PHYSIOCHEMICAL PROPERTIES OF BOREHOLE AND TAP WATER SUPPLIED IN NAGONGERA TOWN COUNCIL, TORORO DISTRICT

By

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DECLARATION

I, Kuloba Polly, declare that this research work is my original work otherwise cited, and where such has been the case reference has been stated and that the same work has not been submitted for any academic award in any other university or tertiary institute of higher education.

Signature: ....

Date: 24th/11/2024

APPROVAL

This research work has been submitted for examination and has been approved by my supervisor.

Signature: ....

Date: ......18.11.2024..............................

Dr. Egor Moses

SUPERVISOR

DEDICATION

I dedicate my research work to my parents, Mr. Kuloba Tsapwe Rogers and Mrs. Nambuya Grace for their endless effort, spiritual and moral support towards my success in education.

ACKNOWLEDGEMENT

I thank my supervisor Dr Egor Moses who always guided me and provided necessary support towards the successful completion of my research project work. I appreciate the members of the Department of Chemistry in particular Dr Kamoga Omar, Dr Andima Moses, and Dr Richard Oriko Owor, Dr Kigozi Moses for the tireless commitment and time offered in support of the research work.

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LIST OF ACRONYMS AND ABBREVIATIONS

NTU: Nepphelometric turbidity units

NWSC: National Water and Sewerage Cooperation

SDG: Sustainable Development Goal

WHO: World Health Organization

Ppm: parts per million

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ABSTRACT

In recent years, there has been an increase in the consumption of the water supplied by the intermittent systems. This water is assumed to be safe for any domestic and other uses; however this research determined the different physiochemical parameters of the water supplied by NWSC to Tororo municipality, Nagongera Town council. This study was carried out to evaluate the physiochemical quality of borehole and tap water parameters in Nagongera town council. The physiochemical parameters analyzed include; electrical conductivity, temperature, Total Dissolved Solids, pH and turbidity using standard methods of analysis and the results obtained were compared with the World Health Organization (WHO) for drinking water and domestic use. This study presents an analysis of Electrical Conductivity (EC) measurements across eight boreholes, identified as B1 through B8. EC values, expressed in micro-Siemens per centimeter (µS/cm), provide insight into the ionic concentration and, therefore, the salinity levels of groundwater sourced from these boreholes. Results indicate that B4 and B5 exhibit notably higher EC values, measuring 602.5 µS/cm and 574.5 µS/cm, respectively. These values suggest a higher concentration of dissolved ions compared to other boreholes. B1 and B2 show relatively low EC values, at 265.0 µS/cm and 264.1 µS/cm, indicating a lower ionic presence. Meanwhile, B3, B6, B7, and B8 display moderate EC levels, ranging from 222.2 µS/cm to 444.8 µS/cm. The data reveal a variability in water quality across the boreholes, with some demonstrating significantly elevated conductivity, suggesting potential implications for water usage and treatment requirements

CHAPTER 1: INTRODUCTION

1.1 Background

Water contains hydrogen and oxygen atoms combined in the chemical structure, linked by the hydrogen bonds undergoing topological reformation. The water quality depends on the place and time variations. Most of the Earth's water is salty which cannot be used by human beings domestically. Few fresh water sources available are highly susceptible to the pollution from anthropogenic sources which degrade its quality. This renders it harmful for domestic and fish existence. Water is the major constituent of the Earth's hydrosphere and the fluid in the bodies of all living things. Where it acts as a solvent therefore, life in all forms depends on water and the earth cannot continue in the absence of water (Epstein et al., 2020).

The domestic water suppliers are of fundamental requirements for human life. And without water life cannot be sustained beyond a few days. In addition, lack of access to safe and adequate water supplies can lead to the spread of diseases. Children, in particular, are at the greatest health risk associated with poor water. This is attributed to poor water supply, sanitation and hygiene. All these account for account for 1.73 million deaths each year and contribute over 54 million die early because of water related diseases. A total equivalent to 3.7% of the global burden of diseases (Musiime et al., 2022).

Intermittent water supply systems represent a range of water supply services that supply water to consumers for less than 24 hours per day or not at sufficiently high pressures. Such systems are typically in developing countries, with more than 1.3 billion people in at least 45 low - and middle - income countries reportedly receiving water through intermittent systems.

It is generally considered that that intermittent water supply systems are not an ideal method of supply and do not constitute the best solution. Where such systems are poorly maintained and have leaky pipe infrastructure, contamination can intrude into water distribution system when pipes are at low or zero pressure. This could be through infrastructure deficiencies for example holes, cracks in some pipes due to aging. Deterioration or break flows through cross connections and this could happen through events that are persistent or temporary (Diop & ENEP, 2002).

In particular, contamination of pathogenic microorganisms causes various diseases. However, intermittent water supply is being used by many water utilities to address water shortages. For example, in drought conditions or increasing demand, without considering long term alternative solutions. These can include using underground water, digging boreholes and getting water from wells or streams (Gevera et al., 2019).

In Uganda vision 2040, the government aims to ‘improve the health, sanitation, hygiene, promote commercial and low consumption industrial setups. Government will construct and extend piped water supply and sanitation systems to all parts of the country’. To accomplish this, the ministry of water outlines ‘improved water quality’ and ‘reliable water quality’ as actionable targets for 2040. This will look at extending water treatment capacity to meet all needs (Nayiga et al., 2022).

