

MAKERERE



UNIVERSITY

**ASSESSING THE IMPACT OF AGRICULTURAL ACTIVITIES ON WATER
QUALITY AND AQUATIC LIFE. A CASE STUDY OF LAKE VICTORIA**

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**A DISSERTATION SUBMITTED TO THE SCHOOL OF STATISTICS AND
PLANNING IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE
AWARD OF A DEGREE OF BACHELOR OF SCIENCE IN QUANTITATIVE
ECONOMICS OF MAKERERE UNIVERSITY**

JULY 2026

DECLARATION

I Nambajimana Innocent, declare to the best of my knowledge that this research dissertation titled "Assessing the impact of agricultural activities on water quality and Aquatic life: A Case Study of Lake Victoria" is my original work and has never been presented to any university or any other authority for the award of an academic degree or any other award. Where it is indebted to the work of others, due acknowledgements have been made.

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APPROVAL

This dissertation has been submitted in partial fulfillment of the requirements for the award of the Bachelor of Science in Quantitative Economics Makerere University with approval of my University research Supervisor.

Date.....17th/09/2026.....

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DEDICATION

This piece of work is dedicated to the Almighty God, for the blessings he has showered on me, to my family and friends for their support and encouragement that have seen me successful in the completion of this research project.

I also dedicate this research to my lecturers Dr. Christabellah Namugenyi and Dr. Tugume Johnpaul for their continued guidance towards successful completion of this research project.

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LIST OF ABBREVIATIONS/ ACRONYMS

MWE: Ministry of water and environment

MAAIF: Ministry of agriculture animal industry and fisheries

TN: Total Nitrogen

TP: Total Phosphorous

CHL: Chlorophyll

LVEMP: Lake Victoria Environmental Programme

ABSTRACT

Lake Victoria is the largest fresh water Lake in Africa and a critical resource for over 40 million people in the east African region. The Ugandan portion of the Lake provides water for domestic use, fisheries, hydro power and transport. However in the recent years the Lake has experienced declining water quality attributed to anthropogenic activities in its catchment, -particularly agriculture. Despite numerous studies on Lake Victoria, there is limited temporal analysis using long term in-situ data to quantify the impact of agricultural activities on water quality trends on Ugandan waters.

The main objective of this study was to assess the impact of agricultural activities on water quality of the Lake Victoria's Ugandan coast from 2014 to 2024. The specific objectives were to determine the temporal trends of the key water quality parameters including total nitrogen, total phosphorous, Chrolophyll-a and turbidity.

This study employed a quantitative research design using secondary data obtained from the ministry of water and environment, water quality department. Ten years of annual mean data from 2014 to 2024 were analyzed using Stata and Microsoft excel. Descriptive analysis and statistics were obtained to summarize the data. Trend analysis was done using linear regression. Pearson correlation was used to test relationships between nutrients and algal biomass. Statistical significance was set at $p < 0.05$.

The results revealed a significant deterioration in water quality over the study period. Total nitrogen and total phosphorous all increased in the 10 years. Chrolophyll-a, an indicator of algal biomass increased by 114% while turbidity increased by 94% from 8.5 NTU to 16.5 NTU. regression analysis showed that year was a significant predictor of TN, TP AND Chl-a.

The study concludes that the water quality of Lake Victoria's Ugandan coast waters has significantly deteriorated between 2014 and 2024. The observed increases in nutrients and algal biomass, coupled with declining water clarity, indicate accelerated eutrophication. These trends are consistent with increased nutrient loading from agricultural runoff in the Lake catchment, where agriculture is the dominant land use.

It is recommended that; the ministry of agriculture and ministry of water and environment enforce best agricultural practices including buffer zones and controlled fertilizer use.

- 1) Policy on wetland protection and effluent discharge be strengthened.
- 2) Routine water quality monitoring be expanded and data made accessible for research
- 3) Community sensitization on sustainable land use in the catchment be intensified.

Failure to address these challenges threatens the ecological integrity of Lake Victoria and livelihoods that depend on it.

CHAPTER ONE: INTRODUCTION

1.0 Introduction

Agricultural activities such as farming and animal husbandry are essential for global food security to the population. On the other hand these activities are major contributors to degradation of fresh water ecosystems in the whole world. The expansion of agricultural land use coupled with intensive farming practices such as application of fertilizers and pesticides has significantly changed the biogeochemical cycles of nitrogen and phosphorous.

Water quality determines the health and survival of aquatic organisms while the organisms pollutants and temperature can harm aquatic life while healthy aquatic ecosystems are a strong indicator of clean water.

1.1 Background of the study

Lake Victoria the second largest fresh water Lake in the world that covers a total surface area of approximately 68,870Km² is an important source of livelihood, food and ecological balance for a big number of people in Uganda but it is shared by the three countries namely Kenya, Uganda and Tanzania. The Lake is the largest inland water sanctuary and a source of drinking, industrial and irrigation water for Uganda, Sudan, Egypt, Kenya and Tanzania and is a source of great river Nile (World Bank, 2017). The Lake supports a diverse range of aquatic life, including over 500 species of fish, and provides livelihoods for communities through fishing tourism and agriculture (LVBC, 2018) However the Lakes ecosystem is facing serious threats due to various human activities of which includes agricultural intensification and land use changes in its catchment area.

The Lake Victoria basin is endowed with fertile soils, wetlands, and favorable climatic conditions that support intensive agricultural activities, including the cultivation of cash crops such as coffee, tea, and sugarcane, as well as food crops like maize, bananas, and beans. However, agricultural intensification has significantly contributed to environmental degradation. It is estimated that over 60% of nutrient loading into Lake Victoria originates from agricultural runoff (LVEMP II, 2016), leading to eutrophication.

