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ASSESSMENT OF IRRIGATION WATER QUALITY OF SELAMIKO DAM SOUTH GONDAR, ETHIOPIA

BERIHUN, MENGISTU

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MENGISTU BERIHUN

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Chemistry

Advisor: Minaleshewa Atlabachew (Ph.D.)

October, 2021

Bahir Dar, Ethiopia

Declaration

This is to certify that the thesis entitled "**Assessment of Irrigation Water Quality of Selamiko Dam South Gondar, Ethiopia**", submitted in partial fulfillment of the requirements for the degree of Master of science in chemistry of Bahir Dar University, is a record of original work carried out by me and has never been submitted to this or any other institution to get any other degree or certificates. The assistance and help I received during the course of this investigation have been duly acknowledged.

Mengistu Berihun	____________	Bahir Dar
Name of the candidate	Date	Place

Bahir Dar University

College of Science Postgraduate Program

Department of Chemistry

Approval of Thesis for Defense

I hereby certify that I have supervised, read, and evaluated this thesis titled "**Assessment of Irrigation Water Quality of Selamiko Dam South Gondar, Ethiopia**" by Mengistu Berihun prepared under my guidance. I recommend the thesis be submitted for oral defense.

Minaleshewa Atlabachew (Ph.D)	________________	_____________
Advisor Name	Signature	Date
_____________________	_______________	____________
Department Head	Signature	Date

Bahir Dar University

College of Science Postgraduate Program

Department of Chemistry

Approval of thesis for defense result

As members of the board of examiners, we examined this thesis entitled "**Assessment of irrigation water quality of selamiko dam south Gondar, Ethiopia**" by *Mengistu Berihun.* We here by certify that the thesis is accepted for fulfilling the requirements for the award of the degree of "Master of Science in chemistry".

Board of Examiners

External examiner name	Signature	Date
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Chair person's name	Signature	Date
______________________	________________	_____________

DEDICATION

This thesis is dedicated to my special families of father Berihun Nigatu and to my mother Tedbabe Shumet who support and give love to reach this stage.

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ABSTRACT

Selamiko dam receives water from different point sources and used for various applications to the people around selamiko kebelie, Farta district of Amhara region. The purpose of this study was to assess the irrigation water quality of selamiko dam found in south Gondar, Ethiopia with respect to selected physico-chemical parameters and heavy metals during dry and wet seasons of 2021. Samples were collected from the inlet and out let of the dam. From these two sampling sites, samples were taken at different times and composite samples were obtained at each site from both seasons. Physico-chemical Parameters such as temperature, pH, turbidity, electrical conductivity and total dissolved solids were measured in situ. Whereas water samples were transported to the lab for the determination of the level of heavy metals using inductively coupled plasma optical emission spectroscopy (ICPOES). Results of the physical parameters during dry and wet seasons were ranged from temperature (20.6^{0}C-23.26^{0}C, pH(7.89-8.34), EC(118.9µS/cm-130.8µS/cm), TDS (58.8mg/L-65.4mg/L) and turbidity (6.57NTU-11.13NTU). Concentrations of heavy metals in mg/L ranged from Cr (0.008-0.323), Mn(0.032-0.285), Ni(0.014-0.212), Zn(0.091-0.184), Cd(0.005-0.01) and Pb (0.014-0.249). According to the result, the mean concentration of heavy metals in dry season was higher than wet season except for lead. In this study, most of heavy metals in dry season were beyond the level of FAO for irrigation purposes. High levels of these metals may negatively affect the land to be used for irrigation. Therefore, the water has to be approved with appropriate treatment to come up with the standard and in turn increase the yield of the irrigation products.

Key words: *irrigation water quality, selamiko dam, physico-chemical parameters, heavy metals and ICP-OES*

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Acronyms and Abbreviations

FAO Food and Agriculture Organization

ICP-OES Inductively Coupled Plasma Optical Emission Spectroscopy

MDL Method Detection Limit

MQL Method Quantification Limit

RSD Relative Standard Deviation

SD Standard Deviation

WHO World Health Organization

TDS Total Dissolved Solid

EC Electrical Conductivity

USEPA United States Environmental Protection Agency

CO-SAERAR Commission for Sustainable Agriculture and Environmental Rehabilitation in Amhara Region.

1 INTRODUCTION

1.1 Back ground of the study

Water is one of the pivotal to both natural ecosystems and human development. It is essential for various activities such as drinking, cooking, industrial, agricultural and recreational purposes. In the human body it is also used in transporting, dissolving organic matter and replenishing nutrients while carrying away waste materials (Jayalakshmi *et al*., 2011).

Water quality is critical for the survival of humans, animals, industry and agriculture. Furthermore the proper management is requisite to meet water quality standards and for ecosystem health. The agriculture success is highly dependable on the quality of water applied in an agriculture area. Due to the application of poor or hazardous quality water the agriculture land/soil is affected and damages the crop yield in several ways (Pimentel *et al*., 1987).

Irrigation water quality is related to its effects on soils and crops and its management. High quality crops can be produced by using high quality irrigation water keeping other inputs optimal (Waterer, 2003).

Characteristics of irrigation water that define its quality vary with the sources of the water. Water from different sources contains considerable amount of unnecessary or unwanted substance dissolved in water that may deteriorate soil fertility and crop growth and crop yield. These unwanted substances have come from natural or manmade (domestic and industrial effluent) sources and its severity depends up on the type of substances and its quantity (Yates *et al.,* 2005).

Water used for irrigation can also vary greatly in quality depending upon the type and quantity of dissolved salts. In irrigated agriculture, the hazard of saltwater is a constant threat. Poor-quality irrigation water becomes more concern as the climate changes from humid to arid conditions. Salts are originated from dissolution or weathering of rocks and soil, including dissolution of lime, gypsum and other slowly dissolved soil minerals. These substances are carried with the water to wherever it is used (Ayers and Westcot, 1985).

Water quality provides current information about the concentration of various solutes at a given place and time. Its quality parameters provide the basis for judging the suitability of water for its designated uses and to improve existing conditions (Iqbal *et al.,* 2004).There is no single or simple measure for water quality. Water may be tested for a few characteristics or numerous natural substances and contaminants depending on their needs. The nature and extent of water pollution is characterized by several physical, chemical and biological parameters (jonnalagadda and mhere, 2001).

Heavy metals are the elements with a density greater than 5 g / cm3. They can be found in air, water and soil. These metals often interfere with the normal course of metabolic processes even in trace amounts (Vitor *et al*., 2005) causing several diseases and act by accumulation effects with an exception of low tolerable doses (Ali *et al*., 2019).

Such metals often have a toxic effect, so their presence in the aquatic ecosystem poses risks to human health and causes harmful effects to living organisms (Vitor *et al*., 2005). Besides, industry development has resulted in a significant increase of residues in natural waters and soils, especially those containing heavy metals. Therefore, the determination of the contents of metallic trace elements in water and soil is essential (singh and steinners, 2020).

Since the quality of water is directly related to health and is important for determination of water utility, it is very essential and important to test the quality of the water before it is used for drinking, domestic, agricultural or industrial purposes (Patil *et al*., 2012).

Since, selamiko dam would have various agricultural activities to be practiced by farmers like fish production, crop irrigation; it was necessary to accessed good quality of water in selamiko irrigation dam for plantation of different crops and required to check the level of chemicals in the dam closed to with the standard of international level of water quality.

As a result studies have been conducted on the contamination of river water, irrigation canals and its impact on animals and humans. But to the best of my knowledge there had been no previous research report on quality analysis of selamiko irrigation water dam. So that the study was aimed at assessing the quality of water in selamiko dam, South Gondar, Amhara Region of Ethiopia.

1.2 **Statement of the problem**

Since Selamiko dam is found below DebreTabor city, it receives different impurities like municipal wastes, university wastes, hospital wastes, abattoir wastes, recyclable materials and various agricultural activities practiced by farmers. Thus water of these sources are stagnated in that area and used as irrigation water sources for cultivating various vegetables and fruits.

It has to be noted that farmers who live around selamiko irrigation dam are using this water for various application but mostly for irrigation purpose. So that this research was focused to study the current condition of the selamiko irrigation water in the dam (investigate what it contained and whether it is polluted or not).

Today the study of trace metals has been given much emphasis due to their nature of being accumulated in different organs and tissues of an organism and intern affect the consumers (human being). So that, it is necessary to know whether the selamiko irrigation water is polluted or not and the pollution level should also be quantified.

1.3 Objective of the study

1.3.1 General objective

The general objective of this study was to assess the irrigation water quality of selamiko dam South Gondar, Ethiopia.

