added to each of the samples and followed by 1ml of ascorbic acid added to each sample.

- The samples were given a reaction time of 20 minutes.
- Then concentration of phosphate in the sample was measured in mg/l at wavelength of 880 nanometers using a Spectrophotometer.

Measurement of total phosphate

Done using Persulphate method which involved digestion of acidified samples by heating them at 120^{o}C for 30 minutes

Procedure

- 25ml of test sample was acidified using 1ml 0.04m Sulphuric acid and then add 5ml of digestion regent (potassium persulphate-5g of potassium persulphate was dissolved into 100ml of distilled water)
- A blank 25ml of distilled water and 25ml of phosphate standard were prepared and treated with as above in the test sample.
- The samples were autoclaved at 120^{o}C for 30 minutes and left to cool to room temperature.
- 3ml of mixed reagent (mixture of Sulphuric acid, potassium antimony tartrate and Ammonium molybdate) was added to each of the samples. Followed by 1ml of ascorbic acid added to each sample
- Samples were allowed to stand for 20minutes for reactions to occur.
- Concentration of total phosphate in mg/l was measured at 880nm using a spectrophotometer.

Measurement of Turbidity

Done using a turbid meter HACH-2100Q, technically turbid meters are known as nephelometers which are able to emit light and measure the amount of light scattered by particles in the sample and reflected back to the sensor which measures turbidity. High turbidity means intensely scattered light and vice versa. Turbidity is measured in Nephelometric Turbidity Unit (NTU)

Procedure

- Turbid meter was calibrated using HACH stabical formazin standards of 10NTU and 100 NTU
- Test sample was shaken thoroughly, waited for air bubbles to disappear and poured into a turbidimeter glass sample tube.

- The glass tube was well cleaned using dry paper tissue and inserted into the turbidimeter
- The instrument directly displayed the turbidity reading of the test sample in NTU.

Measurement of Nitrogen Ammonia

In this analysis Nesslerisation method was used, in alkaline solution the iodide and mercury ions in Nesslers reagent react with ammonia to form a brown complex. The strength of the colour is proportional to the amount of ammonia present.

Procedure

- 25ml of sample was measured and treated with 1ml Nesslers reagent and allowed to stand for one minute reaction. 25 ml of blank sample and 25ml of standard were measured and treated with 1ml Nesslers reagent as well.
- The concentration of ammonia in the test sample was determined by the help of a spectrophotometer at 425nm wavelength, and recorded in mg/l.

Measurement of Nitrate-nitrogen

Determined using Cadmium Nitraver method

Procedure

- 25 ml of test sample was measured and contents of one pillow Nitraver 6 was added.
- Followed by addition of contents of one pillow Nitraver 3reagent powder sample was swirled for one minute to dissolve. Sample stood for 15minutes to react and develop a pink colour indicating the presence of nitrates. 25ml of test sample without adding Nitraver 6 and 3 reagent pillow was poured into the cell and used as a blank.
- The concentration of nitrates was measured using spectrophotometer reading at 507nm wavelength.

Method for analyzing PH

The pH is the negative logarithm of the hydrogen ion concentration in moles per liter. pH in water samples is determined by measurement of a voltage produced between an electrode responsive to hydrogen ions and a reference electrode when both are immersed in the sample.

Equipment/ Reagents

- WTW Ino Lab pH meter
- 3M KCl

- Standard pH buffers (pH 4, 7 and 10)
- Distilled water
- Soft tissue paper

Standardization of the equipment

a) The pH electrode was rinsed with distilled water and wiped gently with a soft tissue paper.
b) The rinsed electrode was then placed in standard pH buffer 4.00 and the reading adjusted to the appropriate pH.
c) Steps (a) to (b) were repeated for pH standard buffers 7.00 and 10.

Sample measurement

- The pH electrode was rinsed with distilled water and wiped gently with a soft tissue paper.
- The rinsed electrode was immersed in a beaker containing the sample and the stable reading taken after 30 seconds.
- The pH electrode was then rinsed with distilled water and dried gently with a soft tissue paper.
- The electrode was stored in 3M KCl.

Electrical conductivity (EC)

Conductivity is a measure of the sample's capacity to convey electrical current; it is directly related to the concentration of ionized substances in the sample.

Equipment/ Reagents

- WTW Ino Lab EC meter
- Standard EC (1413µs/cm)
- Distilled water
- Soft tissue paper

Standardization of the equipment

a) The EC electrode was rinsed with distilled water and wiped gently with a soft tissue paper.
b) The rinsed electrode was then placed in standard EC 1413µs/cm and the reading adjusted to the appropriate EC.

Sample measurement

- The EC electrode was rinsed with distilled water and wiped gently with a soft tissue paper.
- The rinsed electrode was immersed in a beaker containing the sample and the stable reading taken after 30 seconds in µs/cm.
- The EC electrode was then rinsed with distilled water and dried gently with a soft tissue paper.

Total Alkalinity

This reaction is neutralization reaction where the hydroxyl ions present in a sample react with addition of standard hydrochloric acid.

Equipment

- Gloves
- 1000ml Beaker
- 1000ml measuring cylinder
- 1000ml volumetric flask
- 100ml measuring cylinder
- 10ml pipette
- 250ml conical flask
- Burette with stand and clamp
- Hot oven
- Analytical weighing balance
- Desiccator
- Pipette filler

Reagents

- Concentrated Hydrochloric acid
- 0.05N Na_2C0_3
- 0.1N Hydrochloric acid
- Mixed indicator solution
- Absolute ethanol (95%)
- Distilled water

Procedure for standardization of 0.1N Hydrochloric acid

- 8.3ml of concentrated hydrochloric acid were measured and added to one liter distilled water in a beaker (0.1N).
- Using a measuring cylinder, 60mls of distilled water were measured and transferred to a conical flask and added 40mls of 0.05N Na_2C0_3 (I dried 4g of primary standard Na_2C0_3 at 250^0C for 4 hours and cooled in a desiccator. I then weighed out 2.5g, transferred to a one liter volumetric flask and made up to one liter with distilled water)
- A burette was filled to the mark with 0.1N hydrochloric acid.
- The initial burette reading was taken.
- I added 2 drops of mixed indicator solution (100mg of bromocresol green and 20mg methyl red in 100ml of 95% ethanol) to the solution in the conical flask.
- Hydrochloric acid from the burette was then added slowly to the solution in the conical flask mixing thoroughly by swirling the flask until a permanent faint pink color was observed.
- The final burette reading was now taken.
- Normality = $\frac{\text{mass of } Na_2C0_3 \text{ weighed} * 40\text{ml } Na_2C0_3 \text{ taken}}{53.0* \text{ ml of acid used (titer value)}}$