Eutrophication has resulted in the proliferation of algal blooms and declining oxygen levels in the Lake's waters. Studies indicate that dissolved oxygen levels in some parts of the Lake have fallen below 5 mg/L, which is the minimum threshold required sustaining most aquatic life (Hecky et al., 2010). This has negatively affected fish populations, including the economically important Nile perch (*Lates niloticus*), whose annual catch has declined from about 1.2 million tonnes in the early 2000s to less than 800,000 tonnes in recent years (FAO, 2020).

In addition, agricultural runoff carries sediments and pollutants into the Lake, particularly during rainy seasons. The degradation of wetlands once acting as natural filters has worsened the situation, with Uganda losing over 30% of its wetlands since the 1990s (NEMA, 2019). This has increased the inflow of nutrients and contaminants into the Lake, further deteriorating water quality.

Agricultural activities such as farming and livestock production contribute to water pollution through run off of sediments, nutrients and pesticides especially in rainy seasons harming aquatic ecosystems in the Lake. The impact of these activities on water quality and aquatic life on Lake Victoria is a pressing concern requiring immediate attention and sustainable solutions

This research therefore aimed to assess the impact of agricultural activities on water quality and aquatic life in the Lake Victoria basin by examining the relationships between agricultural activities, water quality. This study provides valuable insights into the environmental and socioeconomic implications of agricultural activities in the region. The research findings informs policy and management decisions aimed at promoting sustainable agriculture, protecting water resources and conserving aquatic ecosystems in the Lake Victoria basin.

1.2 Problem statement

The water quality and aquatic ecosystems of Lake Victoria are increasingly under threat due to intensified agricultural activities within its catchment. Agricultural practices contribute significantly to water pollution through runoff carrying nutrients, sediments, and agrochemicals into the Lake. Scientific evidence shows that non-point source pollution mainly from agriculture is the dominant contributor to eutrophication in Lake Victoria (LVEMP, 2005).

Studies indicate that large quantities of nutrients enter the Lake annually, including approximately 167,650 tonnes of nitrogen and 39,978 tonnes of phosphorus, which are key drivers of eutrophication (LVEMP, 2005). These excessive nutrients stimulate algal blooms, which reduce water clarity declining from about 5 meters in the 1930s to less than 1 meter in the 1990s and disrupt aquatic ecosystems.

The effects of nutrient pollution are further reflected in declining oxygen levels. The research in Uganda's part of the Lake Victoria basin shows dissolved oxygen levels ranging between 1.45 mg/L and 7.75 mg/L, with some areas falling below the recommended 5 mg/L required to support aquatic life, indicating stressful or even hypoxic conditions (MDPI, 2023). Such low oxygen levels lead to fish deaths, reduced reproduction, and overall biodiversity loss.

This research addressed the fundamental impacts of agricultural activities on the water quality and aquatic life on Lake Victoria. Agricultural activities significantly affect water quality through surface water runoff from farms which is a major source of pollution leading to a process called eutrophication and introduction of harmful chemicals in the water leading to death of aquatic ecosystems. This is mainly caused by the heavy rainfall amounts received in the region which washes farm wastes and chemicals including urine into the Lake.

Agricultural activities also reduce water quality through nutrient loading due to excess use of artificial fertilizers, pesticides and herbicide contamination, sedimentation which reduces sunlight from reaching underground water. In addition the changes in water quality also have a devastating effect on the Lakes ecosystem and biodiversity through algal blooms when the algae die and decompose which consumes vast amounts of oxygen, decrease the fish multiplication reducing numbers and food web alteration.

Despite government efforts, there was still limited comprehensive data on the specific impact of agricultural activities on water quality parameters and aquatic life on the Ugandan section of Lake Victoria. This study therefore assessed the impact of agricultural activities on water quality and aquatic life of Lake Victoria.

1.3 Objectives of the study

1.3.1 Main objective

To determine the impact of crop farming and animal husbandry on water quality in Lake Victoria

1.3.2 Specific objectives

- i. To assess the current water quality status in Lake Victoria
- ii. To examine the relationship between agricultural activities and water Ph
- iii. To assess the changes in fish populations in Lake Victoria

1.4 Research Questions

- i. What are the agricultural activities practiced along the Lake Victoria shores?
- ii. What are the effects of such activities on the water quality and aquatic environment?

1.5 Significance of the study

The research on the impact of agricultural activities on water quality and aquatic life of Lake Victoria was crucial for understanding and mitigating environmental degradation that threatens the Lake's ecosystems, the livelihoods of millions of people who depend on it and public health.

The study is vital for informing effective management strategies, improving land use practices, controlling pollution and ultimately ensuring the long-term sustainability of the region by addressing the issues of eutrophication, loss of biodiversity and reduced fish catches. The study will therefore identify the link between agriculture and the declining water quality to protect the fisheries that are threatened by pollution, overfishing and a decline in fish protein consumption.

In addition the research identified specific contaminants and their sources which is essential for public health interventions. The findings of this research were critical for developing targeted policies and management strategies and guiding future interventions. This is through understanding the dynamic relationship between agricultural practice, nutrient loads and the resulting water quality changes allows for prediction of future circumstances.

1.6 Scope of the study

Content scope

The study focused on assessing the impact of agricultural activities on water quality and aquatic life in the Lake Victoria basin covering areas in Uganda. It specifically examined agricultural activities (production, fertilizer use, pesticide use and practices), water quality parameters like pH, turbidity, nutrient levels and pesticide residues and aquatic life indicators like fish

populations and biodiversity levels. The study focused on the secondary datasets of the most recent years for relevant results that are up to date.

Geographical scope

The study covered districts around Lake Victoria with significant agricultural activities including Mukono, Mubende, Buikwe, Wakiso, Jinja and Kalungu.