1.3.2 Specific objective

The specific objectives of this study were to:-

- Determine the concentration of some heavy metals such as Cr, Ni, Zn, Mn, Cd & Pb in water samples using Inductively Coupled Plasma –optical emission spectrometry (ICP-OES).
- Determine selected physico-chemical water quality parameters like: pH, conductivity, total dissolved solid, temperature and turbidity.
- Compare selamiko irrigation water quality with international water quality standards.
- Assess the spatio-temporal of selected heavy metals and physical parameters in dry and wet season.

1.4 Scope of the study

This study does not cover the assessment of all physicochemical parameters and the level of heavy metals. It is limited to asses only pH, conductivity, turbidity, TDS, and temperature from the physical parameters and nickel, cadmium, manganese, lead, zinc and chromium from heavy metals of selamiko irrigation water.

1.5 Significance of the study

- ✓ To ensure sustainable agriculture and to improve food security among the farming communities since, water is the most important resource for irrigation.
- ✓ The study is vital because the problem relating to water quality affects the livelihood of the farmers. Due to the dam serves for irrigation, fish production & consumption of livestock.
- ✓ The study also used as spring board to create awareness on safety measures required to prevent pollution of selamiko irrigation dam.
- ✓ The study can help the concerned body to plan, monitor and implement something to tackle the problem appearing related trace metals.
- ✓ The study of selamiko irrigation water dam has a great significance to identify some trace metals which can pose risk to human health and designed to conduct determination of physicochemical parameters of selamiko catchment for irrigation purpose. Similarly, the study is also important for providing scientific evidences to take care of the physical and chemical pollutants of water.
- ✓ The study result may serve to provide information for other researchers those who desire to make future studies on similar aspect of the study.

2 LITRATURE REVIEW

2.1 Water quality for irrigation

Understanding knowledge of irrigation water quality is critical to the management of water for long-term productivity. Irrigation water quality is related to its effects on soils and crops and its management. High quality crops can be produced only by using high-quality irrigation water keeping other inputs optimal. Characteristics of irrigation water that define its quality vary with the source of the water (APHA, 2005). There are area differences in water characteristics, based mainly on geology and climate. There may also be great differences in the quality of water available on a local level depending on whether the source is from surface water bodies such as rivers and ponds or from groundwater aquifers with varying geology, and whether the water has been chemically treated (Nahid *et al*.,2008). The chemical constituents of irrigation water can affect plant growth directly through toxicity or deficiency, or indirectly by altering nutrient availability to the plants (Ayers and Westcott, 1985).

Water quality is the basic to judge the fitness of water for its proposed application for existing conditions. The current information is required, provided by water quality monitor for optimum development and management of water for its proficient uses (Haydar *et al*., 2009).

2.2 Irrigation Water Quality and Agriculture

Understanding irrigation water quality is critical to determining appropriate crop and soil management practices that are necessary for long term productivity.

Water quality affects:

- Fertility needs of the crop
- Crop yield
- Soil physical condition
- Soil salinity
- Irrigation system performance
- Water application method

Water quality for irrigation depends upon salts type and their dissolved quantity. As the total salt concentration increases in various soils caused the crop developing problems resulting in crop yield reduction. The suitability of water to use for particular purpose is decided on the bases of its long term effect (Zalidis *et al.*, 2002).

2.3 **Water quality in the reservoir**

Water quality should be assessed based on the characteristics of the water relative to the beneficial uses of the water. Water quality is not, as frequently used, a list of chemical constituent concentrations. In order to reliably assess whether concentration of a constituent impairs the water quality beneficial uses of a water body, it is necessary to evaluate on a site-specific basis whether the constituent is present in toxic/available forms at a critical concentration for a sufficient duration to be significantly adverse to aquatic life that is important to the beneficial uses of the water body (Lee and Jones, 1999). Irrigation water quality and quantity have direct and indirect impact on soil characteristics (physical, biological and chemical) especially in arid and semi-arid regions that unfortunately depend on irrigation (Rahimi *et al*., 2000).

The quality and quantities of the water used on each scheme are as variable as the environmental and geo-logical characteristics in each of the schemes. Water quality and quantity also vary between different seasons and between years as affected by different factors (Yidana *et al*., 2011).The variation in water quantity is directly related to productivity in irrigation schemes in the short term while water quality affects productivity in the long term (Almas and Scholz, 2006).A water quality assessment is an evaluation of the beneficial use impairment that is occurring, or could potentially occur, due to the presence of a particular chemical(s) or other constituent. It is not an assessment of the frequency of accidence of a water quality standard. Pathogens, organic compounds, synthetic chemicals, micro-plastics, nutrients and heavy metals are some elements that pollute fresh water. Unregulated discharge of wastewater undermines biological diversity, natural resilience and the capacity of the planet to provide fundamental ecosystem services.

2.4 **Water quality problems**

Water used for irrigation can vary greatly in quality depending upon type and quantity of dissolved salts. Salts are present in irrigation water in relatively small but significant amounts. They originate from dissolution or weathering of the rocks and soil, including dissolution of lime, gypsum and other slowly dissolved soil minerals. These salts are carried with the water to wherever it is used. In the case of irrigation, the salts are applied with the water and remain behind in the soil as water evaporates or is used by the crop (Joshi et al., 2009).

The suitability of water for irrigation is determined not only by the total amount of salt present but also by the kind of salt. Various soil and cropping problems develop as the total salt content increases, and special management practices may be required to maintain acceptable crop yields. Water quality or suitability for use is judged on the potential severity of problems that can be expected to develop during long-term use.

The problems that result vary both in kind and degree, and are modified by soil, climate and crop, as well as by the skill and knowledge of the water user. As a result, there is no set limit on water quality; rather, its suitability for use is determined by the conditions of use which affect the accumulation of the water constituents and which may restrict crop yield. The soil problems most commonly encountered and used as a basis to evaluate water quality are those related to salinity, water infiltration rate, toxicity and a group of other miscellaneous problems (Paul et al., 2020).

2.5 Composition and concentration of soluble salts

Salinity is a common problem facing farmers who irrigate in arid climates. This is because all irrigation waters contain soluble salts (Hoffman and Ayers, 1980). Whether derived from springs, diverted from streams, or pumped from wells, the waters contain appreciable quantities of chemical substances in solution, dissolved from the geological strata through and over which the waters have flowed. Waters with a high salt content may have moved from a saline water table. In areas with intensive agriculture, fertilization is a major cause of aquifer salinization (Longenecker and Lyerly, 1974).

2.6 Source of water pollution

It is an introduction of biological, physical and chemical agents in to water that reduce quality of water by matting indefensible use and adversely influence organisms that based on water. Almost all of the ways that we use water supply to water pollution according to (USEPA, 1990) unites state environmental protection agency (USEPA) divided water pollution into the following categories:

1. Ecological wastes consists of human and animal wastes

2. Plant nutrients like phosphates and nitrates enter into the water through sewage and livestock and fertilizers runoff.
3. Sediments consist of minerals or organic solid matter that washed from land into water sources.
4. Toxic chemicals that are not used or disposed properly.

2.7 **Effect of water sources for irrigating crops**

Both irrigation water quality and proper irrigation management are critical to successful crop production. In addition, the quality of the irrigation water may affect both crop yields and soil physical conditions, even if all other conditions and cultural practices are favorable or optimal. Different crops require different irrigation water qualities therefore; testing the irrigation water prior to selecting the site and the crops to be grown is critical(Ragab, 2002). The quality of some water sources may change significantly with time or during certain periods such as in dry or rainy seasons(Cashman, 2010). So it is recommended to have more than one sample taken, in different time periods. Growth of plants is frequently limited by imbalances in electrical conductivity (EC), alkalinity, sodium (Na), and boron (B). High EC levels inhibit the germination of seeds, the rooting of cuttings, and root growth of some established crops. Alkalinity directly influences the pH of the root medium; as alkalinity in irrigation water increases, so does root medium pH. High levels of Na can antagonize the uptake of potassium (K), calcium (Ca), and magnesium (Mg). Leaf necrosis occurs when high levels of boron are present in irrigation water. Other potential irrigation water contaminants that may affect suitability for agricultural use include heavy metals and microbial contaminants (Bauder *et al*., 2007).

2.8 **The physical and Chemical Characteristics**

The physical and chemical characteristics of the irrigation water are of particular importance where extreme of temperature and low humidity results in high rate of evapotranspiration. Water used for irrigation can vary greatly in quality depending upon type and dissolved salts. The consequence of evapotranspiration is salt deposition from the applied water, which tends to accumulate in the soil profile. The physical and mechanical properties of the soil, such as degree of dispersion of the soil particles, stability of aggregates, soil structure and permeability are sensitive to the types of exchangeable ions present in the irrigation water (Mujere *et al*., 2011).

