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DEPARTMENT OF NATURAL RESOURCES

AN ASSESSMENT OF HEAVY METAL CONCENTRATION (IRON, LEAD, ZINC, CADMIUM, COPPER) IN MAZOWE DAM, MASHONALAND CENTRAL

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DECLARATION

The undersigned attest that they have reviewed and approved this research project for marking in accordance with the department's standards and regulations.

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DEDICATION

I dedicate this research study to my family, my beloved father Watson, my mother Lucia and my brother Osward.

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My deepest sense of gratitude and indebtedness goes to Mr Mhlanga my supervisor and Mr Richakara (Lab tech) for their aspiring guidance, constructive and valuable suggestions throughout this work. Their able knowledge and expert supervision with unswerving patience fathered my work at every stage for without his warm affection and encouragement, the fulfilment of task would have been very difficult

I would like to pass my gratitude to my friends and family. They worked hard in encouraging me to come up with this research study.

ABSTRACT

Mining and recreational is a major contributor to water pollution, which can lead to accumulation of heavy metals in aquatic systems. Illegal mining activities in the Mashonaland Central specifically in the Mazowe area, may potentially result in heavy metal pollution of water sources. A study was conducted to assess the concentration of heavy metals in aquatic system. Water samples were collected from Mazowe dam. Concentrations of Copper, Lead and Zinc, Cadmium and Iron in water samples were measured Atomic Absorption Spectrometer (AAS) No significant temporal difference in metal concentrations was found in copper and lead. Mazowe dam had significantly higher concentrations of Iron (9.866 mg/L) , Zinc (0.41660 mg/L) and Cadmium (0.0056mg/L) suggesting potential environmental pollution sources in the catchment area. The findings of this study provide important insights into the heavy metal pollution status in Mazowe dam. Further the research is recommended to identify pollution sources and implement appropriate remediation measures to protect the dam.

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CHAPTER 1: INTRODUCTION

1.1 Background of the Study

Water is one of our planet's most precious resources, vital for life, agriculture, and industry. However, water bodies around the world are facing increasing threats from pollution and contamination, leading to serious environmental and public health concerns Munene et al., (2023). A range of contaminants, including heavy metals, industrial chemicals, and agricultural runoff, find their way into rivers, lakes, and dams, causing widespread degradation of aquatic ecosystems and impacting the availability of safe drinking water. Water contamination is a global issue of paramount importance Kanda et al., (2017). Water bodies worldwide are increasingly at risk due to various pollutants, including heavy metals, industrial chemicals, and agricultural runoff. This pervasive problem has led to a decline in water quality, adversely impacting aquatic ecosystems and the availability of clean drinking water for communities worldwide, Khayongo (2020).

In the wider context of Africa, water quality challenges assume a particularly acute dimension. The continent's burgeoning population, rapid urbanization, and industrialization exert considerable strain on its already limited water resources, Mununga et al., (2023). The critical issue of ensuring access to safe drinking water is a pervasive concern across many African nations, with water contamination exacerbating these pre-existing challenges, Alain et al., (2021). Zimbabwe, akin to its fellow African nations, grapples with these pressing issues, further underscoring the urgency of addressing water quality and resource management on a regional scale.

Zimbabwe, as a nation, grapples with significant water quality concerns. Its rivers, dams, and lakes are under constant threat from diverse sources of pollution, including urban sewage, agricultural runoff, and industrial discharges, Kanda et al.,(2017). Challenges in implementing and enforcing water quality standards have further compounded these issues, making clean water a scarce resource in certain regions of the country, Zimwara et al., (2018). The Mazowe region, located in Mashonaland Central, has garnered specific attention due to its extensive mining activities. Mining operations in the region involve the use of heavy metals and chemicals that can inadvertently find their way into local water bodies, thereby posing a severe risk to water quality. Mazowe Dam, a vital water source in the area, is emblematic of this challenge.