In a bid to attain sustainable development goal (SDG), which focuses on sustainable access to clean water and sanitation, Uganda needs a minimum of 20 years to change all the intermittent water supply systems to the continuous systems. However, safe water quality is required under the intermittent water supply systems until continuous water supply goals are achieved. This will help the country to have a healthy population which drives everything in the country (Amenu, 2023). In this study, assessment of multiple physio-chemical water quality parameters like pH, conductivity in Tororo district water distribution system particularly Nagongera town council and also examine the impact of water quality the intermittent water supply systems. This study considers pH, conductivity because these parameters are related to water contamination by chemical and microbial pollutants that can cause health hazards (Ssemakula et al., 2013).

1.2 Statement of the problem

Poor quality water is one of the problems in Tororo district particularly Nagongera Town council and for health and sustainable development, this has been worked on to some extent by the construction of boreholes and tapped water (Chelangat, 2023). The leakage of the water supply pipes introduce harmful substances into the water which has contributed to the unsafe water quality in the town council and also the Nagongera water supplied by the National Water and Sewerage Cooperation being obtained from a dug hole calls for attention and sensitization of the natives. The harmful substances change the physio - chemical properties which has affected the quality of water being used for drinking, and other domestic uses, resulting into poor human health and natural environment (Wegulo, 2012). This research work examined different physio-chemical parameters of this water to make sure it is of the standard as stated by WHO and UNBS.

1.3 Objectives of the study

This study was directed by the general objective and specific objectives as shown below.

1.3.1 General objective

To assess the physio-chemical properties of water from taps and boreholes supplied in Nagongera Town council and that recommended by the ministry of health.

1.3.2 Specific objectives

i. To determine the physio-chemical properties of water from taps and boreholes in Nagongera Town council.
ii. To compare the levels of key physiochemical parameters in tap and borehole water in Nagongera Town council.

1.4 Research Questions

i. Is the turbidity of the water supplied by NWSC and boreholes safe for consumption?
ii. What is the pH of water supplied by NWSC in Nagongera Town council?
iii. What is the conductivity of the water supplied by NWSC and that of boreholes in Nagongera Town council?

1.5 Justification of the study

The ensuring of good quality drinking water is a basic factor in guaranteeing public health, the protection of the environment and sustainable development. Water of good drinking quality is of basic importance to human physiology and man's continued existence depends very much on its availability. The provision of portable water to rural and urban population is necessary to prevent health hazards associated with poor drinking water. This study examined the physio-chemical parameters of water supplied by NWSC and that from boreholes in Nagongera Town council in conformity to the physio chemical properties standard for portable water. These include pH turbidity, Electrical conductivity, etc. This is to safe guard the life of the people and students in these areas of study. It will also create awareness to the local people about how good quality water is supposed to be. What they have to do to maintain its quality. To NWSC and other concerned bodies, they will be able to use this study to advocate for good quality water supplied to these areas and improve on this services where necessary.

CHAPTER 2: LITERATURE REVIEW

According to the scientific study, it shows that a human being is made of 75% water and 25% solid matter hence providing the necessary evidence to the extent to which we need water in our bodies. We also need it in our daily living in order to continue existing without our bodies becoming dehydrated and all other organs failing to function. Water covers 70% of the Earth's surface in terms of rivers, lakes, oceans seas, springs and all other sources (Mishra, 2023).

2.1 Sources of water for Domestic use

2.1.1 Surface water

Surface water is accumulated on the ground or in the stream, river, Lake Reservoir, or Ocean. The total land area that contributes surface runoff to a lake or river is called catchment area.

The Volume of water depends mostly on the amount of rainfall but also on the size of the watershed, the slope of the ground, the soil type, vegetation, and the land use. Any changes in the water level of the lake are controlled by the difference between the input and output compared to the total volume of the lake (Oksana & Dmytro, 2020).

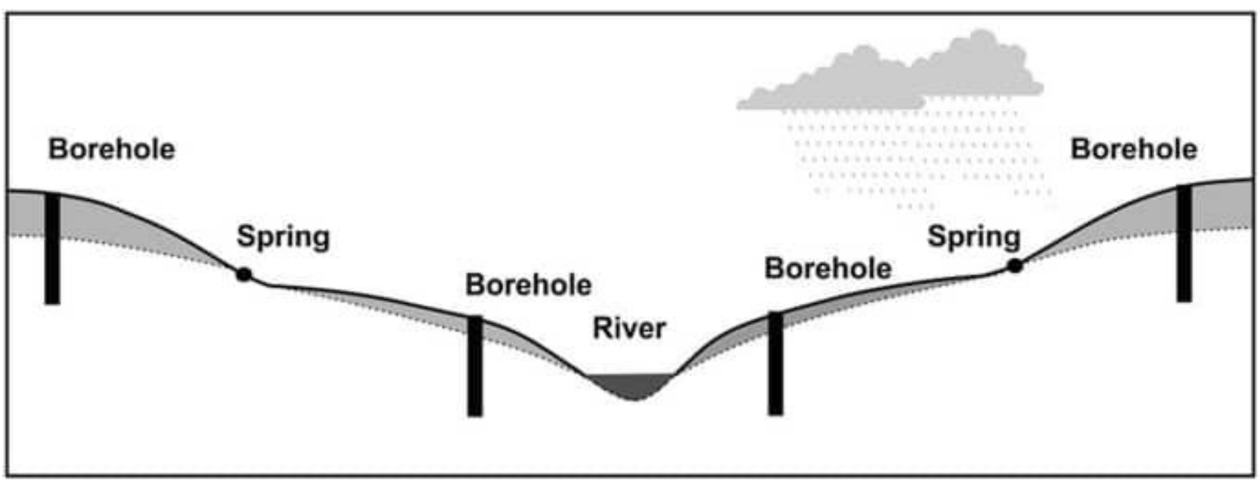

Figure 1: Sources of fresh drinking water

Source: Katsanou & Karapanagioti (2019).

