THE IMPACT OF FLORICULTURAL ACTIVITIES ON VEGETATION COVER AND WATER QUALITY IN LUTEMBE BAY WETLAND, NAMULANDA, UGANDA

BY

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DECLARATION

Declaration by candidate

I hereby declare that the work presented in this research proposal for the award of this degree represents my own work and has not been previously submitted for a degree or any other qualification at this or any other university.

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APPROVAL

We confirm that the work in this dissertation was done by the candidate under our supervision

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DEDICATION

This Research is wholeheartedly dedicated to my family (husband: Tumusiime Posiano and children: Aine John Godrich, Atwiine John Keith and Abenaitwe Miguel) who have been my source of inspiration and have provided moral, spiritual, emotional and financial support.

To my classmates and friends especially Dusabe Daphine who have endlessly encouraged me and supported to finish this study especially during this hardest time when I got transferred to work upcountry.

And lastly, I dedicate this work to the Almighty God has protected, guided and given me the power of mind and a healthy life throught the study period.

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OPERATIONAL DEFINITION OF TERMS

ANOVA	Analysis of Variance
APHA	American Public Health Association
BOD	Biological Oxygen Demand
OC	Degrees Celicious
EC	Electrical Conductivity
e.g.	For example
et.al.	And others
FAO	Food and Agricultural Organisation
GIS	Geographical Information System
GPS	Geographical Positioning System
IPM	Integrated Pest Management
L	Litres
LC	Land cover
LU	Land Use
M	Metres
Max	Maximum
MDL	Method Detection Limit
Min	Minimum/Minute
Mm	Millimetre
Na_2SO_4	Sodium Sulphate
NEMA	National Environment Management Authority
N	Nitrogen
OLI	Operation Land Image
OPM	Open street Mapping
P	Phosphorus
SLM	Selected Ion Monitoring
SP	Species
TN	Total Nitrogen
TP	Total Phosphate
QC	Quality control
WHO	World Health Organisation

ABSTRACT

Floriculture is becoming a key activity around most of the wetlands in Uganda since they provide quick avenues for disposal of effluents. In a bid to understudy the impacts of such floricultural activities on water quality and vegetation cover. A study was undertaken in Lutembe wetland to evaluate the effects of floriculture on vegetation cover and water quality. Water samples were obtained from three different flower farms in different seasons for analysis in the Laboratory for pesticides and nutrient content. In addition, field vegetation cover assessments were undertaken being guided by the pre-produced GIS land use maps of the area. Results portrayed a total of 113 different pesticides thirteen of which were of very high concentration following under all WHO pesticide classes. The concentrations of these pesticides significantly differed among samples collected, and flower farms studied. In addition, eight land uses were observed with settlements and agriculture greatly replacing the wetland cover. The studied sites were dominated by plant species such as *Cyperus papyrus, Mimosa pudica, Lersia hexandra, Marantachlora sp and Pheonix reclinata*. Furthermore, there was severe clearance of the ordinary wetland cover at the edges that saw emergence of invasive species such as *Mimosa pudica.* Water nutrient content differed across the selected flower farms within Lutembe wetland. Indeed, floricultural activities have significant impact on the pesticide loading within the wetland more so during peak flower farming months. Such flower activities also contribute significantly to nutrient loading within the wetland. Thus there is need for the floriculture industry around and within the wetland should practice integrated pest and weed management (IPM) practices to reduce on over dependence on pesticides and herbicides and further research on seasonal and longitudinal effect of floriculture activities on water quality should be conducted.

CHAPTER ONE: INTRODUCTION

1.1 Background to the problem

Wet lands are one of the most productive ecosystems globally due to a number of values they offer such as water purification, carbon recycling, and source of minerals such as sand, firewood, environmental restoration and safeguarding discharges from rivers (Junk et al., 2013; Dar et al., 2020). Regardless of the ecosystem services they provide, the escalating human population is exerting pressure on wetlands due to the ever increasing demand for land for human settlement, farming and industrialization as natural wetlands are being destroyed at a rate higher than that at which artificial wetlands are being established (Ramsar Convention on Wetlands, 2018).

A number of studies have reported agriculture as a predominant driving that shapes land use. For instance as study by Msofe et al. (2019) depicts "spatiotemporal changes in land use change predominantly with the conversion of land into agricultural land use at the expense of other land use/covers, deforestation and wetland conversion". Similarly, Verhoeven & Setter (2010) contend that for decades, people have been farming either in wetlands or areas previously occupied by wetlands.