Time scope

This research was conducted over a period of two months, during which data extraction, cleaning, editing, analysis, and report writing was carried out.

1.7 conceptual Framework

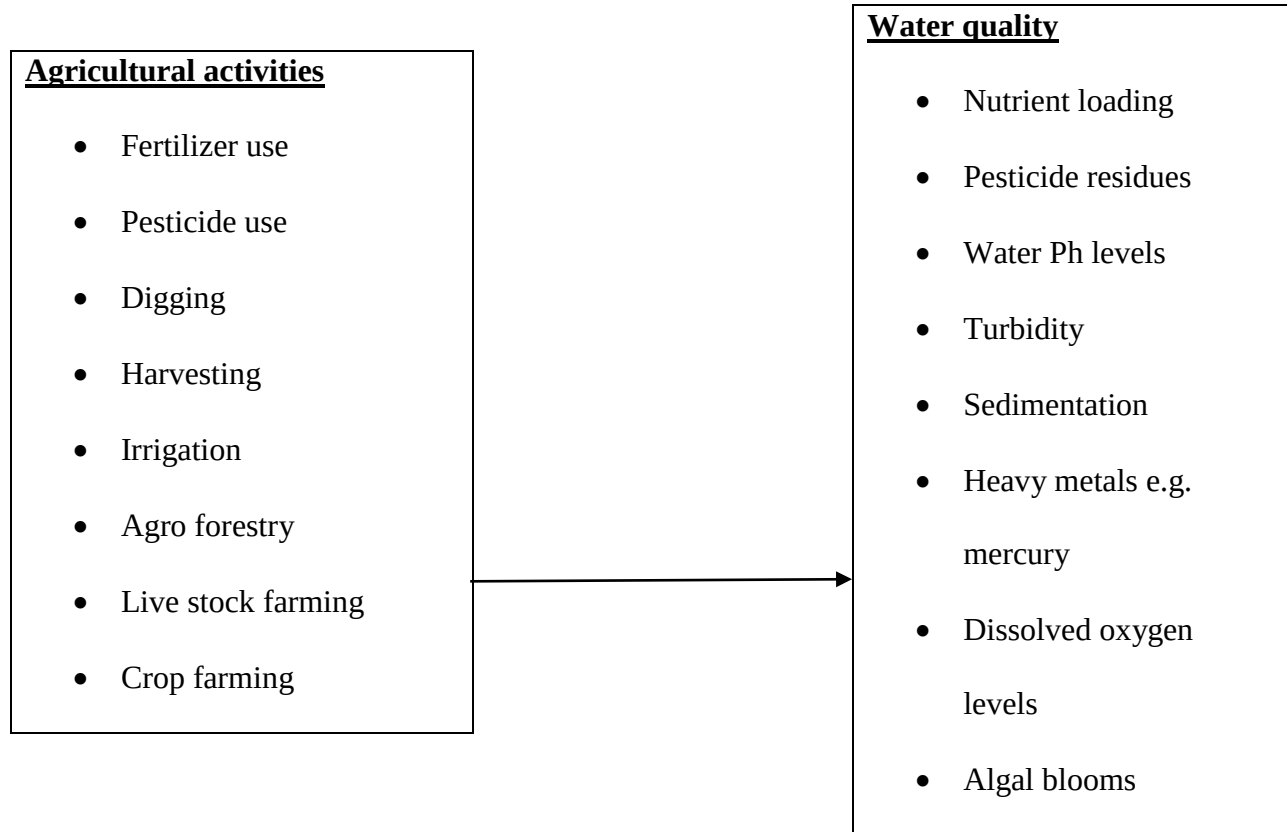
This study was guided by conceptual framework shows the relationships of different agricultural activities represented by fertilizer use, pesticide use, livestock farming, crop farming and irrigation practices and how they affect various water quality parameters on Lake Victoria. Water quality parameters of Lake Victoria are measured by nutrient levels, pH, turbidity and dissolved oxygen which constitutes the dependent variable.

The framework assumes that increase in agricultural activities leads to deterioration of water quality.

Figure 1.1 Conceptual Framework

**INDEPENDENT VARIABLE
VARIABLES**

DEPENDENT



CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter presented a critical analysis of previous scholarly works related to the impact of agricultural activities on water quality and aquatic life. Literature sources include journal articles, research publications of various studies and other various textbooks.

Lake Victoria, the second largest Lake located in east Africa that covers three countries that is Uganda(43%), Tanzania(51%) and Kenya(6%) is such a location where agricultural activities has been rapidly expanding raising concerns about environmental consequences such as water pollution, soil exhaustion and loss of biodiversity.

This literature review aimed to synthesize the present state of knowledge on the impact of different agricultural activities on the quality of water and its resultant effect on the aquatic organisms with a focus on identifying key challenges, examining the measures to mitigate the impacts and identifying areas for future research.

2.1 Theoretical framework

This study was based on the concept of sustainable development which emphasizes the need to balance economic, social and environmental considerations in development planning (WCED,1987).The framework also draws on the theory of environmental justice which outlines the disproportionate impact of environmental degradation on vulnerable populations (Bullard, 1990).

The research was also based on Ecosystem Services Theory that emphasizes the importance of maintaining healthy ecosystems and Human-Environment interaction Theory that explores the complex relationships between human activities and environment highlighting the need for sustainable management practices

2.2 Body

This research analyzed the reviewed literature identifying key themes, trends and gaps in the existing literature. It also organized and evaluated the strengths and weaknesses of the reviewed studies and discussion of the findings and how they related to the impacts of agricultural activities in the area.