2.8.1 Temperature

Temperature of water is a very important physical parameter to assess thermal pollution and associated effects on aquatic biota; this is because abnormal water temperature alters chemical reactions, reaction rates and solubility of gases. Temperature affects the growth and temperature reproduction of aquatic organisms. If the temperature gets too high or too low, the local population of a species decreases. Temperature also affects water chemistry, which in turn affects biological activity. A sudden change temperature of river water can lead to a higher rate of mortality of aquatic biota (Lajunen, 2007).

Temperature influences many life processes such as sexual maturity, migration, metabolic processes, breeding season and growth of aquatic life. Optimum temperature ranges for the productivity of fish is 26 to 32°C. Water and soil samples collected from Panjkora River had temperature within the optimum range required for the growth and reproduction of fish (Patil *et al*., 2012).

2.8.2 Hydrogen ion concentration (pH)

The acidity or basicity of irrigation water is expressed as pH (< 7.0 acidic; > 7.0 basic). The normal pH ranges for irrigation water is from 6.5 to 8.4.Low pH's below 6.4 are caused accelerated irrigation system corrosion where they occur. High pH's above 8.5 are often caused by high bicarbonate (HCO_3^-) and carbonate (CO_3^{2-}) concentrations, known as alkalinity. High carbonates cause calcium and magnesium ions to form insoluble minerals leaving sodium as the dominant ion in solution (Welch *et al*., 2000). The higher the activity of hydrogen ion, the more acid is the solution, and the lower activity of hydrogen ion it is more basic. The pH value of water can have effect on plant growth, irrigation equipment and the drinking quality (pinto *et al*., 2010).

2.8.3 Electrical conductivity (EC)

The electrical conductivity (EC) of water is defined as the capacity of water to transmit the electric current. It depends on the dissolved ions in the water and their charge and movement. Because it is a good solvent, water dissolved mineral salts in the form of ions, which hold the electric current due to ionic conduction. When the EC of water is high, it shows that there is high concentration of ions in the water. The EC indicates the number of total solids in water and is dependent on the temperature of water. The electrical conductivity of water also affects the plant growth. The measurement of EC at 25°C temperature is considered as reference. FAO normal range for electrical conductivity of water is 3000 μS/cm (Ruqia *et al*., 2015).

2.8.4 **Total dissolved solids (TDS)**

The TDS value is a measure of the amount of mobile charged ions and minerals salts in a given volume of water. An elevated TDS value beyond the optimum level can induce toxicity in plants and possibly increase the osmotic potential of the soil water, the consequence of which is an increase in the amount of energy plants that must be expended to take up water from the soil. The TDS permissible range is 450-2000 mg/L for irrigation water by FAO (Ayers and Westcot, 1985).

Water containing more than 500 mg/L of TDS is not desirable for drinking water purpose. TDS can also be taken as an indicator for the general water quality because it directly affects the aesthetic value of the water by increasing turbidity. High concentrations of TDS limit the suitability of water as a drinking source and irrigation supply (Awofolu *et al*., 2005).

2.8.5 **Turbidity**

The amount of cloudiness in the water is known as turbidity which is caused by dissolved or total suspended solids and most of the time those are invisible to the naked eye as they smoke in air. It is important parameter to measure for water quality. Turbidity can be caused by i.e. Silt, sand and mud; Bacteria and germs; Chemical precipitates. The turbidity is measured in Nephelometric Turbidity Units (NTU) defined by US Environmental Monitoring Standard unit. Turbidity is the values of light absorbing or light scattering property of water. High level of turbidity in drinking water possessed a higher risk to people for developing gastrointestinal diseases. Similarly, high level of material affects light penetration and productivity, recreational values, and habitat quality. In streams, the life of fish and other aquatics can be in danger due to increased sedimentation and siltation (Denic and geist, 2015).

Turbidity is also defined as a measure of the transparency of water. Suspended particles (in the range of 0.004–1.0 mm) make it harder for light to pass through the medium, thus it also affects the color of the water (WHO, 2009). The more suspended particles the higher the turbidity, a higher turbidity causes the temperature to increase since there are more particles which absorb heat. This in turn reduces the amount of dissolved oxygen. Since a higher turbidity causes less light to move through the water there is a decrease in photosynthetic activity, a decrease which decreases the amount of dissolved oxygen. Suspended particles in water provide ideal attachments for heavy metals and other organic compounds as well as microorganisms. Drinking water with a high turbidity cause gastrointestinal diseases since the water probably house toxins as well as waterborne diseases. Additionally, turbidity may decrease the infiltration rate in soils. It also has the ability to prevent the establishment of certain crops, like rice (WHO, 2009). According to the WHO, the desirable threshold for drinking water is set to 5 NTU (Nephelometric Turbidity Units). This threshold is based on the aesthetics, not on health risks. A turbidity >3 can be visually seen (Chary *et al*., 2008).

Table 1 Different analytical water quality parameters used for testing of quality of water and their source of occurrence and potential health effects with USEPA guidelines (Wade *et al.*, 2003).

No.	parameter	Source of occurrence	Potential health effect
1	Temperature	Average kinetic energy of the atom or molecule of substance	It affects solubility of gasses in water, gas solubility decreases with increased temperature.
2	Turbidity	Fine organic and inorganic mater soluble colored organic compounds, algae and other microscopic organisms.	Developing gastrointestinal diseases high level of material affects light penetration and productivity, recreational values, and habitat quality
3	Electrical conductivity	Due to different dissolved solids.	Conductivity due to ionizable ions. High conductivity increases corrosive nature of water.
4	pH	pH is changed due to different dissolved gases and solids.	Affects mucous membrane; bitter taste; corrosion
5	TDS	Presence all dissolved salts	Undesirable taste; gastro-intestinal irritation; corrosion or incrustation

2.9 **Toxicity of Trace Metals**

Pollution problems may arise if toxic trace metals are metabolized into the soil solution and then taken up by plants and later consumed by human kind. Wastewater contains considerable amount of trace metals, of which has been put to use for irrigation. Besides, even the treated sewage water also contains Variable amounts of trace metals such as Pb, Ni, Cd, Cu, Mn, Zn, and Cr, which have the potential to contaminate vegetation under such irrigation(Lokeshwari, 2006).

Trace metals are natural components of earth's crust. Although at trace levels some trace metals e.g. Zinc is essential for the human body; most of them are toxic or poisonous even at low concentrations. Trace metals include the elements arsenic, cadmium, chromium, lead, mercury, copper and thallium. Typically they enter the body via the food chain, ambient air. Likewise, contaminants have been introduced into the soil with negative consequences for the food chain and thus, human health is at risk (Ardelt *et al*., 2005).

The presence of toxic metals such as Pb and Cd in the environment has been a source of worry to environmentalists, government agencies and health practitioners. This is mainly due to their health implications since they are non-essential metals of no benefit to human (Borgmann, 1983).

Toxicity of trace metals is dependent on dosage and sometimes acute or chronic. Acute toxicity is as a result of large doses of a metal toxicant and symptoms appear rapidly and may result in death (Oladimeji, 1983).

Factors that determine the toxicity of trace metals in water include concentration, speciation, hardness, temperature, dissolved oxygen content, pH, physiochemical form (ionic or complex) and presence of other metals or substances. Toxicity tends to increase as dissolved oxygen and hardness decrease and as temperature increases. The effect of trace metals on man and animals can be additive, antagonistic or synergistic(Underwood, 1970).

Trace metals are known to induce all kinds of diseases in man and animals, of which will be subsequently discussed when dealing with individual element of trace metals. Virtually all trace metals, including the essential ones (Iron, Copper, etc.) are toxic if safe limits are exceeded.

2.9.1 **Cadmium**

Cadmium is one of the most toxic elements with reported carcinogenic effects in humans. It accumulates mainly in the kidney and liver and high concentrations have been found to lead to chronic kidney dysfunction. It induces cell injury and death by interfering with calcium (Ca) regulation in biological systems. It has been found to be toxic to fish and other aquatic organisms. Cadmium has been implicated in endocrine disrupting activities, which could pose serious health problems. In addition, health effects of cadmium include bone lesions, prostate and lung Cancer (Saini and Dhania, 2020).

Cadmium is a very toxic metal. All soils and rocks, including coal and mineral fertilizers, contain some cadmium. Cadmium has many uses, including batteries, pigments, metal coatings, and plastics. It is used extensively in electroplating. Cadmium and cadmium compounds are known human carcinogens. Smokers get exposed to significantly higher cadmium levels than non-smokers. Severe damage to the lungs may occur through breathing high levels of cadmium. Long-term exposure to lower levels leads to a buildup in the kidneys. And possible kidney disease, lung damage and fragile bones).The permissible limit for irrigation and drinking water set by WHO is 0.0003mg/L.