According to Alexandratos & Bruinsima (2012), pesticides are crucial component of the agriculture systems because they increase food production by lowering the susceptibility of crops to disease and pest infestation. However, Aktar et al. (2009) note that pesticides may introduce contaminants into the soil as well as endangering the beneficial organisms as earthworms, bacterial and vegetation cover that are responsible for the maintenance of soil fertility of these ecosystems.

In addition, the pesticide runoff and ground water infiltration can contaminate water (Pérez-Lucas et al., 2018). Due to their significance in crop production, pesticides are extensively being used in agriculture and FAOSTAT, shows that 4,190,985 tonnes of pesticides had been used by 2019.

In Uganda, FAOSTAT shows an estimated 88 tonnes of pesticides beimg used in 2019. This is justified by the availability of extension officers who are moderately associated with more pesticide use, and the possession of complementary technology and also the availability of pesticides with little economic barriers (Erbaugh et al., 2012).

The extensive subsistance and commercial farming in the wetlands around lake Victoria has facilitaed the widespread use of of pesticides which end up in the lake. For instance, Arinaitwe et al. (2016) shows a general increase of pesticides in the watershed. Relatedly, it is reported that commercial intensive farming in the catchments around Lutembe wetland, primarily horticulture for export, crop production, sewage treatment and industrialization are threating Lutembe Bay wetland ecosystem (Lutembe Bay Wetland Users Association, 2014).

Agricultural inputs such as pesticides and fertilizer find themselves in wetlands through soil erosion and these enhance the nutrient content of wetlands hence contributing to low water quality (Aktar et al., 2009). It is therefore of paramount importance that enough information be gathered to understand how pesticides used in agriculture activities affect the water quality and vegetation cover. This study will therefore assess the agricultural use of pesticides on vegetation and water quality in Lutembe wetland, Uganda

1.2 Statement of the Problem

The problem of wetland degradation due to agricultural practices, particularly in Uganda, is a complex issue that extends beyond the use of pesticides and farming methods. In this context, the focus will be on the impact of floriculture, a branch of agriculture specializing in the cultivation of flowering and ornamental plants for gardens and for floristry, on wetland ecosystems. Floriculture being an extensive form of farming highly demands land clearance hence vegetation cover loss more so during expansion in and around Lutembe wetlands. In addition, the venture requires lots of water, and soil fertilization and consequently increased demand of agrochemical use and the wastewater produced negatively impacts the wetland ecosystem components such as plants and animals

Floriculture, while economically beneficial, can pose significant threats to wetland ecosystems. The construction of infrastructure for flower farms, including greenhouses and irrigation systems, can lead to habitat loss and fragmentation (Dale, 1997). Excavations for these structures can disrupt the natural hydrological processes of wetlands, leading to changes in water flow and quality (Brinson & Malvárez, 2002). Waste disposal from floriculture operations, including the dumping of plant waste and the discharge of untreated wastewater, can lead to water pollution and eutrophication, negatively impacting the wetland's vegetation and aquatic life (Kadlec & Wallace, 2008). Moreover, the use of pesticides and fertilizers in floriculture can have detrimental effects on wetland water quality. These substances can leach into the wetland, causing nutrient overloads and toxic conditions for native flora and fauna (Mitsch & Gosselink, 2007).

This study will investigate the impact of floriculture practices on wetland ecosystems, focusing on the effects of infrastructure development, waste disposal, and the use of pesticides and fertilizers on the health and sustainability of wetlands. This study will therefore seek to provide light on how the use of pesticides as an agriculture practice affects the wetland vegetation and water quality.

1.3 Objectives of the study

1.3.1 General Objectives

The aim of the study was to assess the impacts of floriculture on vegetation cover and water quality in Lutembe wetland.

1.3.2 Specific Objectives

The specific objectives of the study were to;

1. Assess changes in vegetation cover due to floricultural activities in Lutembe Bay Wetland between 2005 and 2021.
2. Assess the impact of floricultural activities on water quality parameters in Lutembe Bay Wetland.
3. Identify the ecological and environmental implications of floricultural activities in Lutembe Bay Wetland.

1.4 Research hypotheses

The research hypotheses that guided the study were;

1. Floricultural activities in Lutembe Bay Wetland have led to a significant reduction in native vegetation cover compared to areas without floricultural activities.
2. Floricultural activities in Lutembe Bay Wetland have resulted in an alteration of water quality parameters, such as increased nutrient levels and decreased dissolved oxygen, compared to areas without floricultural activities.

3. Floricultural activities in Lutembe Bay Wetland have negative ecological implications, including a decrease in overall biodiversity, disruption of habitat quality, and altered ecosystem functioning, compared to areas without floricultural activities.