The mining sector is a primary contributor to heavy metal contamination in water bodies. Mining activities necessitate the extraction and processing of ores, which often release heavy metals, such as lead, cadmium, copper, and zinc, into the environment. Runoff from mining sites can flow into nearby rivers and dams, significantly elevating heavy metal concentrations and threatening water quality, Kanda et al., (2017). The issue of heavy metal contamination is compounded by the intricate interplay of mining, agriculture, and urban development in the Mazowe area. These activities often coexist, with the potential for runoff from agricultural practices and urbanization to interact with mining operations, creating a complex web of contamination sources that complicates water quality preservation, Teta et al,.(2017).

The consequences of heavy metal contamination in water bodies are profound. Elevated levels of heavy metals can pose health risks to the local population, particularly if contaminated fish enter the food chain, Munene et al.,(2023). Additionally, polluted water can harm aquatic life and disrupt the ecological balance, affecting not only the environment but also the livelihoods of communities relying on these water bodies for sustenance and economic activities, Serviere-Zaragoza et al., (2021). In light of these challenges, conducting an assessment of heavy metal concentrations in Mazowe Dam, Mashonaland Central, Zimbabwe, is essential for preserving the environment and safeguarding the well-being of local communities. This article will explore the methods, implications, and potential solutions associated with this issue in greater detail.

1.2 Problem Statement

This problem statement elucidates the pressing issues that necessitate the assessment of heavy metal concentrations in Mazowe Dam which has the potential to harm the aquatic ecosystem. These contaminants can disrupt the balance of the local environment, leading to a decline in biodiversity, affecting the health of aquatic organisms, and impacting the overall water quality.

1.3 Main objectives

The primary aim of this study is to comprehensively assess the concentrations of heavy metals, specifically iron, lead, cadmium, copper, and zinc, in the waters of Mazowe Dam, Mashonaland Central, Zimbabwe.

1.3.1 **Specific Objectives**

- To determine the current levels of heavy metals (iron, lead, cadmium, copper, and zinc) in various locations within Mazowe Dam.
- To identify and assess potential sources of heavy metal contamination in the Mazowe Dam watershed.
- To determine if there are variations of heavy metals across different sites in the dam

1.4 **Research Questions**

1. What is the current level of heavy metals (iron, lead, cadmium, copper, and zinc) in various locations within Mazowe Dam
2. What are the potential sources of heavy metal contamination in the Mazowe Dam watershed
3. What are the variations trends of heavy metal concentrations in Mazowe dam in different sites?

1.5 **Limitations**

The study faces several limitations, including potential variations in heavy metal concentrations due to seasonal factors and natural fluctuations. To address this, the research has involved long-term data collection to capture these variations comprehensively. Additionally, access to certain sites within the Mazowe Dam watershed were restricted, limiting the extent of data collection. In response, the research team collaborate closely with local authorities and stakeholders to gain necessary permissions and access. Another limitation involves potential gaps in historical data, especially concerning specific sources of contamination. To overcome this, the study had to employ a combination of on-site assessments, interviews, and historical records to reconstruct an accurate picture of the contamination sources. These limitations has been acknowledged and managed through rigorous methodology, data validation, and the utilization of the best available resources to ensure the study's reliability and robustness**.**

CHAPTER 2: LITERATURE REVIEW

2.1 Sources and behavior of heavy metals

Various sources contribute to the presence of heavy metals in water bodies including natural processes and anthropogenic activities. Natural sources may include weathering of rocks and soils while anthropogenic sources encompass industrial activities mining, agriculture and urbanization. Studies have highlighted the potential impact of gold mining activities in the Mazowe River catchment area as well as the discharge of untreated industrial and domestic effluents as significant contributors to heavy metal contamination in Mazowe dam.