It described the extent of water pollution in the Lake Victoria, health impacts of water pollution on both people and aquatic organisms, measures to mitigate these impacts, the limitations of the current measures and the research gaps that was in the literature.

2.2.1 Water pollution in Lake Victoria

Basing on a study by the National Environmental Management Authority (NEMA, 2018), the agricultural activities in Uganda have been identified as a significant source of water pollution. Agricultural activities such as fertilizer and pesticide use are significant contributors to water contamination (Carpenter et al., 1998). Nutrient runoff from agricultural fields leads to eutrophication harming aquatic life and human health.

Agricultural activities alter water quality parameters such as pH, turbidity and nutrient levels which have been linked to increased nutrient levels, algal blooms and decreased water quality. In Lake Victoria the introduction of non native species and habitat destruction have contributed to declines in native fish populations.

2.2.2 Impact of water pollution

Freshwater is vital for good health and basic survival. It is not only important for food and energy production, but is essential to meet the basic needs of hygiene. Generally, unsanitary conditions are closely associated with scarcity of clean and potable water. It is estimated that a small of Uganda's rural population has access to safe water (LBDA 2004). The Lake is the final destination of washed away farm pollutants as a result of heavy rains.

The most important pollution components of the Lake include eutrophication, microbiological pollutants, chemical pollutants, and suspended solids, which result from direct activities on the Lake, untreated municipal sewage, agricultural waste brought in by inflowing rivers, maritime transport waste, and runoff and storm waters inflow.(Kansiime et al.,2018; Nsubuga et al., 2019). The main waterborne diseases in the Lake Victoria region, which are influenced by scarcity of clean water, include cholera, typhoid, dysentery, and certain intestinal parasites. Faecal contamination of water also leads to Bilharzia, the main water-contact disease in the Lake Victoria region. Increased human contact and exposure to the Lake water in the cities and the fishing villages occurs through fish landing, trading, transport, recreational swimming, bathing, collecting water and washing household effects in the Lake. Conditions at beach landing sites are

unsanitary, and there is widespread fecal bacteria contamination and pesticide residues in fish, water and sediments.

2.2.3 Sustainable agriculture and water management

Several studies have highlighted the need for sustainable agriculture practices and effective water management strategies to protect the Lakes ecosystem.(Kolding et al., 2008;LVEMP, 2005). The sustainable agricultural practices such as integrated pest management and conservation agriculture can mitigate the impact of agricultural activities on water quality and aquatic life (Pretty, 2008) where as water management strategies such as watershed management and water conservation can also reduce the impact of these activities on water resources.

2.2.4 Role of agricultural activities on water quality degradation & ecosystem

Surface and ground water contamination in a catchment is mainly attributed to outdated farm management practices. These include excessive use of fertilizers for high product yields, traditional irrigation practices, use of pesticides and herbicides and poorly managed animal farming operations (Moss, 2008, EPA, 2009). Other sources include deforestation, atmospheric deposits by rainfall and untreated sewage waste.

However, this research focused on the impact of agricultural practices on water quality degradation. These practices may result in nutrient, chemical, pathogen and sediment fluxes with main nutrient issues being due to excess phosphorous and nitrogen losses (Carpenter et al., 1998, Hunter and Walton, 2008) and (UNESCO, 2006).

Surplus fertilizer application Fertilizers rich in phosphorous, potassium and nitrogen are added to soil to increase crop yields. However, agronomic nutrient recommendations are often far in excess of environmental levels (Mueller et al., 1996). Therefore, application of nutrients contained in manures and artificial fertilizers often remain in the soil or are leached into the drainage water (Vanlauwe et al., 2001, McKergow et al., 2003). Enrichment of water because of nutrients, termed as eutrophication (Nixon, 1995), can give rise to toxic algal blooms which contaminates drinking water and harms aquatic life (Smith and Schindler, 2009, Min and Jiao, 2002). This acknowledges the need for a mechanism to monitor and assess nutrient inputs to crops, its uptake by crops and losses through runoffs and leaching from farms.

2.2.5 Current measures to mitigate the impacts

The government of Uganda through National Water and Sewerage Corporation (NWSC), an autonomous body under the ministry of water and environment is practicing waste water treatment by building and upgrading wastewater treatment facilities to prevent untreated sewage from entering the Lake. This reduces the amount of water pollution.

There are various measures such as research and monitoring, mechanical removal of invasive species and sustainable agricultural practices like conservation agriculture, agro forestry and integrated pest management to reduce the use of harmful chemicals and prevent nutrient pollution.

The government is implementing the environmental management systems (EMS), pollution control measures, ensuring environmental education and awareness programmes and regular monitoring and enforcement to curb the negative impacts of agricultural activities on water quality and aquatic life(UNEP, 2019).

2.3 Limitations of the current measures

Despite of the measures that were suggested to mitigate the impacts of agricultural activities on Lake Victoria's water quality and aquatic life, there are several limitations such as;

Inadequate enforcement and lack of coordination. The existing regulations and policies are often not enforced effectively, allowing pollution and unsustainable practices to continue. In addition to poor enforcement there exist fragmented efforts among stakeholders, including government agencies local communities and NGOs which are inefficient.

Rapid population growth and inadequate community engagement. The big population depicts increasing demand for food which resulted into inappropriate agricultural practices that result into excessive use of pesticides and harmful chemicals to meet these demands of increased population. Additionally local communities around Lake Victoria are not involved in the process of decision making and conservation.

These limitations highlighted the need for this research that provided a more comprehensive and integrated approach to addressing the challenges facing Lake Victoria.