Procedure for determining Total Alkalinity

- Using a measuring cylinder, I measured 100mls of the sample and transferred to a 250ml conical flask.
- I filled the burette with 0.02N hydrochloric acid (diluted 200ml of 0.1N hydrochloric acid to 1000ml with distilled water) up to the mark.
- The initial burette reading was taken
- I added 2 drops of mixed indicator and then added the 0.02Nhydrochloric acid from the burette slowly mixing thoroughly by swirling the flask until the first appearance of a permanent faint pink color was seen in the conical flask.
- The final burette reading was taken.
- Total alkalinity = (Final burette reading minus initial burette reading)* 10 recorded in mg/L.

Biochemical Oxygen Demand (BOD)

BOD is a measure of the amount of oxygen consumed through biochemical degradation of organic carbon, inorganic materials and nitrogenous compounds present in a sample over a specified incubation period usually 5 days. The method involves filling an airtight bottle with a specified volume of sample to overflowing and incubating at a specified temperature for a specified period. Dissolved Oxygen is measured before and after incubation and the BOD is measured as the difference of the initial and final DO.

Equipment

- Dissolved Oxygen (DO) meter
- 300ml incubation bottles
- A 10ml pipette and filler
- Incubator oven
- Aerator
- Jerry can

Reagents used

Phosphate buffer solution

I dissolved 0.85g of KH_2PO_4, 2.18g of K_2HPO_4, 3.34g of $NaHPO_4.7\ H_2O$ and 0.17g NH_4Cl in 50ml of distilled water and adjusted the pH to 7.2 with NaOH solution then diluted to 100ml.

Magnesium Sulphate solution

3.64g of $MgS0_4.7H_2O$ were dissolved in 50ml of distilled water and then diluted to 100ml.

Calcium Chloride solution

I dissolved 3.64g of $CaCl_2.H_2O$ in distilled water and diluted to 100ml.

Ferric chloride solution

I dissolved 0.025g of $FeCl_3.H_2O$ in distilled water and diluted to 100ml.

Procedure

1. **Preparation of dilution water**
   1000ml of distilled water was transferred in a clean jerry can and saturated with air using an aerator.

I added 1 ml of each of phosphate buffer, Magnesium Sulphate solution, Calcium chloride solution and Ferric chloride solution.

I mixed thoroughly before use.

2. **Measurement of Initial Dissolved Oxygen (DO)**

   I added 1 ml of the sample to the 300ml incubation bottle and filled the bottle up to the brim with enough dilution water so that when a stopper is inserted; air would be displaced leaving no bubble.

   The DO meter was now inserted in the sample and the initial DO reading taken (DO_1)

   The bottle was stoppered tightly and placed in the incubator oven to incubate at 20^0C for five days making sure that all bottles were sealed before incubation.

   A blank sample with distilled water was incubated too.

   After 5 days, the prepared bottles were removed and the residual DO measured in the samples (DO_5).

   $$BOD_5\,(mg/L) = \frac{(DO_1 - DO_5) * \text{volume of incubation bottle}}{\text{Volume of sample taken}}$$

Chemical oxygen demand (COD)

Chemical Oxygen Demand determines the amount of oxygen required for oxidation of organic matter using a strong oxidant under reflux conditions.

Equipment

- Borosilicate culture tubes
- Gloves
- Face mask
- Laboratory coat
- Fume cupboard
- COD reactor
- DR Spectrophotometer

Reagents

Digestion solution

I dissolved 10.216g of potassium dichromate primary standard grade which had previously dried at 103^0C for 2 hours to 500ml distilled water, 167ml of concentrated Sulphuric acid and

33.3g of Mercuric sulphate. These were dissolved and then cooled to room temperature and diluted to 1000ml.

$H_2SO_4/AgSO_4$ solution

I added 10g of silver sulphate to one-liter concentrated sulfuric acid, let it stand overnight to dissolve and mixed carefully after dissolving.

4M H_2SO_4

I diluted 100ml concentrated Sulphuric acid carefully with distilled water up to 500ml.

Stock KHP

850mg potassium phthalate was dried at 120^0C for 24 hours, dissolved in 1000ml distilled water. The COD of this solution is 1000mg/L.

Procedure

- The digestion tubes and caps were washed with 4M Sulphuric acid before use to prevent contamination.
- I transferred 2ml of sample to the digestion tube and added 2mls of digestion solution (This procedure is done in a fume cupboard)
- I carefully ran 2ml of $H_2SO_4/AgSO_4$ solution down the inside of the tube so an acid layer is formed under the sample, then tightly capped the tubes and swirled several times to mix completely.
- The above procedure is repeated for the blank (distilled water) and the stock KHP.
- The tubes were then placed in a COD reactor preheated at 150^0C for 2 hours
- The next day, I transferred gently and without mixing to a 1cm tube and measured the concentration at 620nm against the blank using a DR Spectrophotometer in mg/L.