2.9.2 **Lead**

It is potentially hazardous and toxic to most forms of life. It has been found to be responsible for quite a number of ailments in humans such as chronic neurological disorders especially in fetuses and children. Lead is a well-known toxic metal and it has been reported to account for about 50% of the total inorganic lead absorbed by human beings. After absorption by the body, it is carried to soft tissues like the brain, lung, spleen and heart by the blood and finally deposited in the bone where about 90% of the total body lead is found. Lead damages the liver, kidneys, brain, central nervous and reproductive systems causing all kinds of diseases (Mehri, 2020).

2.9.3 **Zinc**

It is an essential element in human diet. High level of zinc in water causes change of taste and color. Zinc is found in nature as the sulfide associated with other metals like (Pd, Cu, Cd and Fe).Without enough zinc in the diet people may be experience loss of appetite, decrease sense of taste and smell (Senedak and Stangl, 2006). Shortage of zinc can cause birth defects.

Hardness, temperature and other environmental factors increase toxicity of zinc in aquatic life. EPA recommended maximum contamination level is 5mg/L.

2.9.4 Manganese

Occurs naturally in the environment (widely distributed in air, water, soil) and constitutes 0.1% of the Earth’s crust; however, it is not found in the elemental form. The concentration in various media varies widely depending on the environmental conditions and proximity to anthropogenic sources such as ferroalloy industry facilities. Water sources of manganese can be natural (from rock and soil weathering) and anthropogenic (from industrial discharges, mining activities and landfill leaching) (Howe, 2004).

2.9.5 Chromium

Chromium is a naturally occurring element present in the earth’s crust. Chromium released into the environment from anthropogenic activity occurs mainly in the hexavalent form [Cr (VI)]. The health hazard associated with exposure to chromium depends on its oxidation state, ranging from the low toxicity of the metal form to the high toxicity of the hexavalent form. Chromium is widely used in numerous industrial processes and as a result, is a contaminant in many environmental systems. Breathing high levels of chromium (VI) can cause irritation and ulcers in the stomach and small intestine, sperm damage and male reproductive system damage (Paul, 2012).

2.9.6 Nickel

It is a naturally occurring element found in a number of mineral ores including nickel phosphate, oxides and silicates. It is present in the enzyme urea and as such is considered to be essential to plants and some domestic animals (Awofolu *et al*., 2005).

However, the essentiality of Ni to health has not been demonstrated, but Ni related health effects such as renal, cardiovascular, reproductive and immunological effects have been reported in animals. Also, its toxicity in man are related to dermal, lung and nasal sinus cancer (Holynska *et al*., 1996)

Table 2 The suggested maximum trace element concentrations for irrigation water (Lindesberg et al., 2009)

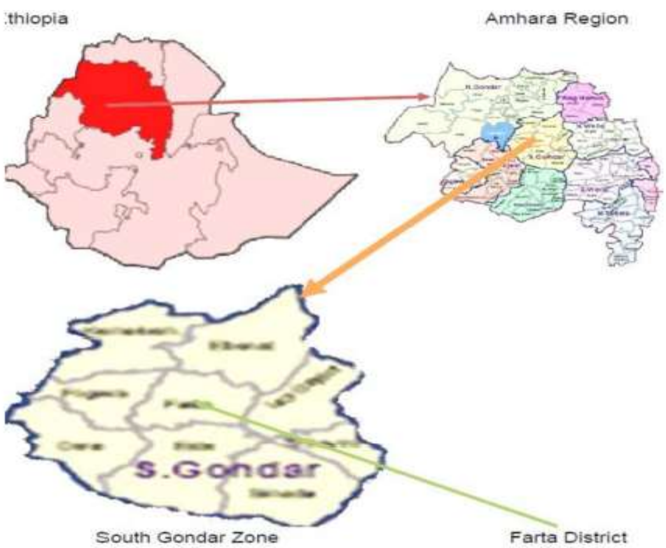
No.	Element	Recommended Maximum Concentration (mg/L)	Remark
1	Cadmium (Cd)	0.010	Toxic to beans, beets, and turnips at concentrations as low as 0.1 mg/l in nutrient solutions. Conservative limits recommended because of its potential for accumulation in plants and soils to concentrations that may be harmful to humans.
2	Lead (Pb)	5.0	can inhibit plant cell growth at very high Concentrations
3	Zinc (Zn)	2.0	Toxic too many plants at widely varying Concentrations; Reduced toxicity at pH >6.0 and in fine textured organic Soils
4	Nickel (Ni)	0.2	Toxic to a number of plants at 0.5 to 1.0 mg/L; reduced toxicity at neutral or alkaline pH.
5	Chromium(Cr)	0.1	Not generally recognized as essential growth element. Conservative limits recommended due to lack of knowledge on toxicity to plants.
6	Manganese (Mn)	0.2	Toxic to a number of crops at few-tenths to a few mg/L in acid soils.

3 MATERIALS AND METHODS

3.1 Descriptions of the study area

The study area, selamiko dam is located in Amhara National Regional State, South Gondar Zone at the eastern side of Debre Tabor town at the command area of selamiko kebele in Farta district. Farta Woreda is one of the 106 Woredas of the Amhara Regional State. This Woreda is located between 11° 51`N latitude and 38° 17`E longitude. The climate condition of this Woreda is 44% moist Dega & 56% Weina–Dega (lemma et al., 2018). Debre Tabor is the capital of the Woreda and is found 655 km from Addis Ababa and 108 km from the Regional capital, Bahir Dar.

Based on the 2007 national census conducted by the central statistical agency of Ethiopia (CSA), Farta woreda has a total population of 232,181an increase of 1.49% over the 1994 census. Of whom 118513 are men and 113,668 women 6,783 or 2.92%are urban inhabitants. With an area of 1,099.25 square kilometer, Farta has population density of 211.22 which is greater than the zone average of 145.56 persons per square meter. The geographical location of farta woreda is as shown in Figure 1.



Source :(wallelign and lemma, 2019)

Figure 1 Geographical location of farta woreda

Selamico micro earth dam was constructed by Co-SERAR in 2005.The dam is 21m high and 216m long with a top/crest width of about 4.5m. Its range is categorized under medium size reservoirs based on height (farta wereda agricultural development office)

3.2 Apparatus and chemicals

3.2.1 Apparatus

Plastic bottle (poly ethylene), micropipettes, measuring cylinder, conical flask, beaker, volumetric flask, funnel, pH meter (model tochpro II), electrical conductivity/TDS meter (model CE 470cond meter 01189), thermometer, Whitman no.40 filter paper, hotplate hood, inductively coupled plasma optical emission spectroscopy (ICP-OES) (8000, perkin Elmer, Germany) were used to conduct the experiment.

3.2.2 Chemicals

Nitric acid, HNO3 (69%) (Spectrosol, BDH, England) and standard solutions of heavy metals Zn, Mn, Ni, Cr, Cd & pb (Buck scientific puro-Graphic^{tm}).

3.3 Sample collection

The water samples were collected using polyethylene bottles. Initially, the prewashed bottles were rinsed with water sample three times. Two points were carefully chosen to get representative water for analyzing selected physicochemical parameters as well as some trace metal concentrations of selamiko irrigation water at places where water enters to the dam and reserved (inlet) and water leaves out from the dam (outlet). A composite water sample was obtained from at each sampling site by mixing the grab samples collected from surface, middle, and bottom of well with one meter depth by direct immersion of bottles into the dam and handled by rope at each sampling site as shown appendix1. Hence, water samples from the two sampling sites were collected separately.

About 1 L of composite water samples were collected twice, that is both in the dry and wet season at each sampling site. So the results in this study could be regarded as seasonal. The first sampling session was before rainy season during the dry season on the last week of April 2021. The second sampling session was after rainfall during the wet season on the first week of July 2021. The samples were labeled or designated a letter and number as A1 for the inlet and B1 for the outlet of the dry season; similarly, A2 for the inlet and B2 for the outlet of wet season.

3.4 Sample preparation

3.4.1 Sample digestion and procedure of analysis

Physical parameters such as temperature, pH, conductivity, TDS & turbidity were determined at the field during sample collection using portable devices. Water temperature was measured in-situ, using thermometer and has recorded in degree Celsius. Electrical conductivity and total dissolved solid were determined with field conductivity meter. pH was measured using portable digital pH meter. Turbidity has measured by portable turbidity meter.