Surface water is often used for large urban water supply systems, as rivers and lakes can supply a large, regular volume of water (Singh, 2024). For small community supplies, other forms of water supply include wells, spring-fed gravity systems, are generally preferred to surface water. This is because the cost of treatment and delivery of surface water is likely to be high and operation and maintenance is less reliable. The advantage of using surface water as a resource for domestic water supply include, it is easy to be abstracted by direct pumping and can be treated after use and put back into the river (Diop & ENEP, 2002). However, surface water is seasonal and will always need treatment.

In the absence of any pollution source, the river quality is similar to the rain or spring water. However, as a river flows to lower topographic areas, its water accumulates fine soil particles, microbe's organic matter, and soluble minerals (WRI, 2005). In polluted areas the quality of surface water as well as ground water is directly influenced by land use and human activities with agriculture as the common source of river pollution.

2.1.2 Ground water

Ground water is the major source of drinking water worldwide and it is hosted in aquifers. Hydrological recharge of aquifers hugely varies geographically and strongly depends, among other factors, on climate, geology, soil type, vegetation and land use (WRI, 2005).

The advantage of the use of ground water as a source for domestic water supply is many. In most inhabited parts of the world, there is a large Amount of ground water, and despite that the abstracted volumes are huge, they are often supplemented. Another advantage is that the upper soil layer's act as a filter against physical, chemical, and biological deterioration which is effective both in terms of quality and cost (Sophocleous, 2004).

(i) Boreholes and Wells

Ground water can be obtained from an aquifer by drilling a well or a borehole below the water table (Allen, 2009). A ground source of drinking water, such as a borehole, can be used as safe water supply no or very little treatment. Even a dug well that pumps shallow water and is subject to weather can be treated effectively with relatively simple equipment.

(ii) Tap water

Tap water is water supplied through a tap or dispenser Valve. I'm many countries tap water has usually the quality of drinking water (Likens, 2009). It's commonly used for cooking, drinking, washing and toilet flushing. Indoor tap water is usually distributed through indoor plumping. Though tap water may be portable, it doesn't mean it's pure or health for just mere drinking. It's susceptible to contamination as it goes through the supply system and this study analyses the quality of tap water (Hunt, 2007).

The equality of water has a great impact on the health of the people as well as water species. Hence examining the parameters of water are essential in characterizing the quality of water.

2.2 Water Quality Definition

Water quality is a general term used to describe the chemical, physical, biological characteristics of water based on the standards of its usage. It can therefore be defined basing in terms of human usage for example, consumption, recreation, and aesthetics (nature and beauty).

The quality of water is therefore the extent to which Water is safe from being harmful to organisms including human beings in terms of its usage for example domestic usage and even agricultural applications (Lekawa-Raus et al., 2014).

2.3 Chemical Parameters of Water Quality

2.3.1 Turbidity

Turbidity is the measure of the relative clarity of a liquid. It is an optical characteristic of water and is a measurement of the amount of light that is scattered by material in water when light is passed through the water sample and is measured in nepphelometric turbidity units (NTU). And for drinking water it should be below 1 NTU. This can be used to measure the efficiency of the water supply system from the point of purification to that particular place of interest (Li et al., 2013).

Turbidity is caused by particles suspended in water and scatter light making it cloudy or milky. These materials include clay, silt, algae, organic matter and plankton and other microscopic organisms. Particles in water provide attachment places for other pollutants, notable metals and bacteria. For this reason Turbidity readings can be used as an indicator of potential pollution in water and can also result into harming of habitats, fish and other aquatic life (Indiarto & Rezaharsamto, 2020).

Excessive turbidity in drinking water is aesthetically unappealing and may also represent a health concern (Sterner et al., 2020). Turbidity can provide food and shelter for pathogens and if not removed, high turbidity can promote regrowth of pathogens and parasites like cryptosporidium in water leading to water borne diseases for example diarrhea, dysentery and cholera which have caused significant cases of intestinal sickness to the people (Arana, 2012).

Although turbidity is not a direct indicator of health risk, numerous studies show a strong relationship between removal of turbidity and removal of protozoa. The particles of turbidity shelter for microbes by reducing their exposure to attach by disinfection and microbial attachment to particular material has been considered to aid in microbe survival (Assiry et al., 2010).

2.3.2 pH

pH is defined as the measure of the degree of acidity, neutrality or basicity of water. This is one of the most important parameters to put in consideration when determining the quality of water. It is expressed as the negative logarithm of hydrogen ion concentration. The acidic water contains extra hydrogen ions and basic water contains extra hydroxyl ions (Caillat et al., 1997).

The pH scale ranges from 0.0 to 14.0, indicating increase in the basicity strength. The safe and acceptable pH range of drinking water by the UNBS and WHO is 6.5 to 8.5 for domestic use and living organisms (Laughton & Say, 2013).