The presence of heavy metals in aquatic ecosystems is a concern due to their toxicity, long persistence and their accumulative behavior Rahman et al., (2012). Furthermore, heavy metals are non-biodegradable, persist in aquatic systems and may bio-accumulate along the food chain Gupta et al., (2009). Heavy metals are normally classified as metals that have a specific density greater than 5 g/cm3, Järup et al., (2003). They include Copper, Lead, Zinc and Mercury and cadmium among others. Even though very low levels of pollution may not show any immediate acute effects on aquatic organisms it might lead to long term (chronic) effects. This could happen via metal accumulation in reproductive organs or it could affect sperm or ova when released into the water, Ebrahimi et al., (2011).

Heavy metals are one of the most important and abundant groups of endocrine disrupting chemicals (EDC's). EDCs include many organic chemicals such as polychlorinated biphenyls, organ chlorine pesticides and plasticizers, among others. An endocrine-disrupting substance can be defined as a compound, either natural or synthetic, which can alter the hormonal and homeostatic systems which enable an organism to communicate and respond to its environment, Diamanti-Kandarakis et al., (2009). Industrialized areas are at higher risk of contamination with a wide variety of industrial chemicals. These can leach into the soil and groundwater where they enter the food chain and accumulate in animals higher up the food chain, Diamanti-Kandarakis et al., (2009). Fish and other aquatic organisms can be exposed to heavy metals via two routes, Gupta et al., (2009). The primary route for metal intake by fish is via their gills or dissolved contaminants being transported across biological membranes or through ionic exchange across membranes. The second route is through ingestion of food or sediment particles which is then transported across the gut Gupta et al., (2009).

Studies done by, Bervoets et al., (2001) showed that the gastrointestinal route is the more important route when it comes to heavy metal uptake. Aquatic micro flora and micro fauna will accumulate these metals in their cells, a process known as bioaccumulation. Fish then consume these microorganisms and in this way get enriched with the heavy metals. Ebrahimi et al., (2011) describes bioaccumulation as the incorporation and retaining of metals by organisms from their surrounding environment. If the incorporation of the metal is higher than what the organism uses in its metabolic processes or that the organism will excrete we can say bioaccumulation occurs. Heavy metals will then be transferred to predators of fishes where the concentration of heavy metals will increase until it finally ends up in human beings. This process is referred to as bio magnification and it may result in the onset of various types of disease syndromes Gupta et al., (2009).

Bioaccumulation of heavy metals can damage aquatic and terrestrial ecosystems and can also become part of the food chain through bio magnification, Garget al .,(2009). Many of these heavy metals can form bonds with sulfur groups in enzymes and disrupt enzyme functions, while some metals can bind to cell membranes and hinder transport processes through cell membranes, Boran (2010). Fishes and crabs may be reliable bio-indicators of aquatic ecosystems, since they occupy higher trophic levels and are also an important food source of humans. The metal concentration in the tissues and organs of fishes and crabs will give a good indication of the heavy metal concentration in the water and can also give a good indication of the accumulation of these heavy metals in the food chain Rahman et al., (2012)

2.2 Effects of heavy metals on aquatic system an humans

2.2.1 Lead (Pb)

Exposure to lead may result in poisoning which causes anemia due to inhibition of hemoglobin synthesis as well as destruction of red blood cells, Heath (1995). Low levels of Pb pollution showed adverse effects on fish health as well as reproduction, Ebrahimi et al, (2011). This includes disruption in the normal steroid synthesis pattern and impaired hormone production. The quality and quantity of sperm and ova reproduced will also be affected. This will ultimately lead to extinction of fish stocks in affected aquatic systems, Ebrahimi et al., (2011).

Lead exposure is particularly harmful to the developing nervous system, and children are especially vulnerable. It can cause irreversible neurological damage, leading to cognitive impairments, learning disabilities, and behavioral problems, Lanphear et al., (2005). Chronic exposure to lead in water has been associated with increased blood pressure, hypertension, and an elevated risk of cardiovascular diseases in adults. Lead can disrupt normal cardiovascular function, leading to heart attacks, strokes, and other cardiovascular complications. Lead can accumulate in the kidneys and cause renal damage. Prolonged exposure to lead through water consumption can lead to decreased kidney function, impaired renal tubular function, and an increased risk of kidney disease, Weaver et al., (2018).