Appendix V: Wastewater results from L. Victoria for Jan 2021

Table A. 2 Water Quality Data Jinja On Lake Victoria

Jan 21		Water Quality Data Jinja on Lake Victoria								
Date	Raw water Source	Raw Water								
Jan-21		***pH***	***EC***	***Col***	***Turb.***	***TSS***	***Hdness***	***Alk***	***Iron***	***Feacal***
		…	*uS/cm*	*PtCo*	*Ntu*	*mg/l*	*mg/l*	*mg/l*	*mg/l*	*CFU/100mL*
1	L. Victoria	6.99	95.9	622	51.3	47	40	28		
2	L. Victoria	7.15	100.7	499	40.1	36				
3	L. Victoria	7.02	98.9	509.0	39	47	44	22	3.06	400
4	L. Victoria	7.21	94.9	499.0	40.6	38				
5	L. Victoria	7.21	104.6	527.0	48.1	39	40	24		
6	L. Victoria	7.31	100.7	641.0	52.6	47	44	20	1.94	620
7	L. Victoria	7.16	96.7	579.0	48.6	44	36	24		
8	L. Victoria	7.01	98.7	612.0	53	49	36			
9	L. Victoria	6.98	106.6	572.0	49.7	45	36	20		
10	L. Victoria	7.14	105.6	649.0	52.9	49			2.12	300
11	L. Victoria	7.12	97.6	655.0	56.8	51				
12	L. Victoria	6.99	95.7	701.0	58.9	50	40	28		
13	L. Victoria	7.22	100.1	617.0	48.6	43	44	24		
14	L. Victoria	7.12	98.6	609.0	53.6	49				520
15	L. Victoria	7.10	100.3	710.0	61.7	56	48	28		
16	L. Victoria	6.97	101.3	849.0	69.7	54			3.21	
17	L. Victoria	7.01	109.7	609.0	49.6	47	36	26		
18	L. Victoria	7.03	110	742	62.7	53	40	28		500
19	L. Victoria	7.06	104	618	56.3	40	38	24		
20	L. Victoria	6.97	107.4	659.0	56.3	49	36	20		
21	L. Victoria	6.94	109	628	53.6	48	36	20	2.64	360
22	L. Victoria	7.10	101	688	58.2	48				
23	L. Victoria	6.90	110.3	726.0	62.3	56				
24	L. Victoria	7.16	99.8	692.0	57.9	49	36	22		400
25	L. Victoria	6.96	104.2	713.0	60.7	58	40	24		
26	L. Victoria	6.99	108.6	685.0	55.4	50	38	20	2.83	
27	L. Victoria	7.05	106.3	716.0	59.6	53	40	20		500
28	L. Victoria	7.09	100.7	746.0	58.8	54	36	28		
29	L. Victoria	7.16	100.9	726.0	62.1	55				
30	L. Victoria	6.90	110.5	812.0	74.1	69	32	20		
	standards	6.5 -8.5	≤400µS/Cm	50.0	25		600		0.2	0