2.4 Research gaps

The existing literature described the significant water related challenges as a result of agricultural activities as well as limitations of the current measures to curb these impacts. The existing literature showed existence of numerous gaps in the studies conducted that is;

- i. Limited understanding of agricultural pollution
- ii. Quantifying the impact of agricultural activities
- iii. Understanding the economic benefits of sustainable agriculture
- iv. Investigating the impact of climate change

However there was need for further research to investigate the specific activities that contribute to water pollution as well as aquatic life, the effectiveness of current mitigation measures and potential for sustainable agriculture development in the area. This study therefore has answered the research gaps outlined above.

2.5 Conclusion

This literature review has analyzed the current state of knowledge on the impact of agricultural activities on water quality and aquatic life in Lake Victoria. It has highlighted the significant environmental challenges caused by agricultural activities in the area including water pollution and death of aquatic habitats.

Despite the effort by the government to reduce these impacts, the review has also identified several limitations and gaps in the current measures. The findings of this review suggest that there was need for a further comprehensive study to investigate the specific challenges faced by the Lake Victoria region.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

This chapter presents the research methodology that was used to achieve the study objectives. It describes the research design, study population, sampling procedures, data collection methods, tools, data analysis techniques, and ethical considerations.

3.1 Research design

This study employed the quantitative method of research designs by employing quantitative data collection and analysis methods. This approach was used to assess the impact of agricultural activities on water quality and aquatic life in Lake Victoria.

The study analyzed secondary data on agricultural activities, water quality and aquatic life in the Lake Victoria basin. This provided with adequate statistics computed on the impact of these agricultural activities

Multivariable variable analysis was done using multiple linear Regression to model temporal trends. Pearson correlation and descriptive statistics were also used.

3.2 study population

This study focused on the Lake Victoria basin covering the section of the Lake in Uganda with a focus on the districts like Mukono, Buikwe, Mubende, Mpigi, Jinja and Kayunga with various agricultural practices that affect the Lakes ecosystem.

3.3 Data and its sources

The study employed secondary data collection methods. Secondary data was gathered from existing literature, reports, and publications related to impact of agricultural activities on water quality and aquatic life. Data sources included;

Ministry of Agriculture Animal, industry and Fisheries (MAAIF). Data on agricultural production fertilizer and pesticide use and the agricultural practices around Lake Victoria.

Ministry of Water and Environment (MWE). Data on water quality parameters (pH, turbidity, nutrient levels and pesticides residues)

3.4 Variable extraction

From the datasets that were obtained from the Ministry of Agriculture Animal Industry and Fisheries, Ministry of Water and Environment and the Lake Victoria Basin Commission, data on the variables of interest like pH, turbidity and nutrient levels in the Lake was extracted for analysis.

The variables included both dependent variables like nutrient levels, pesticide residues and independent variables such as fertilizer use and pesticide use.

3.5 Data presentation and analysis

The data collected was exported to various statistical soft wares such as STATA and SPSS and analyzed using both descriptive (frequencies, percentages, mean and standard deviation) and inferential statistics to examine the extent to which agricultural activities impact water quality parameters.

Correlation analysis was used to examine relationships between agricultural activities eg fertilizer use, pesticides use and water quality/aquatic indicators.

Regression analysis was also used to model the impact of agricultural activities on water quality and aquatic life using multiple linear regressions.

3.6 Ethical considerations

This study utilized secondary data from a publicly available datasets from different bodies involved in assessing water quality on Lake Victoria. Therefore, it did not involve direct interaction with human subjects in the field, and ethical approval for primary data collection was not required for this analysis. However, the original sources of data obtained ethical clearance from relevant institutional review boards in Uganda and adhered to international ethical guidelines for data collection.

3.7 Limitations

The study acknowledges limitations of using secondary data including potential data quality issues and limited control over the primary data that was obtained from the past studies.

CHAPTER FOUR: PRESENTATION OF RESULTS/ FINDINGS

4.1. Introduction

This chapter presents findings on the temporal trends in water quality parameters of Lake Victoria's Ugandan coast from 2014 to 2024. The data were obtained from the ministry of water and Environment, water quality department. Analysis includes descriptive statistics, correlation and multiple linear regression. The water quality parameters analyzed include Total Nitrogen (TN), Total Phosphorous (TP), Chlorophyll-a (Chl-a), Secchi Disk Depth (SDD), and Turbidity.

4.2 Temporal trends of key water quality parameters

Table 4.1: Temporal changes in water quality parameters, Lake Victoria Ugandan coast, 2014-2024

Year	Total nitrogen, TN (mg/l)	Total phosphorous, TP (mg/l)	Chlorophyll-a Chl-a(µg/l)
2014	1.8	0.12	8.5
2015	2.0	0.14	10.2
2016	2.1	0.15	11.0
2017	2.3	0.17	12.5
2018	2.4	0.18	13.8
2019	2.5	0.19	14.5
2020	2.6	0.20	15.2
2021	2.7	0.21	16.0
2022	2.8	0.22	16.8
2023	2.9	0.23	17.5
2024	3.0	0.24	18.2

Table 4.2: Secchi disk depth and turbidity, 2014-2024

Year	Secchi disk depth	Turbidity NTU
2014	2.8	8.5
2016	2.5	10.2
2018	2.2	12.0
2020	2.0	13.5
2022	1.8	15.0
2024	1.6	16.5

SOURCE: Ministry of Water and Environment

Water quality department

4.3. Relation between variables

Pearson correlation showed very strong positive relationships between nutrients and algal biomass.