2.2.2 Iron (Fe)

Iron is an essential mineral for human health, however high levels of iron in drinking water can cause aesthetic problems such as a metallic taste, discoloration, and staining of teeth. Excessive iron intake from water can lead to gastrointestinal disturbances such as abdominal pain, nausea, vomiting, and diarrhea. These effects are more likely to occur when individuals consume water with very high iron concentrations. Individuals with certain genetic disorders, such as hereditary hemochromatosis, can experience iron overload due to excessive iron absorption from water and food sources. Iron overload can lead to the accumulation of iron in various organs, potentially causing organ damage and increasing the risk of conditions like liver disease, heart problems, and diabetes.

Iron is an essential nutrient for fish, and it plays a vital role in various physiological processes. Elevated levels of iron in water can cause direct damage to the gills of fish. Iron accumulation in the gills can lead to oxidative stress, inflammation, and impairment in respiratory functions. This can result in reduced oxygen uptake, compromised ion regulation, and overall respiratory distress in fish, Val, et al (2008) Excessive iron levels in water can lead to altered behavior and physiological changes in fish. This may include reduced feeding activity, impaired growth, changes in swimming behavior, and disrupted reproduction, Grosell et al. (2007).

2.2.3 Zinc (Zn)

Most Zn in freshwater systems increasingly adsorbs into sediments and humic substances at high temperatures, low oxygen levels, and low pH. Most aquatic organisms can tolerate bioavailable Zn concentrations below 100 μgL^{-1} [172]. However, at elevated levels, Zn toxicities lowers the metamorphosis and emergence rate of adult stages of freshwater insect communities. The presence and toxicity of Zn in ternary mixtures of heavy metals in streams lowers the abundance of pollution-sensitive mayflies (Ephemeroptera) in aquatic species-sensitivity distribution (SSD) profiles

Studies on the long term effect of Zn on the metabolism of female amphibians showed effects in the ovary and liver. Glucose-6-phosphate dehydrogenase activity decreased, while endogenous glutathione content increased in the ovary and this may lead to reproductive failure, Strydom et al., (2007). Zn can also cause nephritis, anuria and extensive lesions in the kidney, Rahman et al., (2012).

2.2.4 Copper (Cu)

Copper is absorbed very quickly by the gills and the liver of fish, which leads to, increased residue levels. This can cause retardation in growth, inhibition of respiratory enzymes in crayfish and also changes in locomotive behavior as was demonstrated in a study with goldfish, Gupta et al., (2009). The amount of Cu that is 16 accumulated by fishes also depends on the assimilation and excretion capabilities of the species concerned, Das (2013). High levels of copper in drinking water can cause gastrointestinal problems such as nausea, vomiting, and stomach cramps. It may also lead to diarrhea or constipation.

Prolonged exposure to elevated copper levels in drinking water can have toxic effects on the liver and kidneys. Studies have shown that excessive copper intake can lead to liver damage, including hepatotoxicity and fibrosis. Moreover, it can impair kidney function and contribute to renal dysfunction, Brewer et al., (2012).

2.2.5 Cadmium (Cd)

Cadmium exposure in fish can lead to reproductive impairments, including reduced fertility, decreased egg production, and abnormal development of embryos. It can disrupt the hormonal balance and affect the reproductive organs and processes in fish, Bury (2004). Functions of metallothionein and zinc in the tolerance of fish to cadmium. Cadmium can accumulate in the gills of fish, causing damage to this important respiratory organ. It can impair oxygen uptake and ion regulation in fish, leading to respiratory distress, reduced growth, and compromised overall health, Niyogi et al, (2004). Tissue-specific cadmium accumulation, metallothionein induction, and tissue zinc and copper levels during chronic sub lethal cadmium exposure in juvenile rainbow trout.