1.5 Significance of the study

Globally, wetlands play a crucial role in supporting the livelihoods of numerous populations. Unfortunately, many human activities pose significant threats to these valuable ecosystems. To establish sustainable and mutually beneficial relationships between wetlands and humans, it is essential to assess their current status. Such assessments can inform policymakers in making decisions that promote the coexistence of human activities and wetlands in a sustainable manner. This study focuses on evaluating the impact of floricultural activities on water quality and vegetation cover in Lutembe Wetland. Its overarching objective is to develop an operational framework for the implementation of conservation and management policies at the local level.

The findings from this study will provide valuable information to guide policymakers, decision-makers, and other stakeholders in effectively managing Lutembe Wetland, which holds the status of a RAMSAR site. This wetland serves as a crucial habitat for a diverse range of species, including humans. By understanding the implications of floricultural activities on water quality and vegetation cover, this research will contribute to the development of sustainable management strategies for the preservation of the wetland's ecological integrity.

Moreover, the study outcomes will serve as a valuable resource for the evolving field of sustainable management of the green environment. By incorporating climate smart technologies and practices, the management of Lutembe Wetland can adapt to the challenges posed by climate change while ensuring the long-term well-being of both the wetland ecosystem and the communities that depend on it.

1.6 Scope of the study

The study was carried out in Lutembe Bay Wetland, Namulanda, Uganda, with a primary objective of evaluating the effects of floricultural activities on water quality and vegetation cover. Specifically, the study aimed to assess the impact of floricultural activities on water quality parameters, determine changes in vegetation cover within the wetland, and examine how the use of pesticides in floriculture affects water quality. Lutembe Bay Wetland was chosen as the study area due to its classification as a degraded wetland within the Lake Victoria Basin, primarily affected by floricultural activities.

1.7 Limitation of the study

The study encountered limitations that affected data collection and analysis. Restricted access to key points of value by flower farm managers hindered data collection at intended reference points, particularly the outlet points from the flower farms into the wetland. Additionally, the unpredictable changes in seasons, such as heavy rains, posed challenges as they could dilute collected samples before analysis. These limitations, including restricted access and weather-related constraints, impacted the study's ability to comprehensively assess the effects of floricultural activities on water quality and vegetation cover in Lutembe Bay Wetland.

Conceptual frame work

It was conceptualized in this study that the land use activities in wetlands such as agriculture involve vegetation clearing, hence reduction in vegetation cover. The quest for high productivity of soils and healthy plants introduces the use of fertilizers and pesticides which have a negative impact on water quality. It is thus hypothesized that agricultural activities along Lutembe wetland have changed vegetation cover and the use of pesticides affect water quality by introducing trace elements in water.

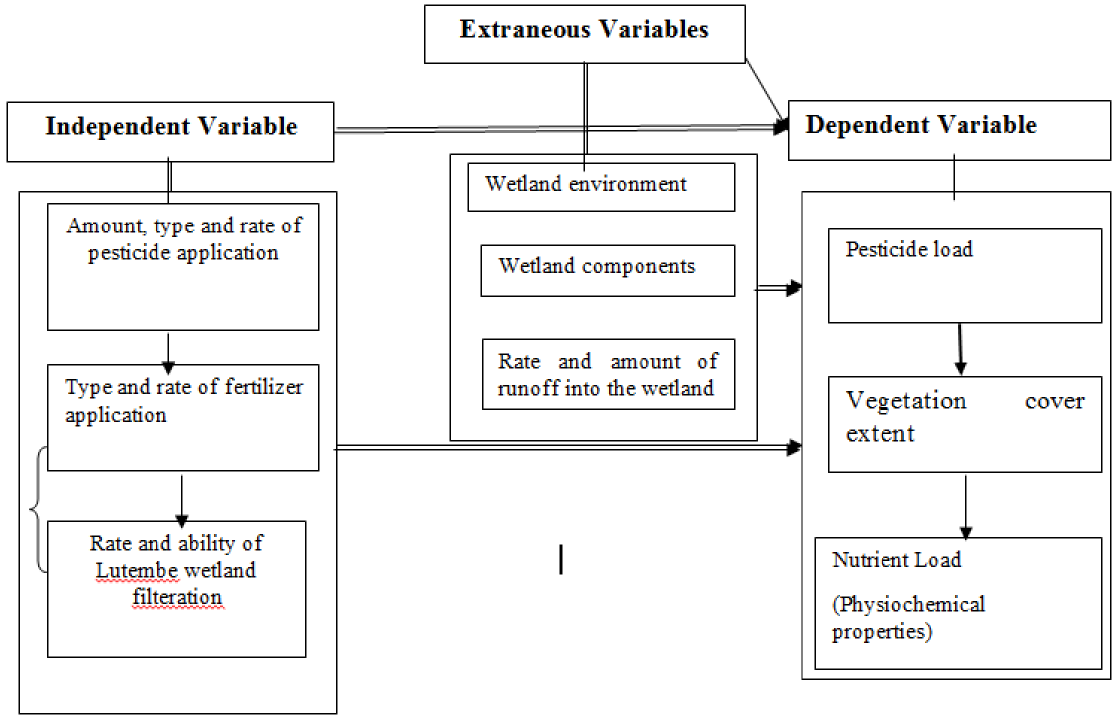


Figure 1. 1: conceptual framework detailing the organisation of the study: (Source: Phionah Kebirungi)