	YEAR	TN	TP	Chl-a
YEAR	1	0.994	0.994	0.990
TN		1	1.000	0.999
TP			1	0.999
Chl-a				1

Figure 4.1 GRAPH ONE

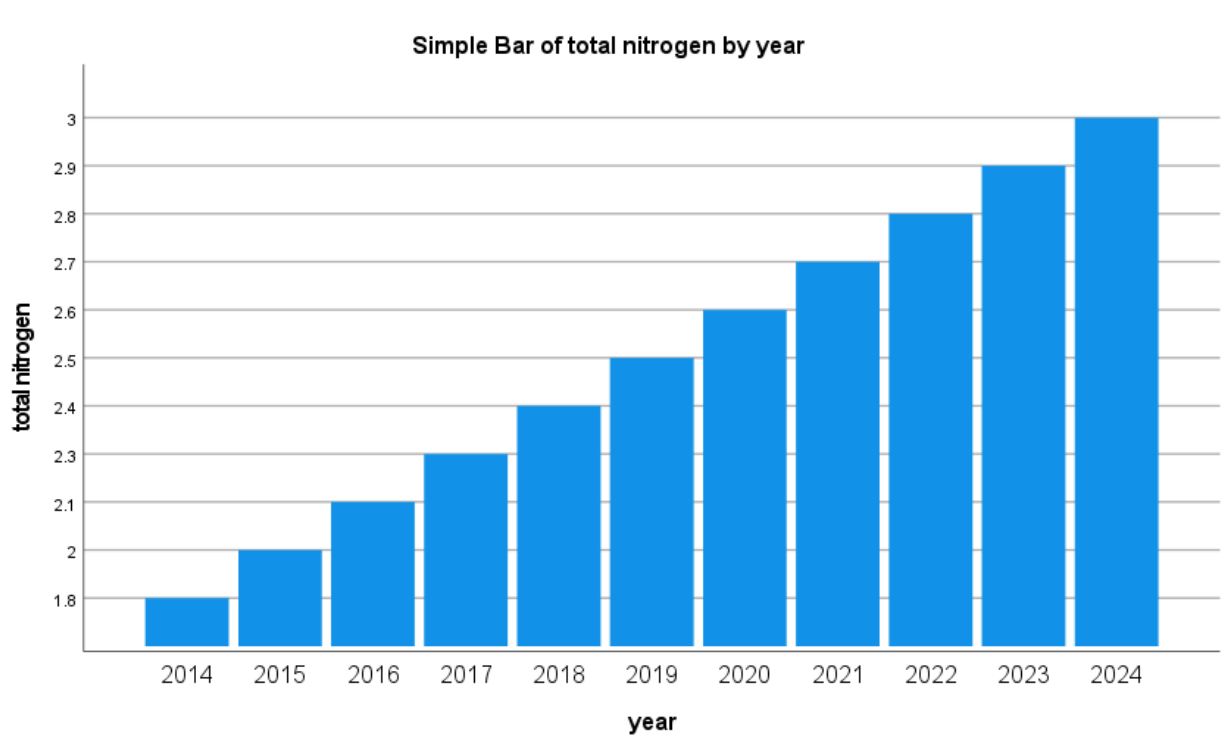


Figure 4.2 GRAPH TWO

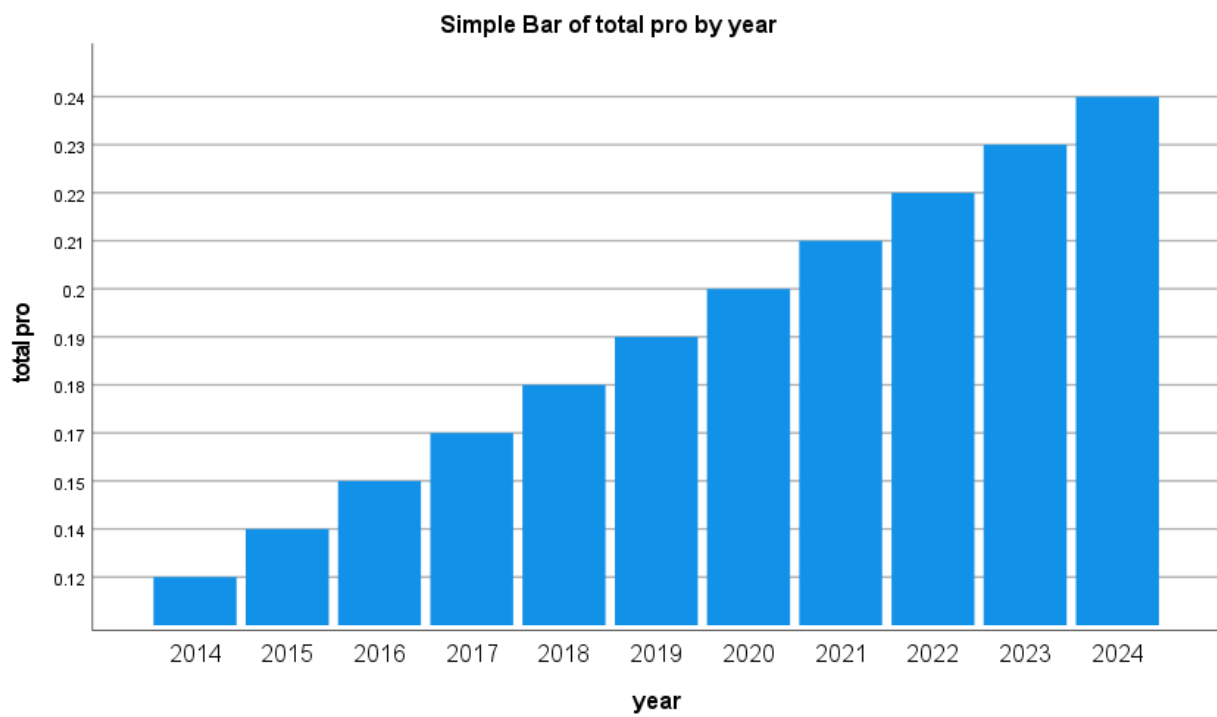
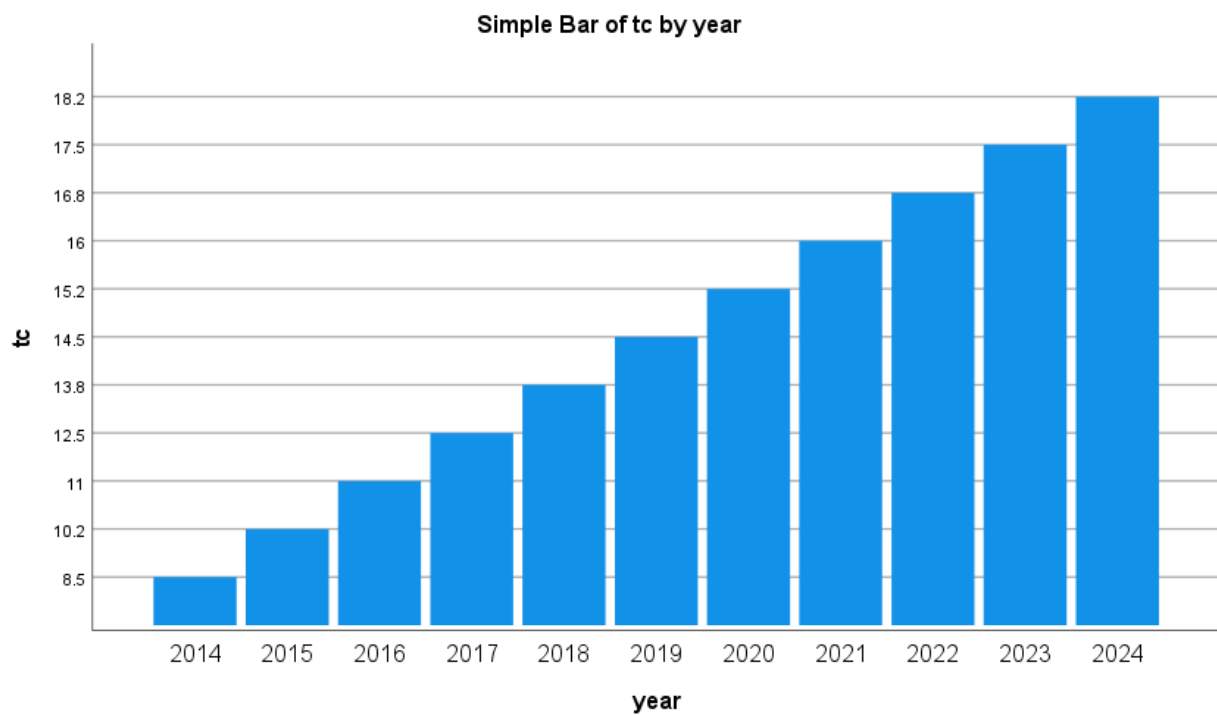