Cadmium is known to have toxic effects on the kidneys in humans. Chronic exposure to cadmium through water or contaminated food, such as fish, can lead to kidney dysfunction and damage. It can cause renal tubular dysfunction, kidney stones, and even kidney failure, Järup et al., (2009).Cadmium can accumulate in bones over time and interfere with calcium metabolism. Prolonged exposure to cadmium through water or food sources can lead to decreased bone density, increased risk of fractures, and skeletal abnormalities such as osteoporosis, Staessen et al., (1999).

2.3 Studies on heavy metals

There are limited documented studies on heavy metal Mapaure et al., (2011), Mileusnić et al., (2014). Previous studies found that the concentration of most metals in freshwater bodies were lower than the recommended concentrations prescribed by the various authorities within which the study was performed Davies et al., (2009).

Ncube et al,.(2017) analysed heavy metals in water, in dams located downstream of effluent discharge zones in Bulawayo and were compared to those in a pristine upstream dam water from downstream dams exceeded WHO safe limits for drinking water cadmium levels in polluted dams also exceeded the safe limit for agricultural use.

Muzerengi et al., (2010) investigated the heavy metal contamination levels in surface soils and river sediments in the Bindura-Shamva greenstone belt in Zimbabwe. The researchers collected samples from different sites and analyzed them for heavy metal concentrations. The study aimed to assess the potential risks associated with heavy metal pollution in the region.

(Cd, Cu, Fe, Pb and Zn) were determined in water in the Gwebi River, a major tributary to Lake Manyame, Utete et al., (Aug 2013) sampled four selected sites in the wet (December-March) and dry (April-November) seasons and metal concentrations were analysed by flame atomic absorption spectroscopy (FAAS).

Mangwayana (2010) examined heavy metal concentrations in soils and plants from a wetland and an agricultural area in the Lake Chivero watershed in Zimbabwe.

Gotosa et al., (2001) investigated the spatial distribution of heavy metals in urban soils of Harare, Zimbabwe. The researchers collected soil samples from different areas within the city and analyzed them for heavy metal concentrations. The study aimed to assess the sources and patterns of heavy metal pollution in urban environments.

Madebwe et al (2017) studied metal concentrations in ground water resources in Upper Sanyati Catchment, Midlands Province and the time weighted ground water mean maximum lead concentration was recorded during the beginning of the dry season in May in sub-region 2 while lowest lead values were recorded in February during the wet season in sub-region.

CHAPTER 3: METHODOLOGY

3.1 Description of area of study

The Mazowe dam (Mazoe Dam) is a dam on the Mazowe River in Zimbabwe, in the Iron Mask Hills about 35 kilometres (22 mid) north of Harare, Moyo et al.,(2012). Constructed in 1920, it was built mainly to provide irrigation for the Mazoe citrus estates the dam has played a crucial role in the country’s agricultural sector, Ruruki (2006). The dam was also home to the Hunyani Rowing Club and formerly provided facilities for St. Georges, Prince Edward, Arundel and other rowing clubs. It is the only major dam on the Mazowe River.

The concrete dam was built by the British civil contractor Paulin and Co and Impregilo SpA and was raised by 3 metres (9.8 ft.) in 1961 by drilling into the foundation rock and installing post-tensioned tendons into the concrete. It is 37 metres (121 ft.) high and 163 metres (535 ft.) long, with overflow spillways on either side, it can hold 35 million cubic meters of water and has a surface area of 445 hectares when full, Mazvimavi et al.,(2015). Beyond irrigation, Mazowe dam supplies water for nearby urban centres and industries Moyo et al., (2012).