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents the key perceptive of the study in relation to existing research that is significant to the study. It prevents an overview of contents of the chapter. It includes an overview of the wetlands as an ecosystem, pollutant retention mechanisms, water quality in wetlands, Land use activities in wetlands, emerging pollutants and impacts of agricultural activities on the wetland ecosystem.

2.2 The concept of wetlands and ecosystems

While a variety of definitions of the term wetland have been suggested, this research will use the definition suggested in the RAMSAR Convention on Wetlands (1971) where it was seen as "areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters". In Uganda, wetlands include marshes, swamps and bogs and these account for only 11% (7.7% of seasonal wetland, 3.4% of permanent wetland and less that 0.15 of swamp forest) of the total land area (Government of Uganda, 2016). It is also important to note that there has been a gradual reduction in the coverage of wetlands due to expansion of land for agriculture as a result of population growth, Industrial and urban expansion targeting wetlands

Wetlands as an ecosystem sustains livelihoods globally, and this concept has been deeply studied for instance in Uganda where people depend on wetlands for food security and household income hence a need to conserve them (Comberti et al., 2015;Akwetaireho & Getzner, 2010). Wetlands are referred to as landscaped kidney because of their ecosystem services of provision, regulating, cultural and supporting (Ramachandra et al., 2011).

Uganda has a wetland policy and other regulations such as the wetland regulations of 2000 and the constitution of 2010 aimed with a goal to improve the productivity of wetlands, and to conserve them (Ministry of Water and Environment, 2019).

2.3 Pollutant retention mechanisms by wetlands

Wetlands in metropolitan communities receive huge quantities of effluent from domestic, agricultural, and industrial sources (Stefanakis, 2020). As effluent laden with organic and inorganic materials from the mainland is intercepted in wetlands, it is processed through either abiotic processes such as sedimentation and adsorption on the mesh-like root structures of the macrophytes or biotic processes such as decomposition by microorganisms perphytons and macropytes thus reducing the pollution load (Gottschall et al., 2007).

The extent of pollutant remediation in wetlands depends on the hydro-chemical and morphological features including the acreage, pollutant loads, retention time, cation exchange capacity, and type of macrophytes (Sharma et al., 2021). A larger acreage increases the residence of the effluent within the wetland thus an increased opportunity for remediation of pollutants, the residence time is also affected by the type of macrophytes and their root-mat. Papyrus, for instance, has a more tightly woven root-mat structure which allows for more filtration and adsorption of suspended materials compared to Miscanthidium (Headley& Tanner, 2006). The macrophytes together with periphyton assimilate nutrients especially P and N from the water column thus cleansing the water column of these nutrients.

Whereas nutrient removal (N and P species), which are the core elements of most fertilizers have been broadly studied in Uganda, more work is left for trace elements like pesticides and heavy metal pollutants (Kansiime et al., 2003). In their review of 47 papers, Vymazal & Brezinova (2015) observed a growing use of wetlands to remove pesticides starting in 1970's. The removal efficiencies of wetlands for the pesticides were highly variable however the highest removal was observed for organochlorine, strobin, organophosphate and pyrethroid groups.

2.4 Water quality in the Wetland

Water quality encompasses the biological, chemical and physical attributes of water (Norman et al., 2006). Water quality in wetlands is influenced by a range of factors. Natural processes have led to large variations between wetlands in terms of salinity, acidity/alkalinity, major ions (e.g. carbonate, chloride), nutrient levels and temperature. However, anthropogenic activities have influenced natural patterns; for example atmospheric pollution has led to acidification of lakes, and reduced freshwater inflows due to water abstraction have led to changes in salinity, particularly in brackish waters. In addition, humans have added new water quality elements, including heavy metals, organic micro-pollutants (e.g. pharmaceuticals, cleaning agents) and nanoparticles. Whilst it is tempting to classify wetland water quality according to natural or human-influenced aspects, the all-pervading influence of humans means that a sub-division based on abiotic components, nutrients and toxic substances is more useful (Acreman et al., 2008).