In the digestion of heavy metals, the water sample were prepared by taking 50ml of each water sample pipette out to a100ml conical flask then 5ml of conc.HNO_3 (69%) were added to each samples and watch glass were used to cover the flask and kept in hood to avoid contamination. Then the solution were boiled at 80^oC-95^oC for 2 hours and evaporate on a hotplate to about 20ml until light colored, clear solution was obtained (zhang, 2007). Thus all samples were taken away and cooled at room temperature. Then rinsed the wall of the flask with distilled water and solution was filtered by using filter paper and the filtrate were transferred in to 50ml volumetric flask and diluted up to the mark using distilled water. Digestions of a reagent blank were also performed in parallel with keeping all digestion parameters the same as the samples. The spiked and non-spiked water samples were digested in similar way. Then the digested and filtered samples (spiked and non-spiked), blank samples and standard solutions were introduced to ICP-OES to determine concentration of metals present in water sample.

3.4.2 Standard preparation and calibration of the instrument

Standard stock solutions containing 1000 mg/L were used for preparing intermediate standards and working standards. The intermediate standards were prepared by using dilution method. Also the working standard solutions were prepared by appropriately diluting the intermediate standards with distilled water and drawing the calibration curve of intensity versus concentration to determine the concentration of metals in water sample (smith *et al.,* 1979).

In this study, the working solutions were prepared by first preparing intermediate standard solution (10mg/L) from stock standard solution (1000mg/L). To prepare 10mg/L intermediate standard solution, 1mL stock solution was transferred into 100mL standard volumetric flask using micropipette and finally diluted with deionized water up to the level and the solution was mixed thoroughly and the working standards were prepared using intermediate standard by serial dilution. The working standards prepared was 0.05mg/L, 1.05mg/L, 2.05mg/L, 3.05mg/L, 4.05mg/L and 5.05mg/L for each metal.

3.5 Method validation

3.5.1 Recovery test

A spiked and non-spiked experiment was done to evaluate the reliability of digestion method and procedure of analysis. In spiked samples known concentration of metals was added to the water samples. From the stock solution (1000 mg/L) the standard solutions of 1.62 mg/L of each metal were added to 50 mL water samples. The spiked and non-spiked samples were carefully digested in similar conditions. Then each digested sample was transferred in to a 50mL volumetric flask and diluted to the mark with distilled water. Finally, the solutions were analyzed for metal concentration with ICP-OES. The present percent recovery was calculated by the standard formula.

$$\% \text{ R} = \frac{Csp - Cunsp}{sp} \times 100$$

Where % R – recovery

Csp – concentration recorded in spiked sample

Cunsp – concentration recorded in unspike sample

Sp –spike value (known concentration added to the sample)

3.5.2 Method detection limit (MDL)

Method detection limit (MDL) for each metal analysis using ICP-OES determined from blank sample. For blank samples, 5 ml HNO_3 (69%) were digested without sample. The digested blank samples were diluted by deionized water to 50 ml volumetric flask for metal analysis. Then the method detection limit of each element calculated three times the standard deviation of the blank samples concentration determined (Shrivastava and Gupta, 2011).

3.6 Instrumentation

The instrument that was used for analysis is Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) (Perkin Elmer Optima 8000) which is commonly used instrument in modern laboratory for the analysis of metals in various fields. An aqueous sample is converted to aerosols via a nebulizer. The aerosols are transported to the Inductively Coupled

Plasma which is a high temperature zone (8,000 - 10,000 ^{0}C). The analytes are heated (exited) to different (atomic and/or ionic) states and produce characteristic optimal emissions (light). These emissions are separated based on their respective wavelengths and their intensities are measured. The intensities are proportional to the concentrations of analytes in the aqueous sample. The quantification is an external multi point linear standardization by comparing the emission intensity of unknown sample with that of a standard sample. Multi-element calibration standard solutions are prepared from single and multi-element primary standard solutions (Charles and Fredeen, 1997). The instrument conditions are shown in table 3.

Table 3 Fast optima 8000 DV ICP-OES instrumental conditions

Optima 8000 ICP-OES parameters	
Power	1500 W
Plasma gas flow	8.0 L/minute
Auxiliary gas flow	0.2 L/minute
Nebulizer gas flow	0.7 L/minute
Pump speed	1.0 ml/minute

4 RESULT AND DISCUSION

4.1 Analyzing of physico-chemical parameter of water

The physical parameters such as temperature, pH, EC, TDS and turbidity were determined for the water sample collected from selamico reservoir. During analysis a field measuring device were used in both dry and wet season the mean values and standard deviation of the data were obtained and expressed on the Table 4 below.

Table 4 Distribution of physicochemical parameters in study area of selamico dam at dry and wet season (mean±sd)

Parameter	Dry season		Wet season		FAO
	A1	B1	A2	B2	(1994)
Temperature(^{0}c)	23.26±0.40	22.46±0.41	20.6±0.15	21.6±0.30	--
pH	7.93±0.04	7.89±0.01	8.34±0.08	8.21±0.02	6.0-8.5
EC(µs/cm)	118.9±9.00	122.9±3.68	130.86±2.39	129.9±3.64	3000
TDS(ppm)	58.8±5.68	61.6±1.76	66.1±1.32	65.4±1.87	2000
Turbidity(NTU)	22.93±0.56	20.93±0.35	11.13±0.50	6.57±0.34	--

Note; A1=inlet sample, B1=outlet sample, A2=inlet sample and B2=outlet sample

Naturally water bodies show changes in temperature daily and seasonally due to different activities that can contribute to changes in surface water temperature. Temperature is a factor of great importance for aquatic ecosystem, as it affects the organisms, as well as the physical and chemical characteristics of water.

In the present study the value of temperature in all sampling sites of selamiko dam A1, B1, A2 and B2 were obtained 23.26^{0}C, 22.46^{0}C, 20.6^{0}C and 21.6^{0}C respectively. The temperatures were comparatively higher during the dry and lower in the wet season (Table 4). This change was due to seasonal variation which could be attributed to warming or cooling at the earth’s surface or introduction of cold water from the surface during high recharge time periods as it rains (Ombaka *et al.,* 2013). These were found within the permissible limit of (WHO, 2008). Thus, the average temperature of the dam is favorable for aquatic ecosystem.

This result is similar to other studies reported within a range of 19.5^{0}C to 21^{0}C (Patil *et al*., 2012).

pH indicates the intensity of the acidic or basic character of a solution and is controlled by the dissolved chemical compounds and biochemical processes in the solution. It is usually monitored for assessments of aquatic ecosystem health, irrigation and drinking water sources, industrial discharges and surface water runoff (Saksena *et al*., 1994). In the present study, the pH value shows slightly alkaline that is A1, B1 A2 and B2 were obtained 7.93, 7.89, 8.34, and 8.21 respectively. These values are within the permissible limit of FAO set for drinking and irrigation purposes. The pH value of water in wet season was shown a small variation than dry season this is because of floods and rain runoff in which some dissolved alkaline salts may be enter to the dam.

Electrical conductivity (EC) is a measure of water capacity to convey electric current. It signifies the amount of total dissolved salts (Shrinivasa and Venkateswaralu, 2000). The recorded EC values for the studied sites of selamiko irrigation water dam of A1, B1, A2 and B2 were118.9µS/cm, 122.9 µS/cm, 130 µS/cm and 129 µS/cm respectively. Conductivity is one of the most important parameters affecting crop growth. The value obtained in all sampling site were within allowable/permissive ranges for irrigation uses of water that set by FAO but the EC of wet season is relatively greater than dry season this may be due to rainy season more electrolyte substances were be present in the dam.

Total dissolved solid (TDS) affects the aesthetic value of the water by increasing turbidity. High concentration of TDS water sample elevates the density of water, limits the suitability of water as drinking source and irrigation supply, influence osmoregulation of freshwater organisms and reduces the solubility of gases. In the present study the concentration of TDS in all sampling site A1, B1, A2 and B2 were 58.8 mg/L, 61.6 mg/L,66.1 mg/Land 65.4 mg/L respectively. These values were below the standard limits that set by FAO. The low level of TDS contents of irrigation water allows the water for drinking and domestic uses.

Turbidity is a measure of cloudiness of water, high turbidity may indicate the presence of organisms including bacteria, viruses, and parasites that can cause symptoms such as nausea, cramps, diarrhea, and associated headaches (Teklay and Amare, 2015).

In the present study in all sites of Selamiko irrigation dam of A1, B1, A2 and B2 were obtained to be 22.93NTU, 20.93 NTU, 11.3 NTU and 6.57 NTU respectively.