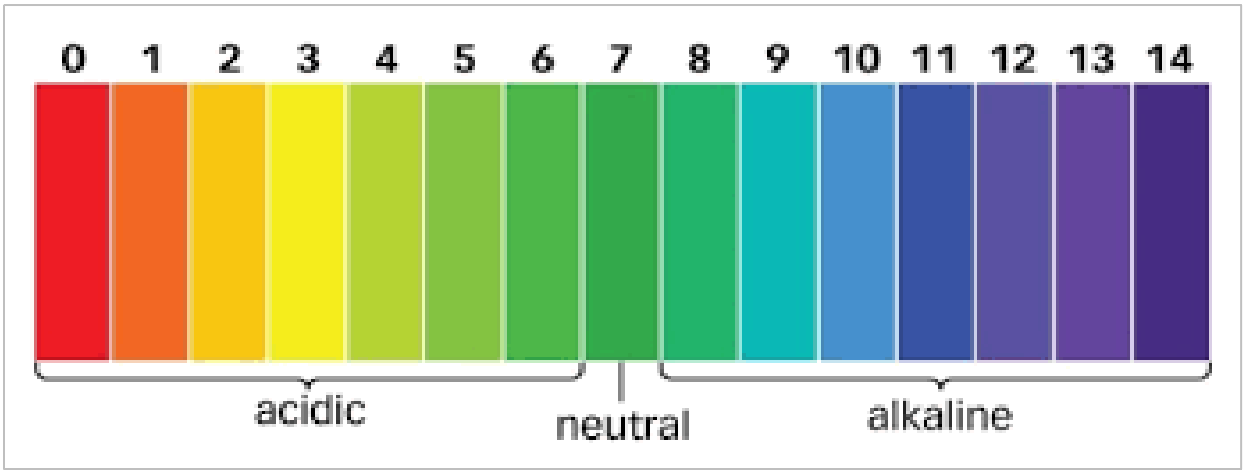

Figure 2: The pH scale

Source: https://www.jansanconsulting.com/ph-scale.html

The alteration of the pH of water can change the forms of some chemicals in water, therefore this may affect living organisms whose life depends on this water. Acidity of water is the measure of free hydrogen ions present in water and this is attributed to carbon dioxide, hydrolyzed salts, minerals that tend to dissolve in water. In addition, the low pH value could be due to the accumulation of organic matter and decomposition of vegetation in water sources, by either biological decomposition or chemical decomposition which gives up carbon dioxide gas as by - product hence ultimately reducing the pH of water (Banti, 2020).

The alkalinity of water, is the capacity to neutralize free hydrogen ions present. This is caused mainly by the presence of hydroxide ions, bicarbonate ions, carbonate ions and many others in water Sources (Minear, 2012).

Water with a very low pH or high pH is very fatal, a pH below 4 or above 10 is dangerous to most fish species and the number of animals that can endure a pH below 3 or above 11 is very minimal.

2.3.3 Electrical conductivity

Electrical conductivity of a substance is defined as its ability to transmit heat, power or electricity and it is measured in Siemens per meter.in water, there is net motion of charged ions, this phenomenon produces an electric current and is referred to as ionic conductivity. Common ions in water that conduct electric current include sodium, chloride, calcium and magnesium. Dissolved salts and other inorganic chemicals conduct electrical current, conductivity increases as salinity increases (Charin et al., 2017).

Conductivity is sometime linked to the total dissolved Solids in water, high-quality deionized water has conductivity of about 0.5 µS/cm, drinking water 200-800 µS/cm.

CHAPTER 3: MATERIALS AND METHODS

This chapter presents the research methodology that was used in the study, it brings with the research design, target population or study population, determinants of the sample size, sampling strategies, data collection methodology, tools to use, quantity control of data, procedure of data collection exercise and lastly the data analysis techniques (Barter & Deas, 2003).

3.1 Sampling strategies and preservations

Because of the parameters that were studied, the researcher collected samples from different taps and different boreholes in Nagongera Town Council (*Figure 3*), Tororo District. The volume collected was sufficient enough to ensure a representative sample, allow for replicate analysis and minimize waste disposal (Neukermans et al., 2012).