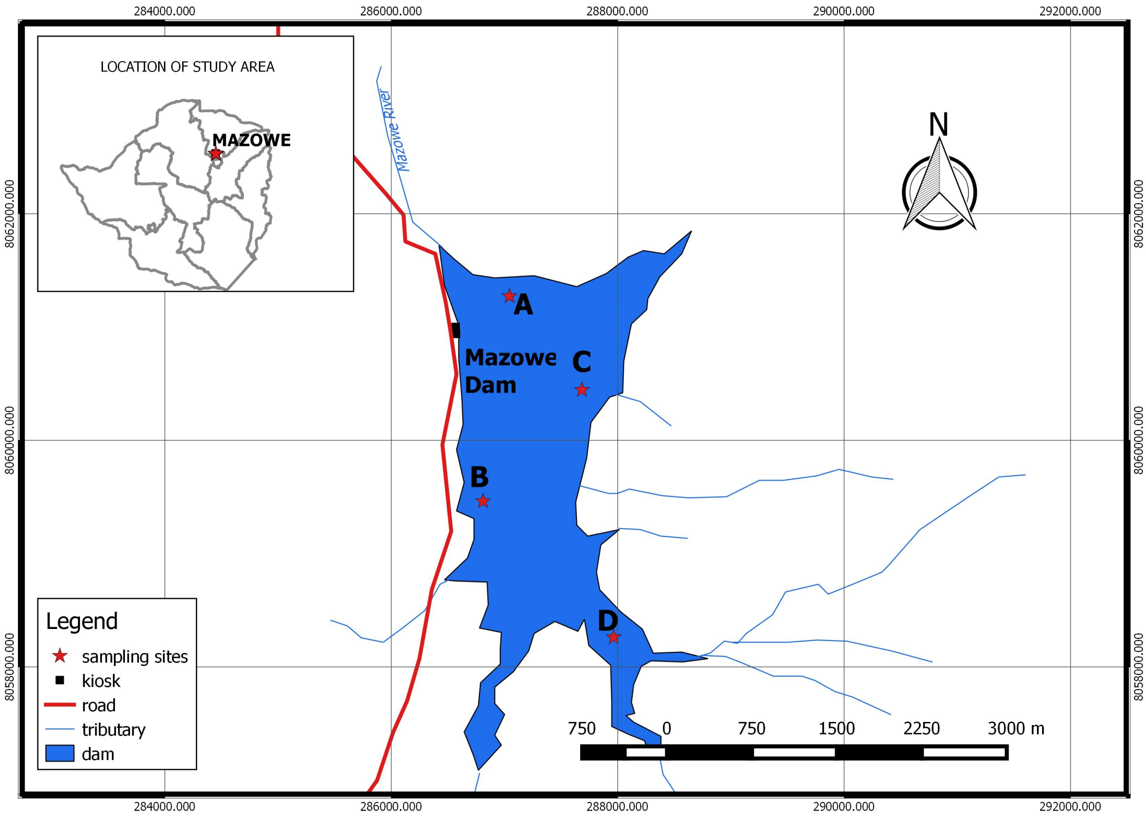

Figure 1 shows a map of Mazowe Dam and locations of the dam from where samples were obtained are indicated by a star.

3.2 Research design

3.2.2 Collection of water samples

Water was collected from the inlet and outlet of the dam at four different sites with four visits. This was done to determine if concentrations of metals decrease with distance from the source. (Figure 1) May 2023 to July 2023 at 2 weeks intervals, to determine whether temporal differences in concentrations of metals exist.

Sites were selected based on their accessibility from the banks for logistical reasons. Site A occurred on the dam-wall, which consisted of deep water. Site B occurred on banks of the dam at the recreational side situated with grass and small stones as well as mud, punctuated by large sized boulders along the river course. Site C was also at the edge/banks of the dam opposite to side of the recreation. Site D was the upstream of the dam where the water enters the dam and was characterized by a layer of short grass surrounding it and a mat of water lilies. This site consisted of large rocks and gravel. Sampling at this site was conducted in a boat.