Serre and Karuppannan (2018) reported poor groundwater quality in the Modjo River basin which was linked to human activity as evidenced by elevated levels of electrical conductivity, pH, total dissolved solids (TDS) and the main mineral elements which affects water quality and quantity as also reported by (Norman *et al.*, 2005). Water quality monitoring is often poor in most developing countries especially Uganda where only a few characteristics of water are evaluated and monitored ignoring the effects of organic matter on water quality, consequently affecting the portability of water from water bodies. In Nsooba, although the management agencies are aware of the illegal discharge especially from human-induced activities, wastewater management becomes challenging (Hongtao .W. *et al.*, 2014). Human activities directly affect the quality of water, particularly surface water where it alters the microbiological communities and the biogeochemical processes due to a series of pollutants such as industrial wastes that find their way into wetlands via rivers (Yadav and Pandey, 2017).

Several studies have investigated various aspects related to wetlands and water quality in Uganda. Isunju, et al., (2013) conducted a study on wetland cover changes in the Nakivubo wetland, which serves as a drainage point for wastewater from Kampala city into Lake Victoria. They classified and mapped recent land cover and observed a 62% loss of wetland vegetation between 2002 and 2014, primarily due to crop cultivation. The authors concluded that increased human activities, along with flooding and pollution, would likely have significant impacts on the health and livelihoods of vulnerable communities. Nyandiga, et al., (2012) discussed the potential effects of climate change on freshwater wetlands in the Lake Victoria Basin. They highlighted the subtle yet significant impacts of climate change on wetland functioning, which can range from changes in community structure to ecological functions. The authors recommended mitigation strategies to minimize the adverse impacts of climate change on wetland ecosystems. (WID, 2018) focused on Lutembe Bay, providing a comprehensive evaluation of water quality. The report emphasized the considerable influence of human activities on water quality, including pollution from agricultural runoff and untreated wastewater. To improve water quality in Lutembe Bay, the WID recommended stricter waste disposal regulations and the promotion of sustainable agricultural practices.

2.5 Land use activities and their impact on wetland ecosystems

Anthropometric activities such as the use of pesticides and inorganic fertilizers in agriculture has been reportedly associated with elevated levels of heavy metals in soil and water bodies which negatively affects aquatic life (Mohammed & Makame, 2015; Morandin & Winston, 2003).

Concentration of diffuse pollutants in wetlands varies with land use activities whereas wetland degradation is associated with increased pollution (Hossain, 2017). Anthropogenic activities can be observed along Lutembe wetland where the is intense commercial farming of flowers, subsistence farming, sand mining and fish processing (Butele, 2016). Therefore, it is important to know how these human activities influence the existing microbial communities and biotransformation processes in these wetlands and the future risk associated with this (Yadav and Pandey, 2017). There is significant evidence showing that land-use activities have continuously led to significant effects on the functionality of ecosystems exposing the vulnerability of surface water to anthropogenic variations in a watershed.

Lutembe wetland absorbs high chemical oxygen demand (COD) levels indicating high levels of biodegradable pollutants finding their way into the wetland. Unfortunately, this leads to depletion of oxygen in the ecosystem at the expense of aquatic life due to excessive growth of algae at the water surface reducing the levels of dissolved oxygen hence death of aquatic animals (Hawumba, 2017). However, the study fell short of documenting other land use activities contributing to the degraded quality and did not also investigate the impact of the effluent on water and vegetation cover of Lutembe wetland.

In addition, Butele (2016) mainly studied the "relationship between regulatory and provisioning services of Lutembe wetland" and therefore ignores the effect of trace elements on water quality and the impact of the land uses on vegetation cover within Lutembe wetland, which this study seeks to address. Similaraly, a report by Infield et al. (2016) highlights the impact of commercial farming activities such as flower growing within Lutembe wetland is not well known and documented.

2.6 Emerging Pollutants – The Case of Pesticides

Scientifically, there are challenges in determining to extent of ground water pollution due to pesticide use due to other substances such as nitrates and heavy metal compounds that also find their way into ground water sources (Schipper and Vissers, 2014).

Pesticides are "substance intended for preventing, destroying, repelling, or mitigating any pest in crops either before or after harvest to prevent deterioration during storage or transport." (Pérez-Lucas et al., 2018). They include compounds herbicides, antimicrobials, insectcides, defoliants and fungicides (Aktar et al., 2009). Fertilizers on the other hand enhance crop growth by availing extra nutrients to the flowers that may be naturally deficient in the soil (Verhoeven and Setter, 2010). The most common fertilizers are either nitrate or phosphate based since these are what is most essential in plant tissue development; however, these nutrients are equally analogous to eutrophication in aquatic ecosystems (Amenu, 2014). Though they have the benefit of improved productivity and longevity of farm products, these compounds find their way into wetlands drains and ultimately into the environment thus causing adverse effects on both the biodiversity of the recipient environment such as fish species and quality of the soil but also on other beneficiaries of the environment such as the local communities that use them as drinking water sources (Phethi et al., 2019).