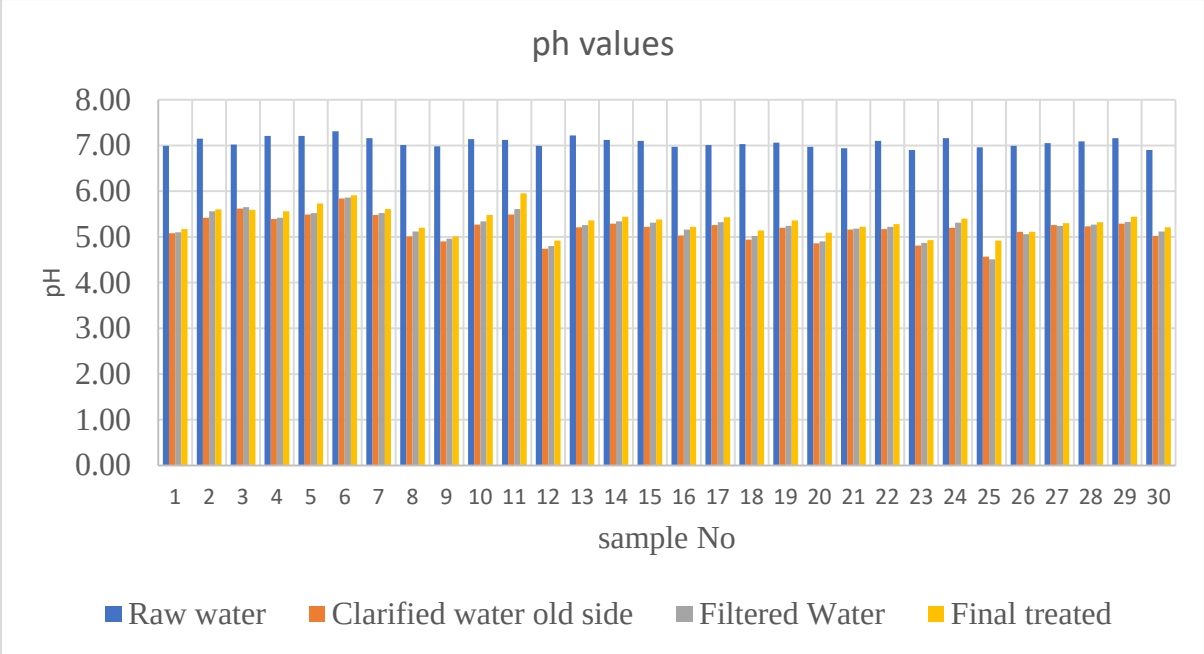

Figure A. 1 pH

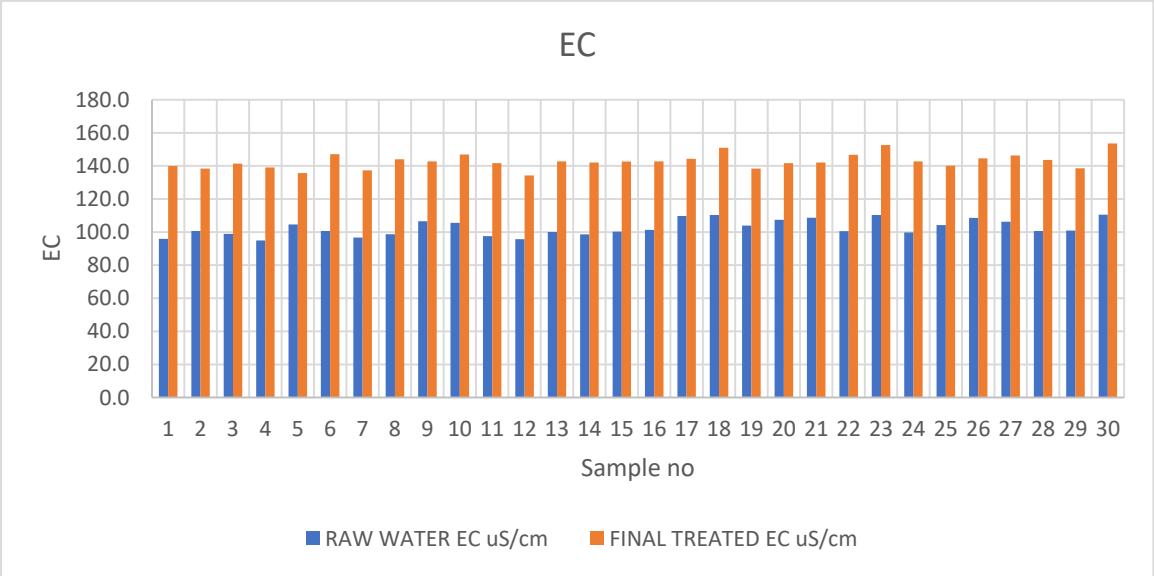

Figure A. 2 EC

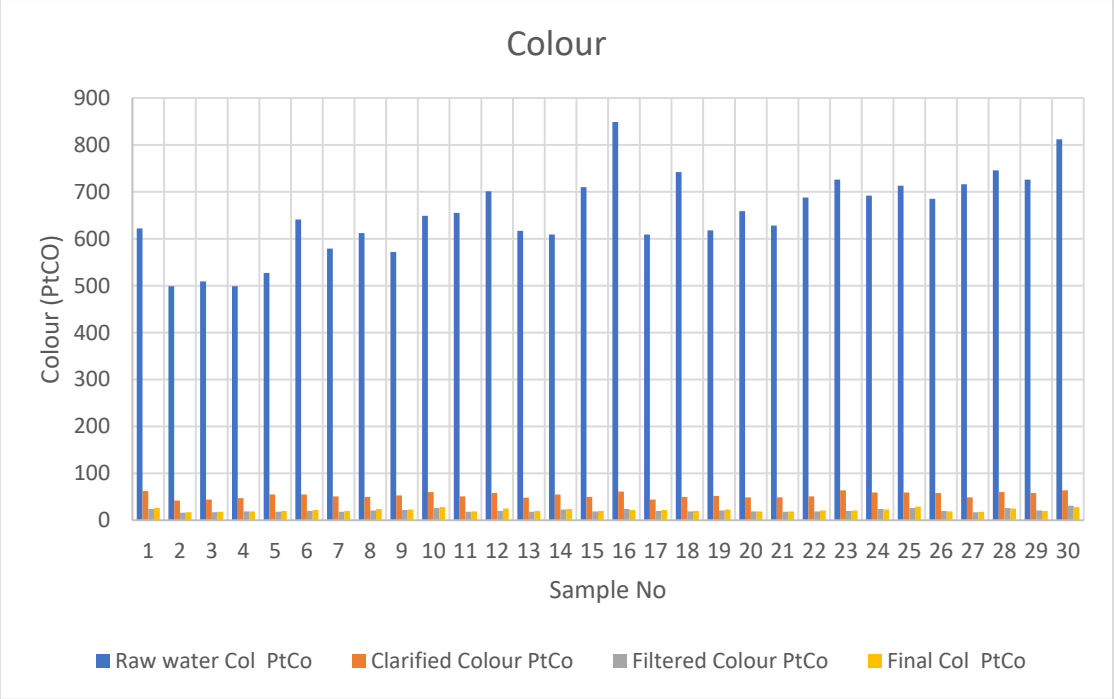

Figure A. 3 Colour

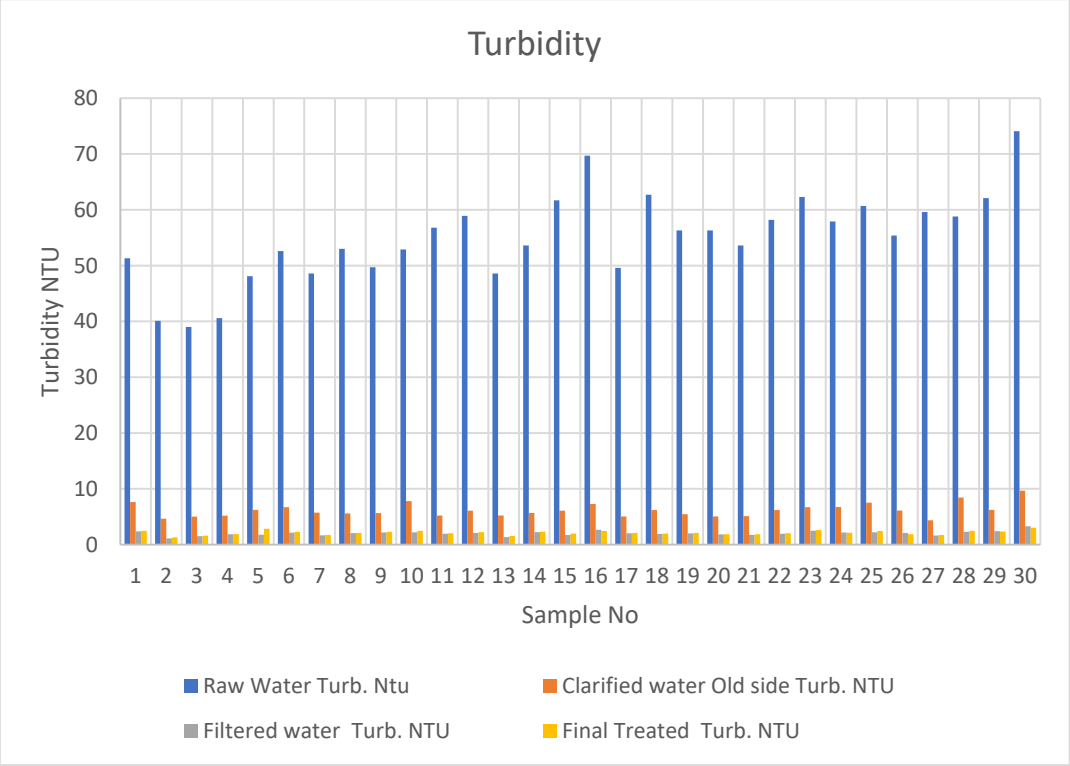

Figure A. 4 Turbidity

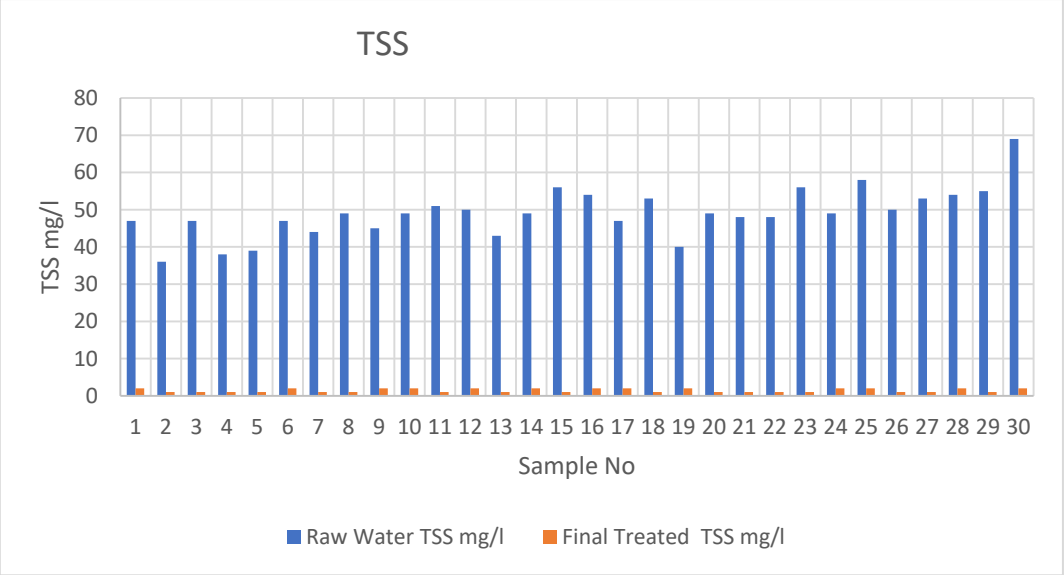

Figure A. 5 Total Suspended Solids

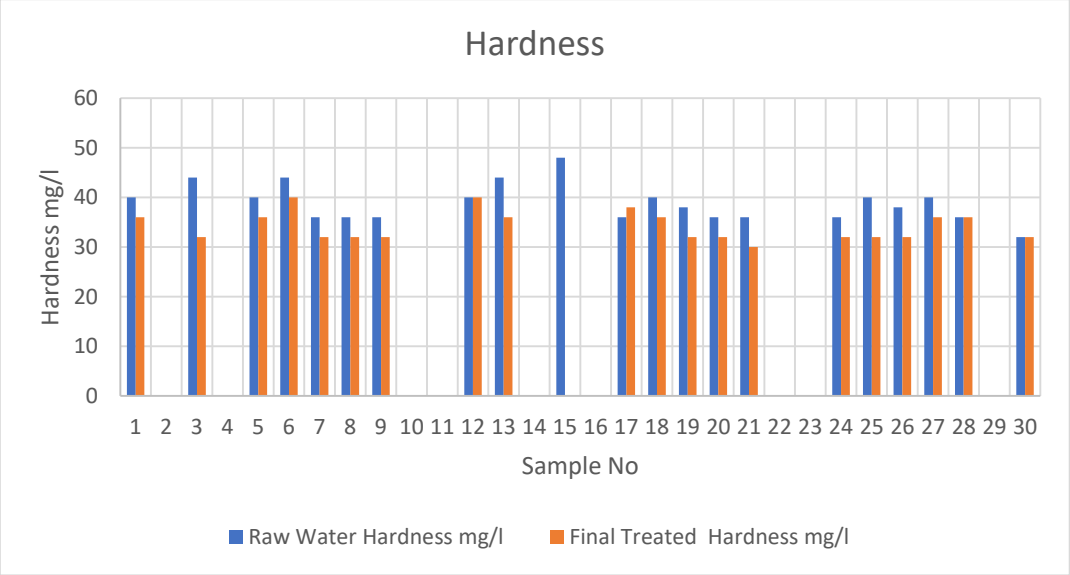

Figure A. 6 Hardness

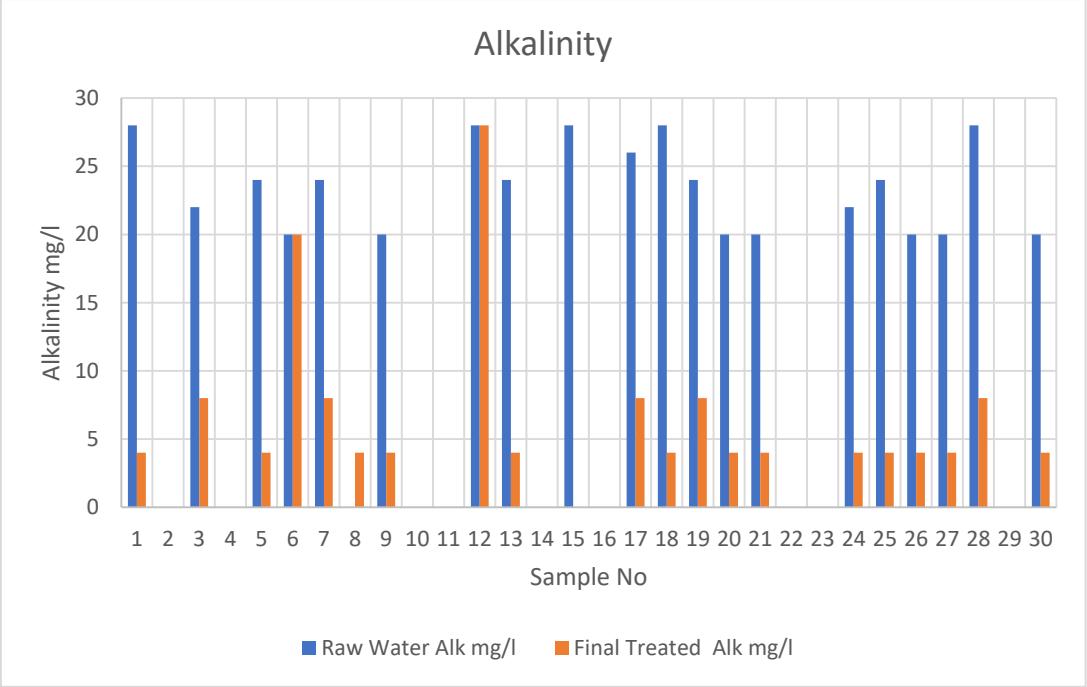

Figure A. 7 Alkalinity

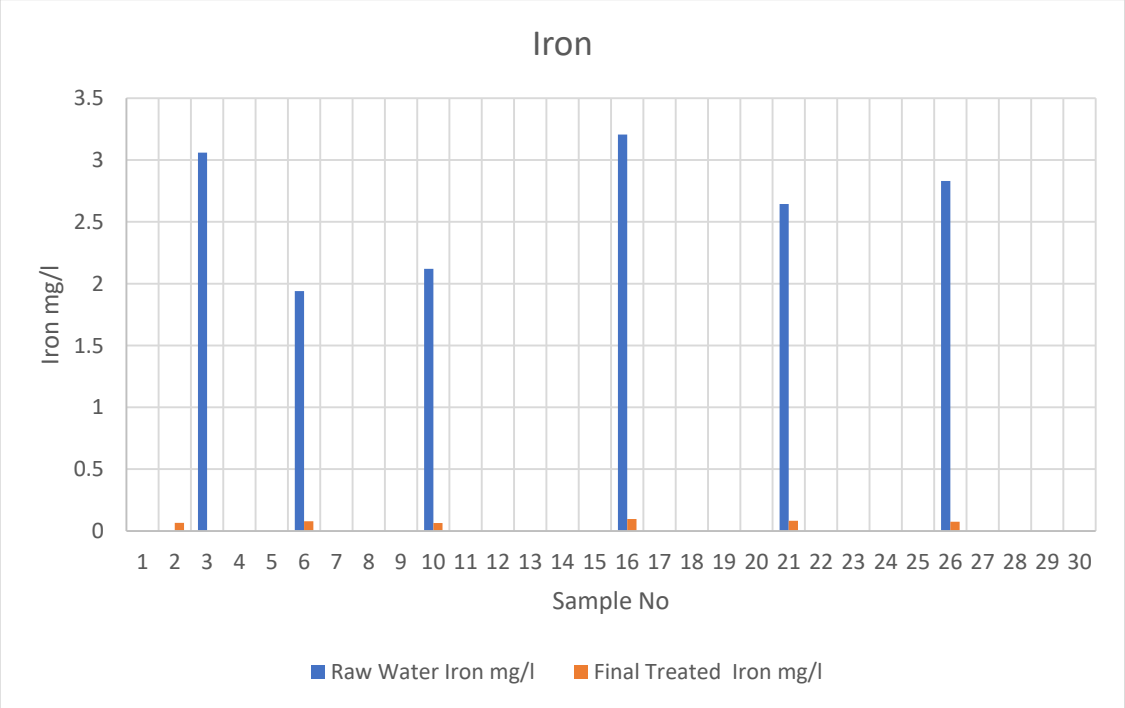

Figure A. 8 Iron

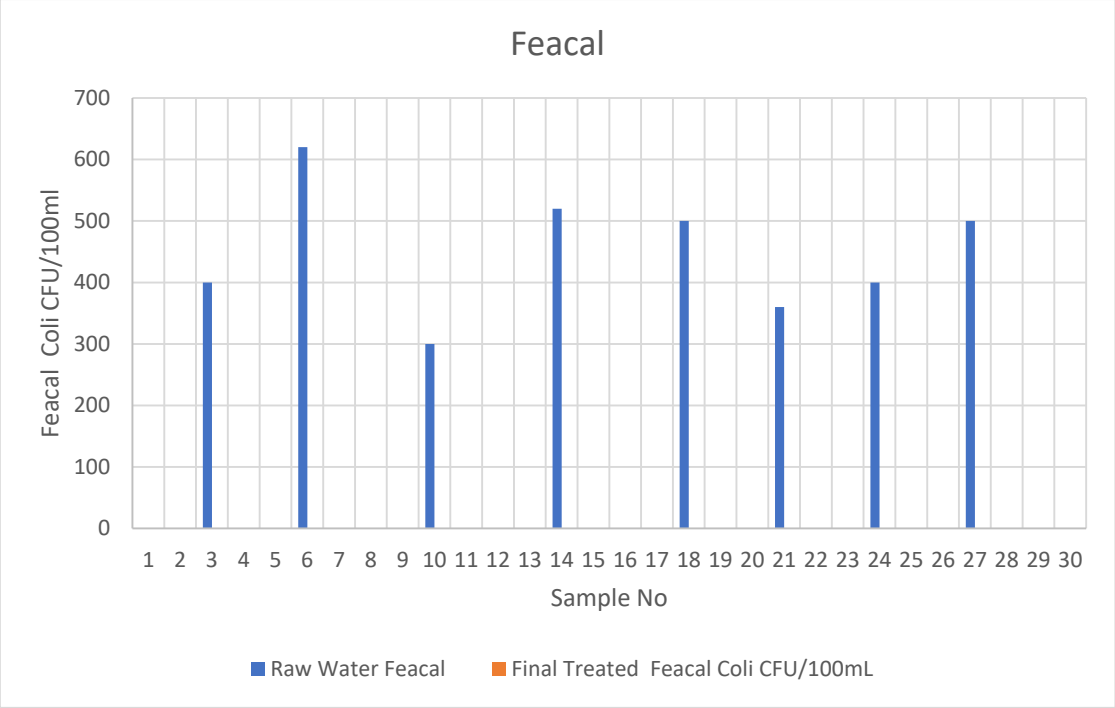

Figure A. 9 Feacal Coliforms

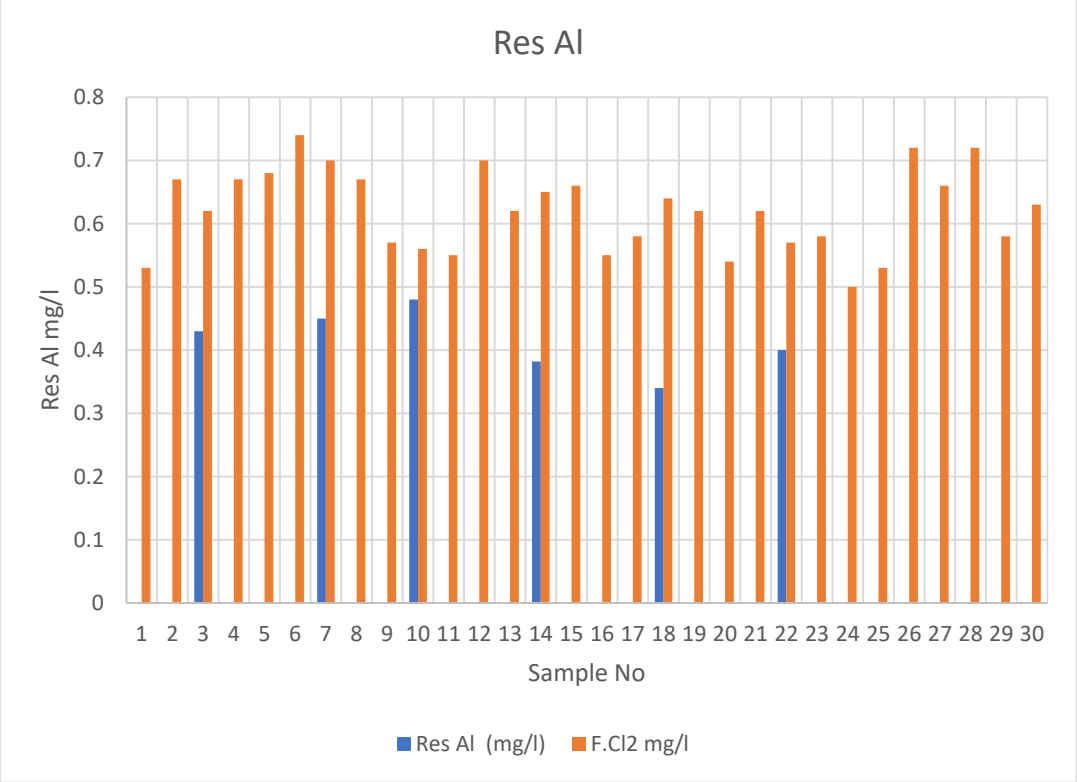

Figure A. 10 Residual Aluminium

Table A. 3 Turkey's post-Hoc comparison results for lake and River water parameters

Comparison of results for both wet & dry seasons	Widest or least difference	Difference	Standard error	t-statistic	P-values
pH					
Lake Victoria samples	Widest	−2.534	0.343	−7.39	0.000