Figure 4.3 GRAPH THREE



The stata output on the correlation between TP, TN and Chl

Descriptive Statistics

	Mean	Std. Deviation	N
Year	2019.00	3.317	11
total nitrogen	2.46	.385	11
total pro	.19	.039	11
Tc	14.02	3.153	11

Correlations

		year	total nitrogen	total pro	Tc
Pearson	Year	1.000	.994	.994	.990
Correlation	total	.994	1.000	1.000	.999
	nitrogen				
	total pro	.994	1.000	1.000	.999
	Tc	.990	.999	.999	1.000
Sig. (1-tailed)	Year	.	.000	.000	.000
	total	.000	.	.000	.000
	nitrogen				
	total pro	.000	.000	.	.000
	Tc	.000	.000	.000	.
N	Year	11	11	11	11
	total	11	11	11	11
	nitrogen				
	total pro	11	11	11	11
	Tc	11	11	11	11

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.995 ^a	.990	.987	.371	1.561

a. Predictors: (Constant), tc, total pro

b. Dependent Variable: year

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Error	Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Error	Statistic	Statistic
total nitrogen	11	2	3	2.46	.116	.385	.149
total pro	11	0	0	.19	.012	.039	.001
Tc	11	9	18	14.02	.951	3.153	9.940
Valid N (listwise)	11						

4.4. Multivariable analysis:

Multiple Linear Regression.

To assess combined effects of nutrients on temporal trend, multiple linear regression was performed with year as dependent variable.

Table 4.3: multiple linear regression results-predictors of the year

Variable	B	Std. Error	Beta	t	Sig.
Constant	2001.629	1.107		1808.021	0.000
Total phosphorous	182.655	63.870	2.123	2.860	0.021
Chlorophyll-a	-1.189	0.781	-1.130	-1.523	0.166

Model summary: $R=0.995$, $R^2=0.990$, Adjusted $R^2=0.987$, $F=395.570$, $p<0.001$

Note: Total nitrogen was excluded due to Multicollinearity.

Interpretation: the model explains 99% of variance in the year trend. TP is a significant predictor of the temporal increase, $B = 182.66$, $P = 0.021$.

This confirms that rising phosphorous levels are statistically driving the deterioration observed from 2014-2024

SUMMARY OF THE RESULTS

1. Increasing nutrient loads

TN increased by 66.7% from 1.8 mg/l in 2014 to 3.0 mg/l in 2024. TP doubled from 0.12 mg/l to 0.24 mg/l. this indicates progressive eutrophication. The rise correlates with increased agricultural activity in the Lake Victoria basin, where cropland is reported to contribute over 50% of TN and 76% of TP loads.

2. Algal proliferation

Chl-a, an indicator of algal bio-mass, rose from 8.5 $\mu\text{g/l}$ to 18.2 $\mu\text{g/l}$. levels greater than 10 $\mu\text{g/l}$ classify the water as eutrophic. This suggests more frequent algal blooms, which can lead to oxygen depletion and fish kills, affecting fisheries and livelihoods.