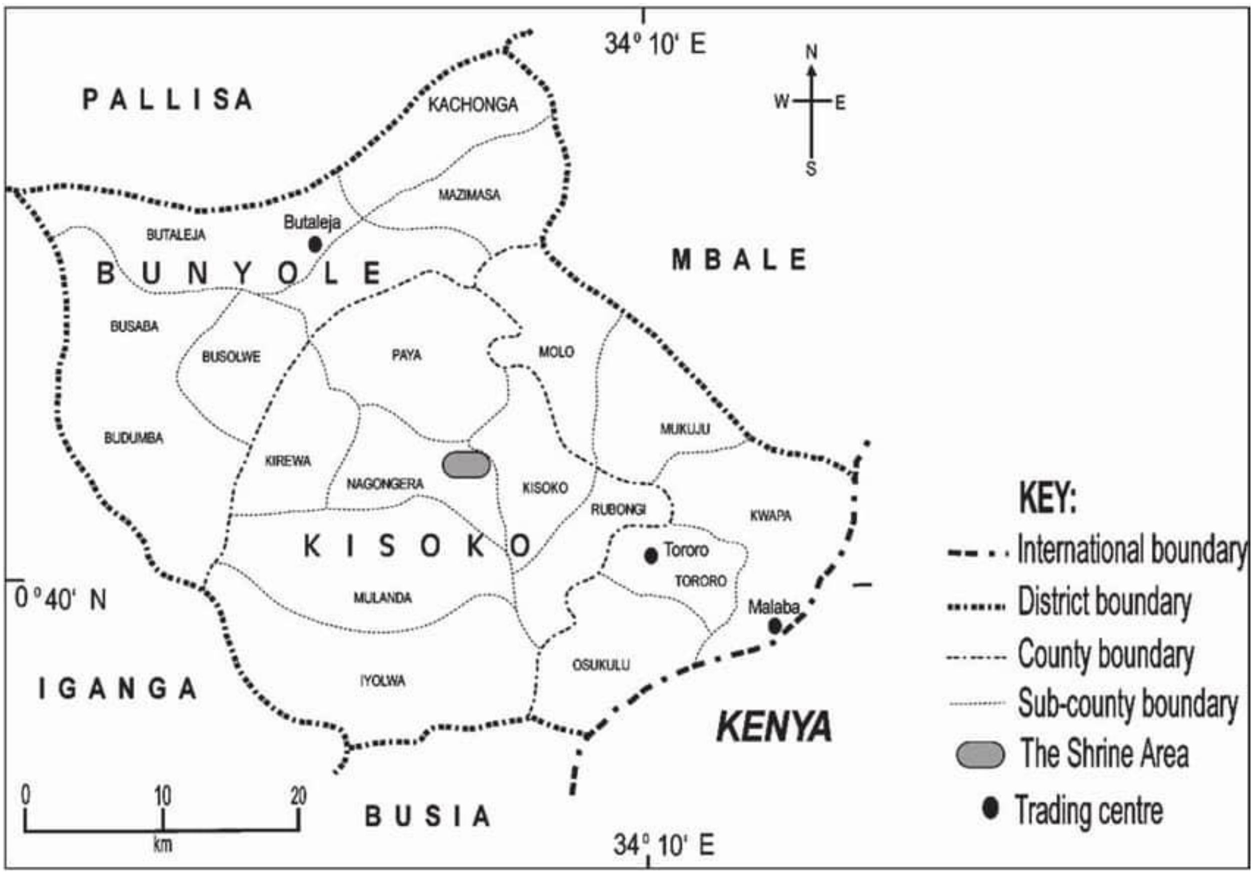

Figure 3: A map showing the location of Nagongera Town Council

Source: https://www.necoc.opm.go.ug/HzEastern2/Tororo%20District%20HRV%20Profile.pdf

Table 1: Location of samples collected

Sample Source	Sample ID	Site location in degrees	
		Nothing	**Easting**
Boreholes	B1	0.760236	34.040113
	B2	0.760196	34.040101
	B3	0.762387	34.036488
	B4	0.762572	34.036210
	B5	0.763477	34.034884
	B6	0.763487	34.034896
	B7	0.763562	34.034850
	B8	0.764463	34.034740
Taps	T1	0.770400	34.028980
	T2	0.770257	34.028955
	T3	0.770810	34.028967
	T4	0.771352	34.038357
	T5	0.771347	34.038394

3.2 Data collection method

The samples of water were collected using 500 ml plastic bottles, first rinsed with the sample before being filled with the sample, observations also was used to take the physical properties of water like color, odor and others (Santos et al., 2012).