	Least	−1.113	0.335	−3.32	0.045
Temperature					
Lake Victoria samples	Widest	−7.500	0.982	−7.64	0.000
	Least	−3.250	0.982	−3.31	0.046
River Nile samples	Widest	−2.031	0.570	−3.57	0.021
	Least	−1.981	0.570	−3.48	0.028
Dissolved Oxygen					
La Victoria samples	Widest	−2.031	0.570	−3.57	0.021
	Least	−1.981	0.570	−3.48	0.028
	Widest	−4.408	0.480	−9.18	0.000
R. Nile samples	Least	−1.702	0.480	−3.54	0.012
Conductivity					
L. Victoria samples	Widest	668.508	117.341	5.70	0.000
	Least	393.258	117.341	3.35	0.041
	Widest	882.933	37.880	23.31	0.000
R. Nile samples	Least	−319.684	37.880	−8.44	0.000
Turbidity					
L. Victoria samples	Widest	169.024	33.684	−5.02	0.000
	Least	112.302	33.684	−3.33	0.047
	Widest	128.593	29.500	4.36	0.001
R. Nile samples	Least	−98.032	29.500	−3.32	0.025

Table A. 4 Turkey's post-Hoc comparison results from springs and open wells parameters

Comparison of results for both wet & dry seasons	Widest or least difference	Difference	Standard error	t-statistic	P-values
pH					
Spring samples	Widest	1.084	0.147	7.360	0.000
	Least	0.083	0.151	0.550	0.850
Open wells samples	Widest	2.724	0.195	−13.960	0.000
	Least	1.118	0.190	5.870	0.000
Temperature					
Spring samples	Widest	17.018	0.968	17.580	0.000
	Least	0.545	0.968	0.560	0.841
Open wells samples	Widest	13.040	0.791	16.480	0.000
	Least	−2.703	0.812	−3.330	0.013
Dissolved Oxygen					
Spring samples	Widest	2.159	0.452	4.770	0.000
	Least	0.657	0.452	1.420	0.342
Open wells samples	Widest	−8.216	1.612	−5.100	0.000
	Least	5.917	1.612	3.670	0.005
Conductivity					
Spring samples	Widest	− 3186.560	78.124	−40.790	0.000
	Least	−186.649	76.479	−2.440	0.052
Open wells samples	Widest	− 3224.843	131.695	−24.490	0.000
	Least	− 527.101	134.388	−3.920	0.002
Turbidity					
Spring samples	Widest	115.071	38.545	2.990	0.019
	Least	−36.026	36.189	−1.000	0.588