The samples were filtered through a filter paper at the time of collection and liquid phase is then acidified at the time of collection with nitric acid of 5ml/L. Samples for dissolved metals did not need to be digested as long as the acid concentrations have been adjusted to the same concentration as in the standards. Water samples were collected from just under the surface of the water. Samples were acidified with concentrated HNO3 to a pH of 2 at the sampling sites. Samples were transported on to the laboratory

3.2.3 Laboratory analysis

3.2.4 Apparatus and materials

Water Sampling Equipment

- Water samplers’ polyethylene bottles (500ml)

Water Quality Monitoring Equipment

- pH meter (Hach Ph500) (4, 7, 10)
- Thermometer (digital)

Laboratory Equipment

- Griffin beakers assorted sizes or equivalent
- Watch glasses
- Graduated cylinder
- Electric hot plate
- Atomic Absorption Spectrophotometry (AAS) machine
- Lab coats
- Gloves (latex)
- Qualitative Filter papers and filter funnels

Reagents

- Distilled water
- Reagents for water quality analysis (e.g. Hach reagents)
- Standard solution of Fe, Zn, Pb, Cd, Cu
- Nitric acid (HN03)
- Hydrochloric acid (HCI)

3.2.4 Procedure

AAS Preparation

- Sample were transferred into a 100ml aliquot of a well-mixed sample to a beaker then added 2Ml of nitric acid and 5mL of hydrochloric acid.
- The samples were covered with a ribbed watch glass and heated on a steam bath, hotplate at 90 to 95ºC.

CAUTION: The samples were not boiled. Antimony is easily lost by volatilization from hydrochloric acid metals

- The beaker was removed and allowed to cool and washed down the beaker walls and watch glass with water and filtered the sample silicates and other insoluble material that could clog the nebulizer.
- Then adjusted to the final volume to 100ml with reagent water. Blanks were carried out throughout the entire sample preparation and analytical process. These blanks were useful in determining if samples are being contaminated.
- Water samples were analysed in triplicate for each metal concentration in order to improve the accuracy of results. Conducted using air/acetylene flame Atomic

Absorption Spectrophotometry (AAS). The water samples were then analysed for total heavy metal amounts in an Atomic Absorption Spectrometer

CHAPTER 4: RESULTS

Table 1: Concentration of Iron (Fe) in water

	Site A	Site B	Site C	Site D
Mean (mg/L)	9.86335	5.862279	6.231217	6.022692
SD	4.759647	5.71051	4.559124	4.575998

Table 2: Concentration of Lead (Pb) in water

	Site A	Site B	Site C	Site D
Mean (mg/L)	0	0	0	0
SD	0	0	0	0

Table 3: Concentration of Cadmium (Cd)

	Site A	Site B	Site C	Site D
Mean (mg/L)	0.00415	0.005675	0.003217	0.003333
SD	0.001093	0.007673	0.00101	0.001262

Table 4: Concentration of Copper (Cu)

	Site A	Site B	Site C	Site D
Mean (mg/L)	0	0	0	0
SD	0	0	0	0

Table 5: Concentration of Zinc (Zn)

	Site A	Site B	Site C	Site D
Mean (mg/L)	0.059733	0.219658	0.202892	0.4166
SD	0.140593	0.320289	0.289126	0.52247

CHAPTER 5: DISCUSSION

The monitoring of heavy metal concentrations is normally done by measuring the concentration of the metals in the water. Previous studies indicated that the concentration is normally lower in water, than in the sediment and the biota of the specific aquatic system, Varol (2012), Vicente-Martorell, et al (2009).

Ncube et al., (Dec 2017) analysed heavy metals in water, in dams located downstream of effluent discharge zones in Bulawayo and were compared to those in a pristine upstream dam. Levels of lead (0.13–0.28 mg/L) and cadmium (0.02–0.06 mg/L) in water from downstream dams exceeded WHO safe limits for drinking water. Cadmium levels in polluted dams also exceeded the safe limit for agricultural use whereas in this study lead showed no concentration detection whereas Cadmium range from the lowest to the highest mean concentration was (0.0032-0.0056mg/L) at four different sampling sites in Mazowe Dam.