2.7 Effects of agriculture practices on wetland vegetation cover

Human activities have altered the vegetation landscape to meet their basic needs (Norman et al, 2005). Due to population pressure, the demand for resources has increased leading to the clearance of wetlands for land for farming (Jia et al., 2019). Human activities such as grazing, farming, and mining, as well as industrialization, construction of roads, building and deforestation among others have altered the vegetation cover (Wang et al., 2015). Deforestation does not only affect the landscape but also increases erosion that affects the water quality in wetlands and vegetation cover which are associated withincreased solar radiation due to poor carbon-dioxide recycling (Gülbaz, 2014; Wang *et al.*, 2015). Changes in vegetation cover alter the structure and the functioning of ecological processes leading to floods and blockage of drainage systems (Parreira et al., 2018; Matagi, 2001).

Nelson, et al. (2013) found that there have been significant changes in wetland cover in Uganda between 1986 and 2011. The main factors responsible for these changes were subsistence farming, migration, and the proximity to urban centers. Increased crop farming in wetlands was driven by economic opportunities created by new market outlets. The study also highlighted the socio-economic consequences of wetland drainage, such as the loss of water supply sources. Similarly, a study by Kyarisima, et al., (2008) found that socio-economic factors, poor farming practices and weak policies are responsible for the rapid conversion of wetlands in the Lake Victoria Basin in Uganda. They also found that wetland agriculture contributes significantly to the household income of resource-poor communities. In the study by Kizza et al. (2017) on the land use patterns in the Lake Bunyonyi catchment area in Western Uganda, population growth, agricultural expansion, urbanization, and infrastructure development were identified as the main drivers. These factors have resulted in the conversion of natural ecosystems into agricultural and built-up areas, causing habitat loss, soil erosion, and biodiversity decline.

2.8 Lutembe Bay Wetland and its Significance

Lutembe Bay Wetland is located in the Wakiso District of Uganda, on the northern shores of Lake Victoria (Ramsar Sites Information Service, n.d.). It is a Ramsar site, recognized internationally for its importance to biodiversity, particularly for water birds. The wetland is a significant habitat for several bird species, some of which are globally threatened. It is characterized by papyrus vegetation, open water, and seasonally flooded grassland (NatureUganda, n.d.). The wetland plays a crucial role in filtering water that flows into Lake Victoria, the largest freshwater lake in Africa.

Lutembe Bay Wetland plays a significant role in the Lake Victoria Basin. It provides essential ecosystem services such as water purification, flood control, and climate moderation (MWE, 2009). The wetland acts as a natural filter, removing pollutants and sediments from the water that flows into Lake Victoria. It also serves as a critical habitat for a variety of species, including several types of water birds. The wetland's biodiversity contributes to the overall health of the Lake Victoria Basin, supporting the livelihoods of communities that depend on the lake for fishing and other activities.

Despite its ecological importance, Lutembe Bay Wetland faces several threats. Floricultural activities, such as flower farming, have led to significant changes in the wetland's vegetation cover (NEMA, 2011). These activities often involve the use of fertilizers and pesticides, which can leach into the water and degrade water quality. Additionally, the conversion of wetland areas for agriculture or settlement has resulted in habitat loss and fragmentation. Other threats include overfishing, pollution from nearby urban areas, and climate change. These pressures have led to a decline in the wetland's health and biodiversity, impacting the ecosystem services it provides.

2.8.1 Climate of Lutembe Bay

Lutembe Wetland Bay is characterized by a tropical rainforest climate. The area experiences consistent high temperatures throughout the year, with relatively small variations between seasons. Lutembe bay Wetland has a fairly constant and warm temperature range throughout the year, with average highs ranging between 26°C (79°F) and 30°C (86°F). The average low temperatures range between 17°C (63°F) and 21°C (70°F). The area's proximity to Lake Victoria helps moderate the temperature, providing a cooling effect. Lutembe bay Wetland receives a significant amount of rainfall throughout the year due to its location in a tropical region. The area experiences two wet seasons, from March to May and from September to November, with heavy rainfall occurring during these periods. The annual precipitation averages around 1,500 to 2,000 millimeters (59 to 79 inches), contributing to the lush vegetation and vibrant ecosystem in the area. Lutembe bay Wetland has high humidity levels throughout the year, ranging between 70% and 80%. The combination of warm temperatures and humidity creates a tropical and often sticky atmosphere in the area. It is advisable to stay hydrated and dress in lightweight and breathable clothing when visiting or residing in Lutembe bay Wetland. Despite the regular rainfall, Lutembe bay Wetland enjoys a fair amount of sunshine. The area experiences an average of 6 to 8 hours of sunshine per day, providing ample daylight for various activities. While Lutembe bay Wetland does not have distinct seasons, there are slight variations in temperature and rainfall throughout the year. The wet seasons bring heavier rainfall, while the dry seasons experience less precipitation. However, it is important to note that Lutembe bay Wetland remains relatively humid throughout the year