Open wells samples	Widest	100.114	42.282	2.370	0.147
	Least	6.012	39.551	0.150	1.000

Table A. 5 Wastewater analysis results for Jinja

Sampling Date: 21/07/2019 Analysis Date: 23/07/2019 Report Date: 30/07/2019

Sample Description	Lab. No.	pH	EC µS/cm	Alkalinity: total as $CaCO_3$ mg/l	Total Suspended Solids (TSS) mg/l	BOD_5 at 20°C mg/l	COD mg/l	Total Phosphorus (TP) mg/l	Ortho-Phosphate ($O\text{-}PO_4$) mg/l	Ammonia-Nitrogen (NH_3-N) mg/l	FC cfu/100mls
Standard			**1500**	**800**	**100**	**50**	**100**	**10**	**5**	**10**	**5000**
Kirinya Raw Sewage	**N604**	9.34	2009	1220	425	405	381	17.8	15.95	52	N/D
Anaerobic(1)	**N605**	6.54	1264	460	154	525	396	10.925	9.70	19.5	
Anaerobic(2)	**N606**	7.37	1712	780	192	294	471	22.75	20.575	60.25	
Maturation 1	**N607**	7.73	1448	580	31	183	133	17.475	15.45	33.75	N/D
Maturation 2	**N608**	7.73	1424	500	21	168	30	1.65	1.60	47.75	
Final water	**N609**	7.74	1098	340	28	204	105	5.00	4.925	4.25	N/D