Turbidity values obtained for the Selmiko dam water at all four sampling sites are higher than WHO which suggests 5 NTU for drinking purposes (WHO, 2008). This indicates that the entire dam is contaminated and posing problems to aquatic lives. This might be due to improper disposal of sewage, surface runoff and wastewater from different domestic activities. Similarly higher turbidity values are also recorded by many workers as compared to the limit set by WHO (Pal et al., 2013).

4.1.1 Spatio-Temporal variations in irrigation water quality parameters

Statistical analyses were performed to examine the Spatio-Temporal variations between water samples of mean value in the dry and wet season.

Statistical significance or p-value of t-test for testing mean difference has been widely used for the comparison of two groups (miller, 1993). In this study (table 5) paired t-test was conducted to compare the mean values of the different irrigation water quality indicators for the wet and dry seasons.

Table 5 Comparisons of physical parameters of the selamiko dam irrigation water between dry and wet season with its p-value

Parameter	Dry season Mean ± std	Wet season Mean ± std	p-value	Remark
Temperature (^{o}c)	22.86±0.56	21.1±0.707	0.11	Ns
pH	7.91±0.028	8.27±0.092	0.033	S
EC(µs/cm)	120.9±2.828	130.38±0.67	0.043	S
TDS(ppm)	60.2±1.97	65.7±0.5	0.06	Ns
Turbidity(NTU)	21.93±1.41	8.85±3.22	0.0343	S

Note: S=significant, Ns=not significant according to paired t-test value

Paired t-test value showed physical parameters such as pH, EC and turbidity shows a significant difference in the mean value of dry and wet season ($p < 0.05$). But temperature & TDS did not differ significantly at 95% confidence level ($p > 0.05$).

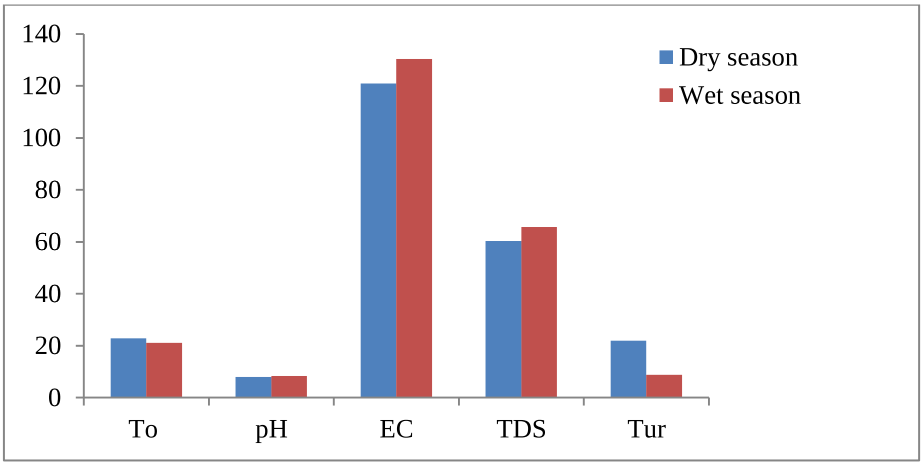


Figure 2 Physical parameters at dry and wet season in selamico irrigation water dam

4.2 Analyses of metals

4.2.1 Validation of experimental procedures

The validation of experimental procedures helps to know the efficiency of the experimental analysis which is proved by some parameters (Bruce & Gill, 1999). In the determination of the level of some selected trace metals in the water samples of selamiko irrigation dam, some of experimental procedures validation were seen such as method detection limit (MDL), recovery test (% recovery), coefficient of variation using standard deviation of triplicate sample analysis (CV), linear range, and plotting calibration curve with their coefficient of determination (R^2) were seen for the analysis of six selected trace metals in water samples of selamiko irrigation dam.

I. Coefficient of determination or regression coefficient (R^2)

It is used to infer the linearity of an analytical method only when standard solutions, based on which the calibration curve is determined (Guideline, 2005). As shown in Table 6, all the coefficient of determinations of the six trace metals are above 0.99 which is deemed a good fit to the linearity of calibration curve potted analytical methods.

A calibration curve is used to determine the unknown concentration of element. Individual calibration curve of each metal was obtained from the instrument by using series of solution of known concentration.

Table 6 Concentration of working standards and correlation coefficients for calibration curves

Metal	Concentration of working standard (mg/L)	Regression equation (y =mx + b)	correlation coefficient (R^2)
Mn	0.05, 1.05, 2.05, 3.05, 4.05, 5.05	y =10430000x-305069	0.999
Cr	0.05, 1.05, 2.05, 3.05, 4.05, 5.05	y = 1436000x-8167	0.999
Ni	0.05, 1.05, 2.05, 3.05, 4.05, 5.05	y = 485000x-1262	0.999
Zn	0.05, 1.05, 2.05, 3.05, 4.05, 5.05	y = 36203x-1474	0.998
Pb	0.05, 1.05, 2.05, 3.05, 4.05, 5.05	y = 76742x-730	0.999
Cd	0.05, 1.05, 2.05, 3.05, 4.05, 5.05	y = 76328x – 13970	0.999

The following figure shows Calibration curves of working standards using ICP-OES

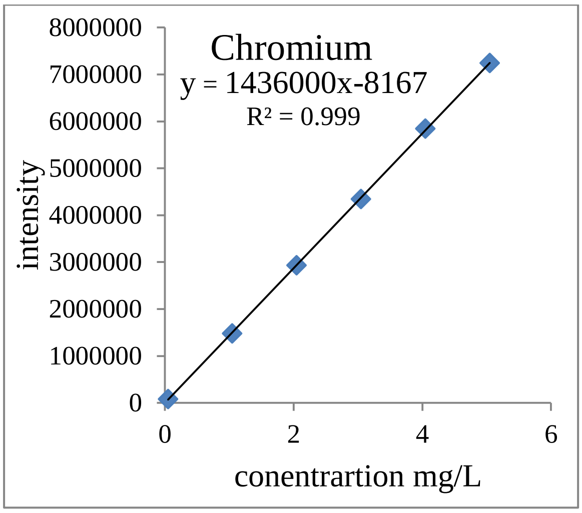


Figure 3 calibration curve for Chromium

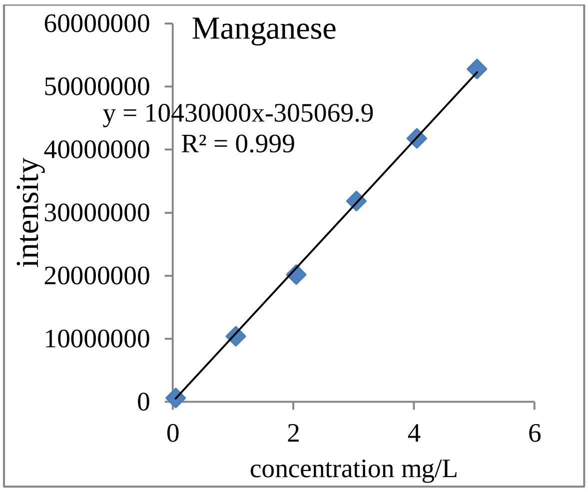
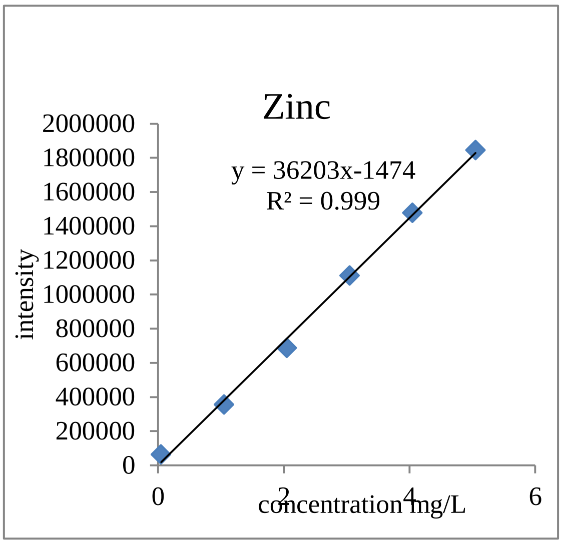