2.8.2 Vegetation cover of Lutembe Bay

The "dominant vegetation is a mosaic of papyrus on the open waterside, and *Miscanthus* sp. and *Vossia* sp. towards the dry land. However, the shallow bay extends into a *Miscanthus* swamp and merges with medium altitude moist semi-deciduous forest remnants to the north, and a recently cleared horticultural farm to the northwest on the landward side. The area is in the neighborhood of post cultivation communities, Cymbopogon-Imperata and the dry Combretum savannahs, Combretum- Hyparrhenia. The vegetation in the areas adjacent the wetland is Elephant grass with forest remnants. The Water hyacinth, *Eichhornia crassipes* an introduced invasive species is one such species that should be noted. The weed has changed the ecology of the waters in Lake Victoria. Other flora include; *Mosaic papyrus, Miscanthus, Typha, Phragmites, Echinochloa sp, Afromomum, Alchornia sp, Cladium, Cymbopogon sp, Themeda sp, Vossia sp, Eichhornia sp, Laudetia sp, Phoenix reclinata, Sesbania sp, Acacia mosaic, Raphia swamp, Rattan cane, Piptadeniastrum, Albizia celtis sp, Chrysophyllum sp, Pennisetum sp, Bulrush sorghum* and *Marantocloa sp.*" (Lutembe Bay Wetland Users Association, 2014).

2.8.3 Land use activities in the wetland ecosystem

Within the wetland, there is agriculture characterized with commercial intensive horticulture, fishing, crafts as well as subsistence farming for food crops such as yams, bananas, sweet potatoes and cassava (Lutembe Bay Wetland Users Association, 2014). Within the surrounding of the wetland, stone quarrying and sand mining, recreation, water supply, forestry, industry are some of the identified uses (Lutembe Bay Wetland Users Association, 2014).

2.9 Floricultural Activities and their Environmental Impacts

2.9.1 Overview of Floriculture Industry

The floriculture industry involves the cultivation of flowering and ornamental plants for gardens and floristry, comprising the floral industry. The development, plant breeding, and better technologies have propelled this industry to new heights, especially in countries like the Netherlands, Colombia, and Kenya (FAO, 2018).

Floricultural activities encompass a wide range of practices, including propagation, cultivation, harvesting, and post-harvest handling of flowering and ornamental plants. These activities can be carried out in open fields, greenhouses, or controlled environments (FAO, 2018).

The flourishing floriculture industry has not only benefited from advancements in plant breeding and technology but has also seen significant growth in certain regions. Countries like the Netherlands, Colombia, and Kenya have emerged as key players in the global market, owing to their expertise and favorable conditions for floriculture (FAO, 2018). This industry's success can be attributed to the combination of traditional and modern cultivation practices, allowing for the production of diverse plant species to meet the demands of the market.

2.9.2 Environmental Impacts of Floricultural Activities

In recent years, there has been growing concern about the environmental impacts of the floriculture industry. A comprehensive study was conducted to investigate these issues and shed light on the detrimental effects of floriculture practices on the environment.

The study revealed that water pollution is a significant consequence of floriculture activities. The use of fertilizers and pesticides in flower cultivation can result in the leaching of these chemicals into water bodies, leading to contamination and subsequent water pollution. This contamination triggers eutrophication, a process in which excessive nutrients stimulate the overgrowth of plants, particularly algae and nuisance weeds. This excessive plant growth, commonly known as algal bloom, depletes dissolved oxygen levels when the decomposing plant material consumes it, causing harm to various organisms (Bouwman et al., 2013). Most commercial flower farms in Uganda occupy a relatively big piece of land and production is majorly done inside doors (Indoor system).The system uses metallic and sometimes wooden structures, cladding material (plastic cover) which lasts 5-7 years depending on care, climate and the type. When the quality of these plastic films deteriorate, they are always removed and disposed of to the environment and sometimes, they are burnt releasing gases into the atmosphere. (Nantamba, et al., 2016)

Furthermore, intensive floricultural practices were found to contribute to soil degradation. The excessive application of chemical fertilizers alters soil pH and depletes organic matter, resulting in a decline in soil fertility. Additionally, improper irrigation practices can lead to soil erosion and the loss of topsoil, further exacerbating soil degradation issues (FAO, 2005).