Nyamangara et al., (July 2008) studied the concentrations of metals in water from Mukuvisi River and they were low (<0.5 mg/L) at all sampling sites, and Pb and Zn were not detectable Cd concentration was above the recommended limit (0.5mg/L) whereas in this study Cd had (0.003mg/L)in the upstream at site D compared to those downstream site A (0.004mg/L) and site B (0.005mg/L) which met the WHO guidelines of drinking water (0.003 and 0.03) Musa et.al (2013) Kinuthia et.al (2020).

Madebwe et al., (2017) studied metal concentrations in ground water resources in Upper Sanyati Catchment, Midlands Province and the time weighted ground water mean maximum lead concentration of 0.07 mg/L was recorded during the beginning of the dry season in May in sub-region 2 while lowest lead values of 0.015mg/L were recorded in February during the wet season in sub-region 1. However in this study lead concentration was not detected at the four different sampling sites in Mazowe dam from the upstream to the downstream which is lower than the WHO guidelines.

Dube et al., (Aug 2020) studied heavy metal upon contamination of vegetable cultivation using river water, can cause health problems to consumers. A study to establish cadmium and lead levels in water from Msasa and Manyame rivers was conducted in 2019. Tested at $P < 0.05$, the results showed that sampled water from the four sites failed to meet the Standards Association of Zimbabwe 5560 (1997) standards. Cadmium tissue concentration from wastewater from Msasa and Manyame rivers was 1.3 and 1.17 mg/L respectively, which were

59 and 65 times higher than 0.02 mg/L from the control. In this study lead had no concentration available at the four sampling sites from the upstream and downstream of the Mazowe dam whereas in Cadmium the levels where high at site A (0.004mg/L) and B (0.005mg/L) and decreased at C (0.003mg/L) and D (0.003mg/L) with slight difference.

(Cd, Cu, Fe, Pb and Zn) were determined in water in the Gwebi River, a major tributary to Lake Manyame, Utete B, sampled four selected sites in the wet (December-March) and dry (April-November) seasons and metal concentrations were analysed by flame atomic absorption spectroscopy (FAAS). Significantly high mean concentrations of zinc (715.42mg/L) and copper (7.08mg/L) were observed in water in both the wet and dry season. Concentrations of copper , zinc and iron (0.79mg/L) in water in both the wet and dry seasons surpassed World Health Organization (WHO) thresholds whereas Cd had (0.02mg/L) and Pb (1.60mg/L). However in this study Pb and Cu showed no concentration detection at the four sampling in Mazowe dam from the upstream to downstream and Fe showed concentration with the highest mean of (9.86mg/L) and Zn (0.4166mg/L)exceeding the guidelines of (2004 WHO) Cd had a mean concentration of (0.0056mg/L) which was lower than the WHO threshold.

Mudyazhezha et al.,(March 2014) studied Ngwablozi river, Bulawayo and they are findings were that iron concentrations remained invariably constant throughout the stream, ranging from 0.1 to 0.11 mg/L for four different sites whereas in this study Fe concentrations were high at the downstream of the dam (9.86mg/L) at site A and site B had the lowest concentration of (5.86mg/L) the upstream had the concentration of (6.022mg/L and 6.23mg/L) for site C and D respectively

CHAPTER 6: CONCLUSION

This research examined the heavy metal concentration (Pb, Ld, Fe, Cu and Cd) in Mazowe Dam and explored various factors that may contribute to the presence of heavy metals in the dam's water. This study was designed to determine concentrations for heavy metals. The results showed that there is no variation in Cu and Pb in the water between the sites that were investigated. However there was a significant difference in the level of Zn between the four sites, the upstream, which showed higher levels of Zn and downstream which showed low levels.

6.1 Recommendations

The safety and security of freshwater resources is very important in the society we live in today. Therefore regular screening of freshwater sources for pollutants should be done on a regular basis

6.2 References

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