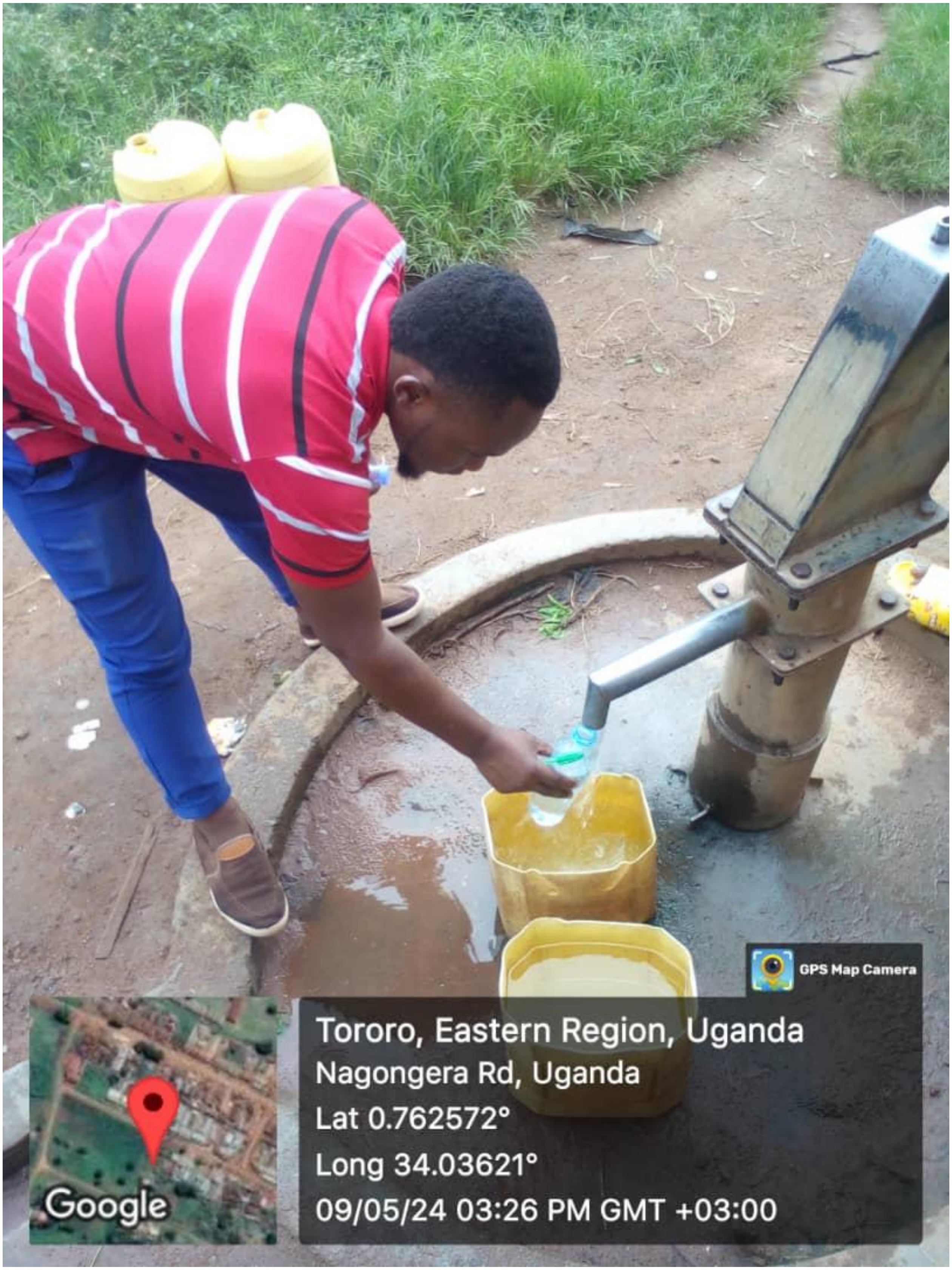

Figure 4: Sample collection at the borehole Nagongera Town council

3.3 Materials, reagents and measuring equipments

Apparatus and instruments: plastic bottles, pH meter, conical flasks pipette, measuring cylinder, conductivity meter, Turbidity meter, beakers. Electrical conductivity, temperature, total dissolved solids, and pH were measured using Thermo scientific EUTECH PC 450 pH/mV/Conductivity/TDS/^{o}C/^{o}F meter (see **Error! Reference source not found.** *(a)*). The meter w as calibrated before the electrode was infused into the samples. The turbidity of the water samples was measured using Thermo scientific EUTECH TN-100 Waterproof Turbidimeter (see **Error! R eference source not found.** *(b)*).

Figure 4: Devices that were used to measure physicochemical parameters

3.4 Experimental procedure

3.4.1 Turbidity

Thermo scientific (EUTECH TN 100) water proof turbid meter was calibrated before the electrode was infused into the different water samples collected from different water points.

3.4.2 pH

Thermo scientific EUTECH PC 450 pH/mV/Conductivity/TDS/^{o}C/^{o}F meter was calibrated with buffers of known pH 4.0 and 7.0. The pH of the water samples was then measured using the electrode. The electrode was rinsed with distilled water after every measurement of each sample to minimize contamination of other water samples as well as ensure accuracy (Irvine et al., 2011).

3.4.3 Electrical conductivity

The electrical conductivity was measured using a Thermo scientific EUTECH PC 450 pH/mV/Conductivity/TDS/^{o}C/^{o}F meter which was rinsed after determining the conductivity of each sample (Skarbøvik & Roseth, 2015).

3.4.4 Temperature

The temperature of each water sample was also read on Thermo scientific EUTECH PC 450 pH/mV/Conductivity/TDS/^{o}C/^{o}F meter and there exists a possibility of finding out slight deviation of temperatures of different water samples (Khamis et al., 2015).

3.4.5 Total Dissolved Solids

The Total Dissolved Solids of each water sample was also taken using the same calibrated turbidity meter and each water sample showed different value of TDS (Brown et al., 1970). Total Dissolved Solids (TDS) is a crucial parameter used to measure the quality of water. TDS represents the total concentration of dissolved substances in water, including minerals, salts, metals, and other organic and inorganic compounds. High levels of TDS can affect the taste, odor, and overall quality of water, making it essential to monitor and control TDS levels in various water sources (Alley et al., 1999). The presence of elevated TDS levels in water can indicate potential contamination from various sources such as industrial discharge, agricultural runoff, and natural geological processes. Monitoring

TDS is vital for ensuring the safety and portability of drinking water, as high TDS levels can indicate the presence of harmful contaminants that may pose health risks to humans and aquatic life. TDS levels can vary significantly depending on the source of water and the surrounding environment. Factors such as geology, land use, and human activities can all influence (Paaijmans et al., 2008). TDS concentrations in water bodies. By regularly monitoring TDS levels, water quality managers can identify trends, assess potential risks, and implement appropriate mitigation measures to protect water resources and public health. In addition to its impact on human health, high TDS levels can also have adverse effects on aquatic ecosystems. Excessive TDS concentrations can disrupt the balance of aquatic environments, affecting the growth and survival of aquatic organisms.

By monitoring and managing TDS levels in water bodies, environmental authorities can help preserve biodiversity and maintain the ecological integrity of freshwater ecosystems (Rasmussen et al., 2009). Overall, Total Dissolved Solids serve as a critical indicator of water quality, providing valuable insights into the overall health and integrity of water resources. By understanding the significance of TDS as a parameter of water quality and implementing effective monitoring and management strategies, we can ensure the availability of safe and sustainable water sources for current and future generations (Gillett & Marchiori, 2019).

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Results

Table 2 summarizes the results of physio-chemical properties of the water samples considered thestudy. Figure 5 and Figure 6 give a visualized comparisons of the parameters for all samples collected.

Table 2: Results of the measured parameters of samples

Sample ID	E.C (µS/cm)	Turbidity (NTU)	TDS (ppm)	pH	Temp (^{o}C)
WHO Value	*≤ 400*	*≤ 5*	*< 600*	*6.5 – 8.5*	*15*
B1	265.0	2.62	139.2	6.01	28.2
B2	264.1	92.5	138.9	6.20	27.5
B3	222.2	4.98	117.0	6.43	27.4
B4	602.5	5.55	317.0	6.50	27.5
B5	574.5	5.46	248.2	7.10	27.8
B6	402.8	1.94	212.2	6.83	25.8
B7	444.4	58.3	233.9	6.85	25.7
B8	444.8	12.04	234.0	6.45	26.3
T1	284.7	2.50	149.6	7.48	26.8
T2	268.2	2.87	141.0	6.46	26.7
T3	270.2	2.79	142.0	6.50	29.5
T4	547.2	1.42	287.6	6.79	29.4
T5	399.3	1.77	210.3	6.90	29.8