Figure 4 calibration curve for Manganese



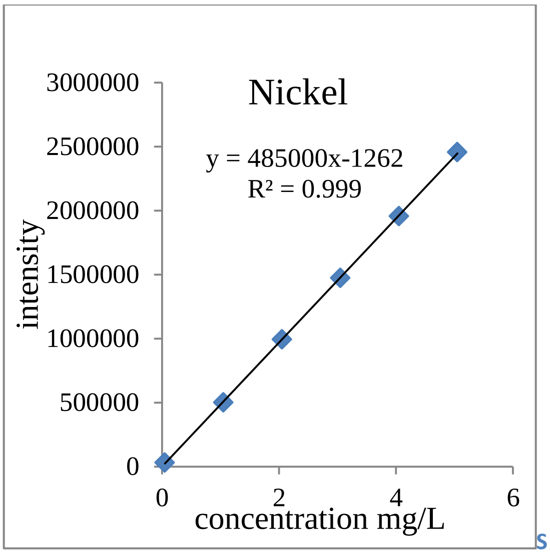
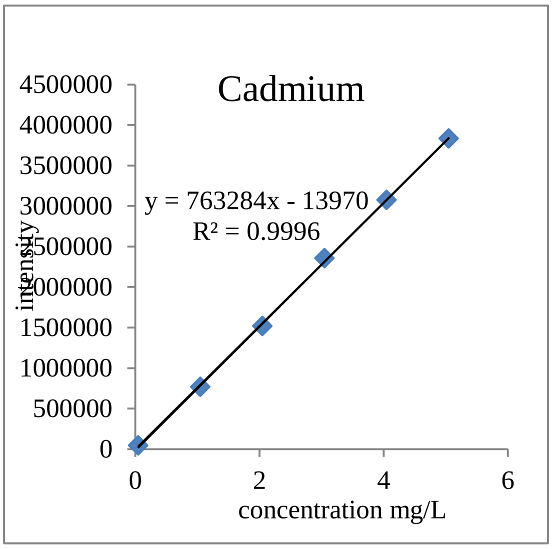


Figure 5 calibration curve for Zinc

Figure 6 calibration curve for Nickel



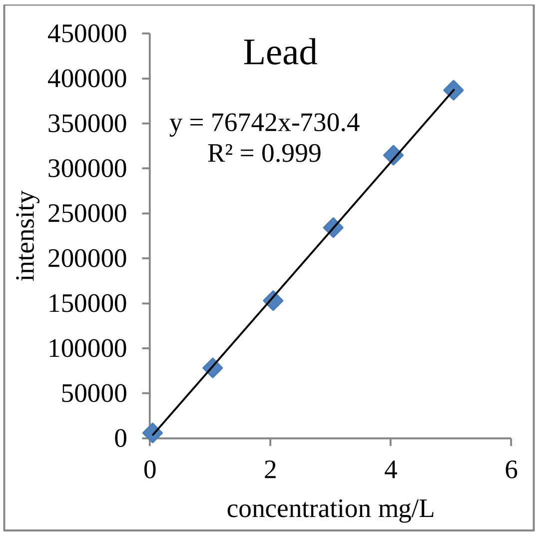


Figure 7 Calibration curve for Cadmium

Figure 8 calibration curve for Lead

II. Method detection limit (MDL)

Method detection limit is the lowest concentration of the analyte that reliable in the measurement procedure. This value was obtained by multiplied the standard deviation of the blank by three

$$MDL = 3\times Sb$$

Where MDL=method detection limit, Sb= Standard deviation of blank sample

III. Limit of Quantification (LOQ)

The lowest concentration level at which a measurement is quantitatively meaningful is called the limit of quantification (LOQ).The LOQ is most often defined as 10 times standard deviation of the blank samples concentration determined (Shrivastava and Gupta, 2011). In this study, LOQ was obtained from blank sample that were digested in the same digestion procedure as that of the water samples and the obtained results are displayed in Table 7.

$$LOQ= 10\times Sb$$

Where LOQ=limit of quantification, Sb= Standard deviation of blank sample

Table 7 Method detection limit and method quantification limit for determination of metals in water samples

Metal	Cr	Mn	Pb	Cd	Zn	Ni
MDL (mg/L)	0.0021	0.0006	0.0036	0.000	0.0012	0.0012
LOQ (mg/L)	0.007	0.002	0.012	0.000	0.004	0.004
IDL (mg/L)	0.0061	0.0014	0.042	0.0027	0.0059	0.015

Note: MDL= method detection limit, LOQ= limit of quantification, IDL = instrumental detection limit

From this study method detection limit lies in between 0.000-0.0036mg/L and limit of quantification lies between 0.000-0.012mg/L. Both the LOD and LOQ are lower enough to detect and quantify traces of the metals in the real sample.

IV. Recovery (%)

The efficiency and accuracy of the optimized method was evaluated by analyzing the digests of spiked samples. The percent recoveries obtained for the studied metals (Cr, Mn, Ni, Cd, Zn and Pb) are presented in Table 8.

Table 8 Recovery results after spiking with standard solutions

Metal	Spike value(mg/L)	Concentration recorded in unspike sample (mg/L)	Concentration recorded in spiked sample (mg/L)	Recovery (%)
Cr	1.62	0.331 ±0.0017	1.725 ±0.0126	86.04
Mn	1.62	0.143 ± 0.0002	1.58 ±0.0147	88.7
Ni	1.62	0.229 ± 0.0018	1.687 ±0.0109	90
Zn	1.62	0.772 ± 0.0071	2.055 ±0.0356	79.19
Cd	1.62	0.012 ±0.000	1.605 ±0.0269	98.3
Pb	1.62	0.023 ±0.0002	1.498 ±0.0046	91.04

Note: Concentration of spiked samples is average of the analyzed sample ± standard deviation.

Accordingly, the recoveries of metals in the spiked samples were obtained in the range from 79.19% to 98.3 %. All the recovery values were within the acceptable range of 80–120% for metal analysis (Machado and Griffith, 2005) except zinc. These results indicate that the proposed method was accurate and confirms that the method of analysis for each metal was acceptable.

V. Coefficient of variation (CV)

It is one of the measures of precision measurement of an analysis, which is determined by calculating the percent relative standard deviation or coefficient of variation (Guideline, 2005). Most of the CV values are found to be less than 15%, which confirms that results of the measurement were reliable.

4.2.2 Level of the metals in the studied samples

The concentration of heavy metals in selamiko irrigation dam water in dry and wet season were determined by using ICP-OES and reported in mg/L are shown in Table 9. Except for the concentration of lead, all heavy metal concentrations were found to be lower during the wet season than the dry season. This might be due to dilution effect by the heavy rain and runoff from the surrounding environment.

Table 9 the levels of trace metals in the water sample from Selamiko catchment (Mean ± STD) in mg/L.

Metals	Dry season		Wet season		Average value of dry and wet season	
	A1	B1	A2	B2	Dry season	Wet season
Cr	0.323±0.009	0.317±0.018	0.013±0.001	0.008±0.0007	0.32±0.004[a]	0.011±0.0008[b]
Mn	0.135±0.002	0.285±0.052	0.133±0.018	0.032±0.0002	0.21±0.027[a]	0.082±0.009[b]
Ni	0.214±0.012	0.212±0.017	0.022±0.002	0.014±0.007	0.213±0.001[a]	0.018±0.004[b]
Zn	0.369±0.036	0.531±0.002	0.184±0.0048	0.091±0.001	0.45±0.114[a]	0.137±0.065[a]
Cd	0.010±0.0001	0.010±0.0001	0.005±0.0007	0.005±0.0007	0.01±000[a]	0.005±000[b]
Pb	0.017±0.003	0.014±0.004	0.249±0.007	0.207±0.0048	0.015±0.002[a]	0.228±0.029[b]

NB: Values in the same row of the last two column that are followed by a different letters (a and b) are significantly different ($p<0.05$) by paired t-test.

A1=inlet sample in dry season, B1=outlet sample in dry season, A2=inlet sample in wet season and B2=outlet sample in wet season.

From the results presented in Table 9, the concentration of chromium were obtained in all sites of selamiko dam A1, B1, A2 and B2 were recorded 0.323mg/L, 0.317 mg/L, 0.013 mg/L and 0.008 mg/L respectively. The values in both sites of the dry season were above the permissible limit of FAO for irrigation purposes but below the permissible limit in both sites of wet season.

Chromium in excess amounts can be toxic especially in the hexavalent form. Sub chronic and chronic exposure to chromic acid can cause dermatitis and ulceration of the skin. Long-term exposure can cause kidney, liver, circulatory and nerve tissue damages. Chromium often accumulates in aquatic life, adding to the danger of eating fish that may have been exposed to high level of chromium (Hanaa et al., 2000).

Table 10 International Guidelines of heavy metals water quality (mg/L)

Metals	FAO(1985)	USEPA(1990)
Cr	0.1	0.1
Mn	0.2	0.3
Ni	0.2	0.1
Zn	2	5
Cd	0.01	0.005
Pb	5	0.003

Manganese**-** is naturally occurring in many surface and ground water sources and in soils that may erode in to this water. However, human activities are also responsible for much of the manganese contamination in water in some areas. In the present study of selamiko dam in sites of A1, B1, A2, and B2 were obtained as 0.135 mg/L, 0.285 mg/L, 0.133 mg/L and 0.032 mg/L respectively. All the values recorded were below the permissible limit set by FAO except in the out let of the dam during the dry season.