(Source: NWSC, 2019)

Table A. 6 Wastewater analysis results for Jinja

Sampling Date: 24/06/2020 Analysis Date: 26/06/2020 Report Date: 30/06/2020

Sample Description	Lab. No.	pH	EC µS/cm	Alkalinity: total as $CaCO_3$ mg/l	Total Suspended Solids (TSS) mg/l	BOD_5 at 20^{O}C mg/l	COD mg/l	Total Phosphorus (TP) mg/l	Ortho-Phosphate ($O\text{-}PO_4$) mg/l	Ammonia-Nitrogen (NH_3-N) mg/l	FC cfu/100mls
Standard			**1500**	**800**	**100**	**50**	**100**	**10**	**5**	**10**	**5000**
Kirinya Raw Sewage	**N588**	8.86	2480	1060	298	639	805	38.775	33.77	45.75	N/D
Anaerobic(L)	**N589**	7.65	1136	380	10	228	154	12	9.25	1.00	
Anaerobic(R)	**N590**	7.73	1403	580	13	228	266	18.25	15.675	29.25	
Maturation 1	**N591**	7.66	1216	420	51	210	121	3.60	3.075	1.75	N/D
Maturation 2	**N592**	8.69	1124	360	44	153	76	2.55	2.10	1.50	
Final water	**N593**	7.70	1437	560	39	135	267	12.60	11.125	24.2	N/D

(Source: NWSC, 2020)

Table A. 7 Wastewater analysis results for Jinja

Sampling Date: 21/6/2021 Analysis Date: 21/6/2021 Report Date: 28/6/2021

Sample Description	Lab. No.	pH	EC µS/cm	Alkalinity: total as $CaCO_3$ mg/l	Total Suspended Solids mg/l	BOD_5 at 20°C mg/l	COD mg/l	Total Phosphorus (TP) mg/l	Ortho-Phosphate ($O\text{-}PO_4$) mg/l	Ammonia-Nitrogen ($NH_3\text{-}N$) mg/l	FC cfu/100mls
Standard			**1500**	**800**	**100**	**50**	**100**	**10**	**5**	**10**	**5000**
Kirinya Raw Sewage	**N958**	6.95	919	460	162	339	196	11.75	5.75	32.00	4000000
Kirinya Anaerobic (R)	**N959**	7.48	1007	480	47	240	39	10.00	5.00	21.25	ND
Kirinya Maturation	**N960**	7.69	643	260	62	65	51	4.20	3.03	5.00	ND
Final Effluent	**N961**	7.69	621	260	92	50	106	3.03	3.00	3.50	120000
Kimaka Raw Sewage	**N962**	6.97	590	260	130	107	174	7.45	6.25	21.75	2200000
Anaerobic (L)	**N963**	7.06	525	200	92	74	80	7.33	5.50	18.00	45000
Anaerobic (R)	**N964**	7.06	545	220	57	50	88	7.13	6.33	13.50	52000

(Source: NWSC, 2021)

Table A. 8 Demographics

S/N	Item	Category	Frequencies (N=285)	Percentages
1	Age in years	20-30 years	23	11%
		31-39 years	124	60%
		40-49 years	42	20%
		50 years and above	16	8%
2	Gender	Male		
		Female		
3	The highest level of education of the respondents	Primary	12	4%
		Secondary	151	53%
		Tertiary	85	30%
		University Degree	17	6%
		Master's Degree	20	7%
4	Main household sources of income/livelihoods	Business/Self-employment		52%
		Agriculture (crop products)		28%
		Agriculture (animals & cop products)		8%
		Salary		6%
5	**Main household sources of water**			
	Source	**Sex of the household head**		
		Males headed	Female-headed	Overall total
5.1	Public taps	37%	40%	38%
5.2	Protected well/spring	21%	24%	22%
5.3	River/stream/lake	17%	18%	18%
5.4	Vendor bicycle/Boda Boda	14%	12%	12%
5.5	Private tap connection	5%	5%	5%
5.6	Bore holes	3%	3%	3%
5.7	Rain water	2%	2%	2%

(Source: (Primary data, 2022))

Table A. 9 Demographics cont'd

6	**Distance to the water source category**				
		Male headed Households		Female-headed Households	
	Distance(km)	Improved	Not improved	Improved	Not improved
6.1	0 km	90	9	95	5
6.2	0.0-0.5 km	76	24	81	19
6.3	0.51-1 km	73	27	73	28
6.4	1.01-2.9 km	67	33	70	30
6.5	3 above km	52	49	43	57
6.6	Average Percentages	74%	26%	77%	23%
7	The perceived cost of water among households in Jinja City	V. Expensive	6		
		Expensive	14		
		Moderate	49		
		Cheap	31		
8	Household head category and type of toilet facility used	**Type of toilet facility used by the household**	**Household headship category**		
			Males headed	Female-headed	Overall
		Covered pit latrine private	49%	45%	48%
		The covered pit latrine shared	30%	35%	32%
		Uncovered pit latrine	15%	14%	14%
		VIP latrine shared	2%	3%	2%
		Flush toilet private	2%	2%	3%
		VIP latrine private	1%	1%	1%
		Flush toilet shared	1%	1%	1%
		Total	100	100	100
9	Availability of water washing facility on latrines	Yes without water	8%		
		No	12%		
		Yes with water and soap	29%		
		Yes without soap	51%		

(Source: (Primary data, 2022))

Table A. 10 Demographics cont'd

10	Availability of other essential items at household	Wastewater disposal method	10%
		Child faeces disposal	15%
		Presence of utensils drying rack	21%
		Water storage required at household	54%

(Source: (Field data, 2022))