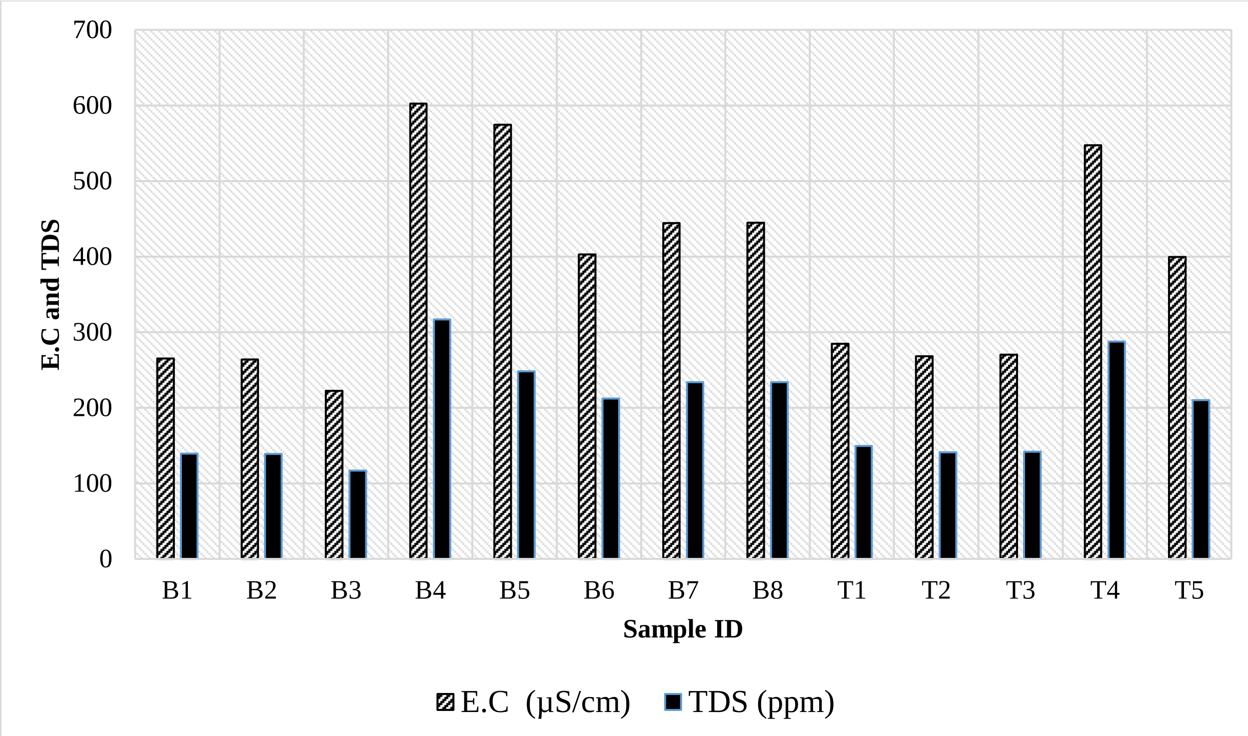

Figure 5: E.C and TDS of the collected samples

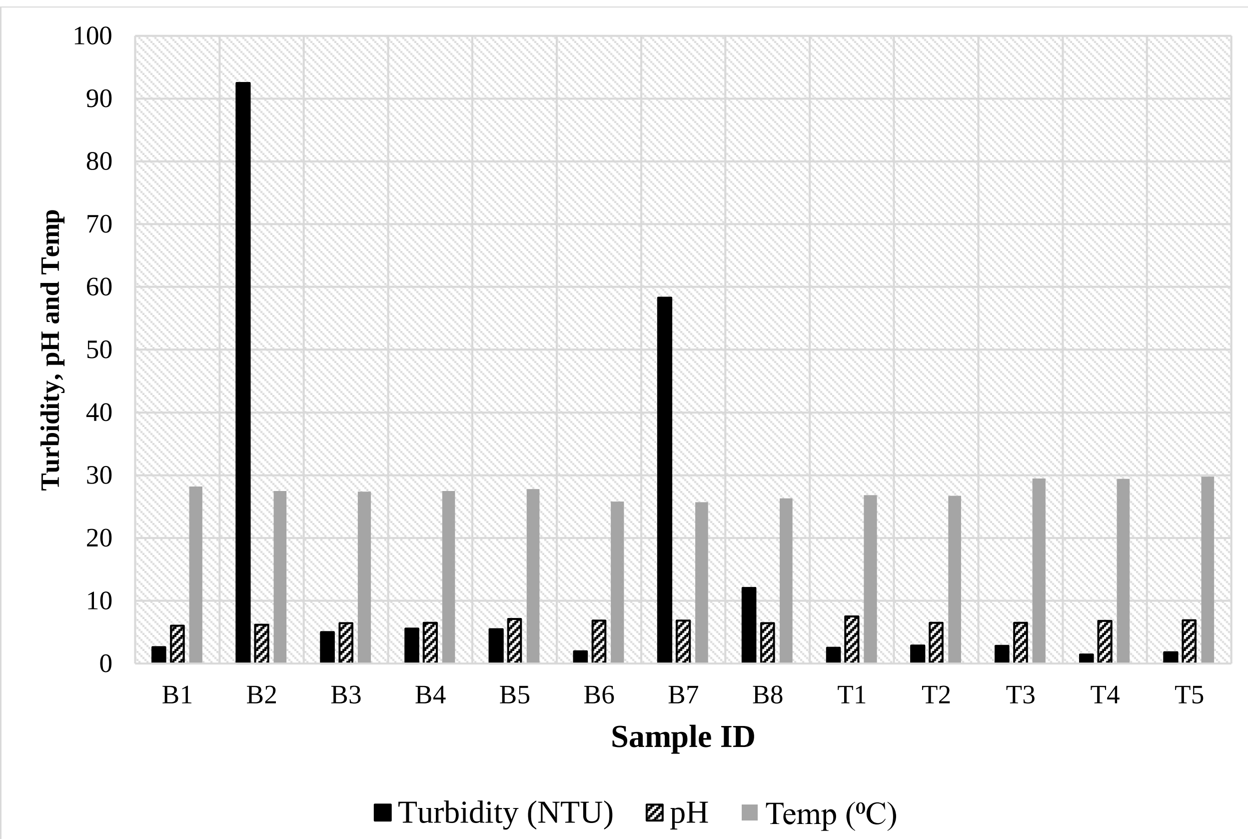

Figure 6: Turbidity, pH and Temperature of the collected samples

4.2 Discussion

4.2.1 Electrical Conductivity

Electrical conductivity (EC) is a measure of water's capacity to allow electric current to flow. EC is determined by the ion concentration in water. These ions originate from inorganic elements and dissolved salts (Jameel & Sirajudeen, 2006).

The electrical conductivity of water obtained from borehole samples in Nagongera Town Council was in the range of 222.2 – 602.5 µS/cm; whereas that of tap water samples, the range was between 270.2 – 547.2 µS/cm. The World Health Organisation guideline set a standard of < 400 µS/cm beyond which water is unsuitable for domestic use (WHO, 2008). Therefore, electrical conductivities for all tap water sources considered, other than one, were within the ranges recommended by the World Health Organisation. Therefore water from taps in the area is recommended for use. On the other hand majority of the samples obtained from boreholes had water with EC values above the recommended maximum. Electrical conductivity is influenced by the presence of dissolved salts such as sodium chloride and potassium chloride which produce ion that migrate in solution and then generate electric current.

4.2.2 Turbidity

The degree of cloudiness or muddiness of a water sample is known as its turbidity. The optical quality that enables light to be absorbed and scattered by the water samples is measured (Likambo, 2014). There is no correlation between turbidity and the amount of suspended particles in the water sample. The turbidity of water samples collected ranged between 1.42 – 92.5 NTU with majority samples collected from boreholes exceeding the WHO (2008) recommended value (≤ 5 NTU) and all samples collected from taps registering values below 5 NTU.

4.2.3 Total Dissolved Solids

The total dissolved solids of water samples obtained from boreholes are in the range of 117 – 317 ppm while that of tap water samples is in the range of 141 – 287.6 ppm. The World Health Organization suggests that TDS levels should be below 600 ppm for palatability, with 300-500 mg/L being optimal ((WHO, 2008). The ranges above are therefore acceptable for water to use for domestic purposes.

The higher the TDS, the higher the EC at almost neutral pH ranges and varying temperatures. The TDS and EC levels in borehole water are higher than those in tap water because borehole water comes from underground layers which have higher levels of dissolved solids like calcium, magnesium and potassium due to the presence of fluoride bearing minerals (Kanda, 2010). Tap water undergoes treatment processes that remove the dissolved salts and solids (Pushpalatha et al., 2022).

High concentration of dissolved solid in water is also responsible for hardness, turbidity, odors, taste, color and alkalinity the maximum permissible concentration of TDS is 1200 ppm in potable water. Elevated TDS values in water indicates that water is highly mineralized which can be due to the presence of rock constituent materials in the area which are resistant to dissolution.