Nickel- concentration of 0.214 mg/L, 0.212 mg/L, 0.022 mg/L and 0.014 mg/L were noted in samples of sites A1, B1, A2 and B2 respectively. Therefore, the results in this study were comparable and greater in some extent with the permissible limit set by FAO but higher than USEPA.

Zinc- is an essential element in human diet. Zinc with a low concentration and high concentration can cause health problem .High level of zinc in water change taste and color of water (Nazir *et al.,* 2015). The recorded value of zinc in all sampling site of A1, B1, A2 and B2 were 0.369 mg/L, 0.531 mg/L, 0.184 mg/L and 0.091 mg/L respectively. These values in all sampling sites of the present study were below the permissible limit of the guideline set by FAO.

Cadmium- Human activities can contribute to increased Cadmium levels as a result of agricultural practices (Adriano, 2001). Cadmium metal of this work in all sampling sites of selamiko dam results of A1, B1, A2, and B2 were 0.01 mg/L, 0.01 mg/L, 0.005 mg/L and 0.005 mg/L respectively. According to the present study, the value in dry season was comparable with FAO. This value of cadmium caused possibly health potential problems and accumulates in the human body affecting negatively several organs: liver, kidney, bones, lungs, placenta, brain and central nervous system (Goering et al., 1994).

Lead- is found in trace amounts in various foods, notably in fish, which are heavily subjected to industrial pollution. High concentration of lead in the body can cause death or permanent damage to the central nervous system, the brain, and kidneys (Hanaa et al., 2000). In this study, the concentration of lead in all sites of A1, B1, A2 and B2 of selamiko dam were 0.017 mg/L, 0.014 mg/L, 0.249 mg/L and 0.207 mg/L respectively. The study results were under the permissible limit of FAO for irrigation purposes.

4.2.3 **Spatio-Temporal variations of heavy metal concentrations in selamiko irrigation water during dry and wet seasons**

The quality of some water sources may change significantly with time or during certain periods such as in dry or rainy seasons (Islam *et al.*, 2009). So it is recommended to have more than one sample taken, in different time periods.
During the present study of selamiko irrigation water dam the concentration of heavy metals present were significantly different in the dry and wet season. According to the result the concentration of heavy metals in the dry season were greater than the wet season except lead.
This is due to high evaporation rate during the dry season which resulted to higher concentrations of heavy metals in dam's water compared to dilution in wet season by addition of rain water and subsequent outflow of reservoir water (Ndeda and Manohar, 2014).

The results showed that the mean concentrations of metals ranked (high to low): Zn > Cr > Ni > Mn > Pb > Cd during dry season, whereas the concentration of heavy metals during wet season was in the following order of decreasing magnitude Pb > Zn > Mn > Ni > Cr > Cd (Figure 9).The concentration of heavy metals during dry season was higher than the wet season except for Pb in which the highest concentration was found during wet season. The highest concentration of Pb during wet season could attributed to high runoff during rainy season eroded the soil particles containing lead. Whereas the highest concentration of most of the metals during dry season is because of water volume in the dam had reduced during the dry season making the dissolved metals to be at higher concentration levels in the liquid phase.

As shown from appendix 2 paired t-test value shows all heavy metals such as Cr, Ni, Cd, Mn and Pb shows a significant difference in mean concentration of dry and wet season ($p < 0.05$). But Zn did not differ significantly at 95% confidence level ($p > 0.05$).

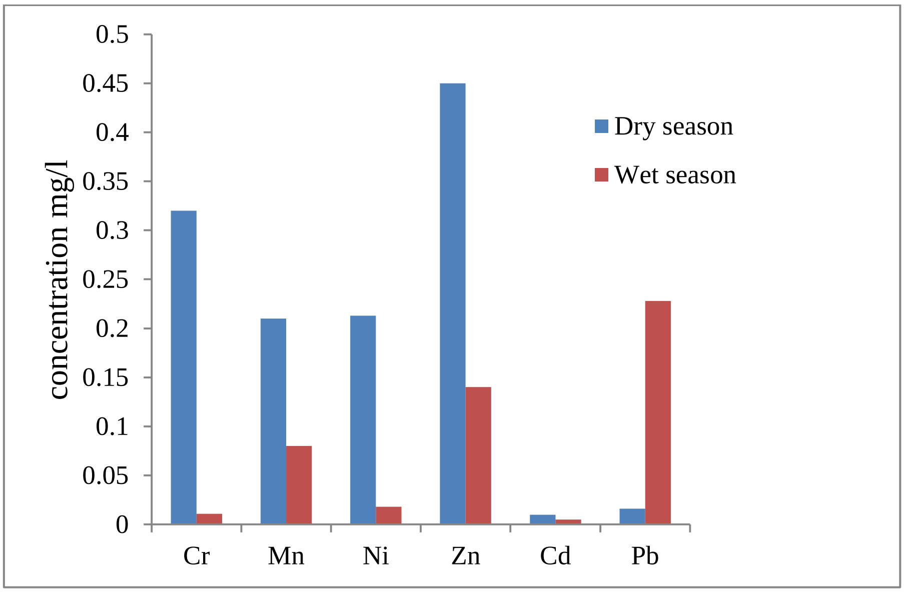


Figure 9 Heavy metal mean concentrations at dry and wet season of selamiko irrigation water dam

5 CONCLUSION AND RECOMMENDATION

5.1 Conclusions

The present study was tried to assess the irrigation water quality of selamiko dam in terms of physicochemical parameters such as temperature, pH, EC, TDS and turbidity as well as the level of heavy metals such as Cr, Mn, Ni, Zn, Cd and Pb during the dry and wet season by taking water samples from the inlet and out let of the selamiko dam.

As a result, the value of physicochemical parameters such as temperature, and turbidity were higher in dry season than in the wet season but the remaining parameters pH, EC& TDS were lowered in the dry season. Generally, except turbidity (set by the limit of WHO) all physical parameters in the dam were within the allowable limit of water for irrigation purposes.

The accumulation of heavy metals in the dam was detected both in the dry and wet season by using ICP-OES. The concentrations of heavy metals were higher in the dry season than wet season except lead. According to the result, the heavy metals (Cr, Mn, and Ni) in the dry season were higher than the permissible limit of standards set by FAO for irrigation purposes.

5.2 Recommendations

Based on the result of this study, the following recommendations have been proposed such as:

- In this study high levels of some heavy metals in the dry season may negatively affect the land to be used for irrigation and needs appropriate treatment to come up with the standard and in turn increase the yield of the irrigation products .
- Stake holders should take care of the removal of different pollutants at the source of the dam and it should be controlled by the concerned body.
- Further study should be carried out to conduct other physical, chemical & biological parameters of significant health concern.
- Another researcher should study this area on the bases of different seasonal variation and use replicate sampling.

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APPENDIX 1

Photographs in selamico catchment

Photograph of during field measuring

photograph of during sample collection

APPENDIX 2

I. Comparison of heavy metals of selamico irrigation water dam in the mean value of dry and wet season with p-value

Metals(mg/L)	Cr	Mn	Ni	Zn	Cd	Pb
Dry season mean±std	0.32±0.004	0.21±0.027	0.213±0.001	0.45±0.114	0.01±0001	0.015±0.0022
Wet season mean±std	0.011±0.0008	0.082±0.009	0.018±0.004	0.137±0.065	0.005±0001	0.228±0.029
t-calculated	-107.126	-6.36	-66.884	-3.373	-500	10.36
p-value	0.0001	0.0238	0.0002	0.0778	<0.0001	0.0092
Remark	S	S	S	Ns	S	S

Note: S=significant, Ns=not significant according to paired t-test value

II. Comparison of physical parameters in the mean value of dry and wet season

Parameter	Dry season Mean ± std	Wet season Mean ± std	T-calculated	p-value	Remark
Temperature (^{o}c)	22.86±0.56	21.1±0.707	-2.76	0.11	Ns
pH	7.91±0.028	8.27±0.092	5.294	0.033	S
EC(µs/cm)	120.9±2.828	130.38±0.67	4.613	0.043	S
TDS(ppm)	60.2±1.97	65.7±0.5	3.827	0.06	Ns
Turbidity(NTU)	21.93±1.41	8.85±3.22	-5.262	0.0343	S

Note: S=significant, Ns=not significant according to paired t-test value