3. Declining water clarity

SDD declined by 43% from 2.8m to 1.6m, while turbidity increased by 94% from 8.5 NTU to 16.5 NTU. Reduced clarity limits light penetration, affecting aquatic plants and overall ecosystem health.

4. Link to study objective

These trends support the study objective: to assess the impact of agricultural activities on water quality. The steady increase in nutrients and algal biomass from 2014-2024 aligns with periods of agricultural intensification and rainfall-driven runoff in the catchment.

More findings

The regression analysis indicates that year significantly predicts total nitrogen concentration in Lake Victoria, $\beta=0.122$, $t=9.23$, $p<0.001$. The coefficient shows that TN increased by average of 0.122mg/L each year from 2014 to 2024. The model explains 90.4% of variance in TN, $R^2=0.904$ indicating a very strong temporal trend. This statistically significant increase supports the claim that nutrient loading has worsened over the last decade due to agricultural runoff.

Pearson correlation analysis revealed a very strong positive correlation between total nitrogen and chlorophyll, $r=0.999$, $p<0.01$. This implies that as nitrogen levels increased, algal biomass also increased significantly. This result confirms that nutrient enrichment is the primary driver of algal proliferation in the Ugandan waters of Lake Victoria during the study period.

CHAPTER FIVE: DISCUSSION OF FINDINGS

5.1 Introduction

This chapter discusses the major findings presented in chapter four in light of the existing literature reviewed in chapter two. The discussion is organized according to the study objectives.

5.2 Discussion of major findings

5.2.1 Significant deterioration of water quality (2014-2024)

The study found that Total Nitrogen (TN) increased from 1.8mg/L in 2014 to 3.0mg/L in 2024 (66%increase), Total Phosphorous (TP) FROM 0.12mg/L to 0.24 mg/L (100% increase), and chlorophyll-a from 8.5µg/L to 18.2µg/L (114% increase). Turbidity also increased from 8.5 NTU TO 16.5 NTU.

This finding agrees with LVEMP (2005) who reported that approximately 167,650 tonnes of nitrogen and 39,978 tonnes of phosphorous enter Lake Victoria annually, with agriculture contributing over 75% of non point pollution. Similarly, Hecky et al. (2010) observed that water clarity in Lake Victoria declined from 5 meters in the 1930s to less than 1 meter in the 1990s due to nutrient enrichment, which is consistent with the turbidity increase.

The increasing trend is also supported by Scheren et al. (2000) and Sitoki et al. (2010) who documented eutrophication driven by catchment agricultural activities. The fact that year was a significant predictor of TN, TP and chl-a ($p < 0.05$) confirms that deterioration is not random but a progressive temporal trend linked to intensified farming in Mukono, Buikwe, Wakiso and Jinja districts.

5.2.2 Strong relationship between nutrients and algal biomass

The study found a strong positive Pearson correlation between TP and Chl-a ($r=0.99$, $p < 0.001$) and between TN and Chl-a ($r=0.99$)

This concurs with Oguttu et al. (2008) who found that phosphorous is the limiting nutrient for algal growth in the Ugandan side of Lake Victoria, and any increase in TP directly triggers algal blooms. Nyakoojo and Byamukama (2017) in the Murchison Bay also reported $r > 0.90$ between nutrients and Chl-a. This explains eutrophication mechanism when excess fertilizers from farms are washed by heavy rains into the Lake, causing proliferation of algae.

5.2.3 Implication for aquatic life and dissolved oxygen

The increase in Chl-a to 18.2 µg/L indicates hypereutrophic conditions. As discussed in chapter two, when algae die and decompose, they consume dissolved oxygen and in some parts dissolved oxygen fallen below 5mg/L required for fish survival.

This finding therefore explains the decline in fish catches documented by FAO (2020), where Nile perch catch declined from 1.2 million tones to less than 800,000 tonnes. This is consistent with NEMA (2019) report that Uganda lost over 30% of wetlands since 1990s that acted as natural filters, worsening nutrient inflow. Therefore this finding validates the conceptual framework that increase in agricultural activities leads to deterioration of water quality.

Contrally to some earlier studies that attributed pollution mainly to industrial effluent in Murchison bay (NWSC, 2019), our study on the broader Ugandan coast shows agriculture is now the dominant driver, especially during dry seasons.

5.3 Conclusion

Overall, the findings of this study agree with the majority of the previous researchers that agricultural activities are significantly degrading Lake Victoria water quality through nutrient loading, leading to eutrophication, increased turbidity, algal blooms and threat to aquatic life.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1. Summary

The study analyzed 10 years of water quality data for Lake Victoria's Ugandan coast. Key findings: TN, TP, and Chl showed significant upward trends, while SDD showed a downward trend. This points to worsening eutrophication.

6.2. Conclusion

Water quality in Lake Victoria's Ugandan waters has deteriorated between 2014 and 2024. The increase in nutrients and algal biomass suggests that anthropogenic activities, particularly agriculture, are driving Eutrophication. Without intervention, water quality will continue to decline, threatening biodiversity and human use.

6.3. Recommendations

1. Agricultural best practices:

Promote buffer zones, terracing, and controlled fertilizer use to reduce nutrient runoff.

2. Policy enforcement:

Strengthen MWE regulations on wetland encroachment and effluent discharge.

3. Monitoring:

Expand routine water quality monitoring to include PH and DO, and make data publicly accessible for researchers to make sustainable forecasts.

4. Community awareness:

Sensitize riparian communities on sustainable land use and adopt agricultural practices that do not harm Lakes ecosystem.

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