Increased total dissolved solids in water may also be attributed to surface run-off constituents like bicarbonates, chlorides, nitrate, sodium, potassium, calcium and magnesium which may result to hard water which is unfit for consumption and unsatisfactory for bathing and washing since it cannot form lather.

4.2.4 pH

The pH range of borehole water was 6.01 – 7.1. The variation in the ranges is based on geological conditions such as the type of rock the water passes through. Tap water had pH values in the range of 6.46 – 7.48. According to the WHO (2008) guidelines, the accepted pH ranges between 6.5 - 8.5; outside that range it is not accepted – all samples fulfilled this requirement.

4.2.5 Temperature

Due to its impact on aquatic species' chemical and biological reactions, temperature is an essential water quality (Kurup et al., 2010). Samples collected registered temperatures between 25.7 – 39.8^{o}C which is above the 15^{o}C recommended by World Health Organization ((WHO, 2008). The high temperatures are possibly due to turbidity and suspended solids that absorb sun's heat.

CHAPTER 5: RECOMMENDATIONS AND CONCLUSIONS

5.1 Conclusions

During the study research, all the above water parameters of both boreholes and taps were well analyzed and this research work provides knowledge to the users on what quality of water they are using and its effects to human life and it also creates awareness on the different sources of water pollution and how best they can treat the water before its used for both domestic uses and consumption. . The results showed that the EC of water samples (B4, B5, B6 and T4) were above the WHO permissible limit of 400 µS. The temperature results were above the WHO criteria of 15 ^{o}C. The TDS results for all the water samples were within the permissible limit of the World Health Organization of 500 ppm. The results of the pH showed that most water samples had their pH below the minimum permissible value of 6.5 within the range of 6.5 to 8.5 as per WHO guidelines of drinking water. The turbidity results showed that some water samples had turbidity permissible limit as by the guidelines of WHO whereas other water samples had their turbidity values beyond that recommended by WHO.

5.2 Recommendations

Basing on the findings of this research work, the water supplied to Nagongera Town council is of different quality with borehole water showing much of the total dissolved solids than that of tap water and also borehole water showed some differences in water appearance in terms of color

I do recommend other researchers to proceed with analyzing the causes and effects of low and high levels of physicochemical parameters of water in an area.

I also do recommend the government of Uganda to establish regular monitoring program to track and provide the relevant information on the changes in key physicochemical parameters of water of an area.

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