The study also highlighted the alarming consequences of floriculture-related habitat destruction and biodiversity loss. The conversion of natural habitats to make way for flower cultivation has led to the destruction of crucial ecosystems, particularly in regions with high biodiversity such as tropical rainforests and wetlands. This destruction has resulted in the loss of numerous species and has had a profound impact on global biodiversity (Phalan et al., 2011).

Moreover, the study emphasized the adverse effects of pesticide use in the floriculture industry. Pesticides, although necessary for pest and disease control, have detrimental impacts on non-target organisms. Beneficial insects, birds, and aquatic life are often affected by these chemicals, leading to disruptions in the delicate ecological balance. Pesticides can also contaminate soil and water, posing risks to ecosystems and human health (Damalas & Eleftherohorinos, 2011).

2.10 Studies on the Effects of Floricultural Activities on Wetlands

Several studies have been conducted to understand the impact of floricultural activities on wetlands. For instance, a study by Kansiime et al. (2007) investigated the impact of floriculture on the water quality of Lake Victoria in Uganda. Similarly, a study by Mekonnen et al. (2015) examined the environmental and health impacts of floriculture in Ethiopia. These studies provide valuable insights into the effects of floriculture on wetland ecosystems.

The study by Kansiime et al. (2007) found that floriculture activities contributed to the pollution of Lake Victoria, with high levels of nutrients detected in the lake water. This pollution was linked to the use of fertilizers and pesticides in flower farms. The study also noted changes in the vegetation cover around the lake due to the expansion of floriculture activities. Similarly, Mekonnen et al. (2015) found that floriculture activities had significant environmental and health impacts. The study reported contamination of water bodies and a decrease in biodiversity due to pesticide use. The authors recommended the adoption of integrated pest management strategies to mitigate these impacts.

In their study, Kansiime et al. (2007) used a combination of water sampling and laboratory analysis to assess the level of pollution in Lake Victoria. They also conducted field observations to assess changes in vegetation cover. Also, Mekonnen et al. (2015) used a similar approach, collecting water samples from different locations in the study area for laboratory analysis. They also conducted interviews with local residents and floriculture industry workers to gather information on pesticide use practices.

2.11 Summary and Research Gap Identification

The literature review indicates that floriculture activities, particularly the use of agrochemicals, can have substantial negative impacts on wetland ecosystems. The application of fertilizers and pesticides often leads to eutrophication, loss of biodiversity, and pollution of water bodies in wetland areas. This is supported by a study on the environmental concerns of floriculture in Ethiopia, which highlighted the excessive use of pesticides and chemical fertilizers that damage the environment and biodiversity (Sisay, 2009).

However, there is a gap in research when it comes to the impacts of floriculture on wetlands in Uganda, especially the Lutembe Bay Wetland. Most existing studies focus on regions like Asia, Europe, and North America, leaving a knowledge gap for East Africa. The effects of floriculture may differ in Lutembe Bay Wetland due to unique factors such as climate, soil conditions, pollution levels, and types of flowers and chemicals used.

This study aims to fill this research gap by exploring how floricultural activities influence both water quality and vegetation cover in Lutembe Bay Wetland. An integrated study of this nature can provide a more comprehensive understanding of the overall impacts of floriculture on this sensitive wetland ecosystem. The findings can help inform policies and regulations to promote more sustainable floricultural practices in the region. This study also addresses the need for more localized research by focusing specifically on Lutembe Bay Wetland in Namulanda, Uganda.

The importance of such localized studies is further emphasized by the case of Lake Victoria, where the introduction of Nile perch by the British colonial administration led to a significant shift in the ecosystem, affecting the livelihoods of local communities (Satoyama Initiative Thematic Review, 2019). This example underscores the need for careful management of local ecosystems and the potential consequences of not doing so.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This section provides an explanation and description of the methods and procedures that were used in conducting this study. This chapter gives the reader a description of Lutembe bay wetland as the study area, its location, climate and vegetation cover, surrounding land use activities, research design, data collection materials and methods used and data analysis tools used.

3.2 Study Area

3.2.1 Study Area Description

Lutembe Bay Wetland is located 25 km south of Kampala, the Capital City of Uganda. The Bay covers an area size of 500 ha between coordinates 32°32” – 32° 36”E and 00°09” – 0011”N, at an elevation of 1,135 to 1,173 m above sea level (Byaruhanga & Kigoolo, 2005). The Bay forms a secluded backwater at the mouth of Lake Victoria’s Murchison Bay, and is almost completely cut off from the main body of Lake Victoria by a papyrus (Cyperus papyrus) island.

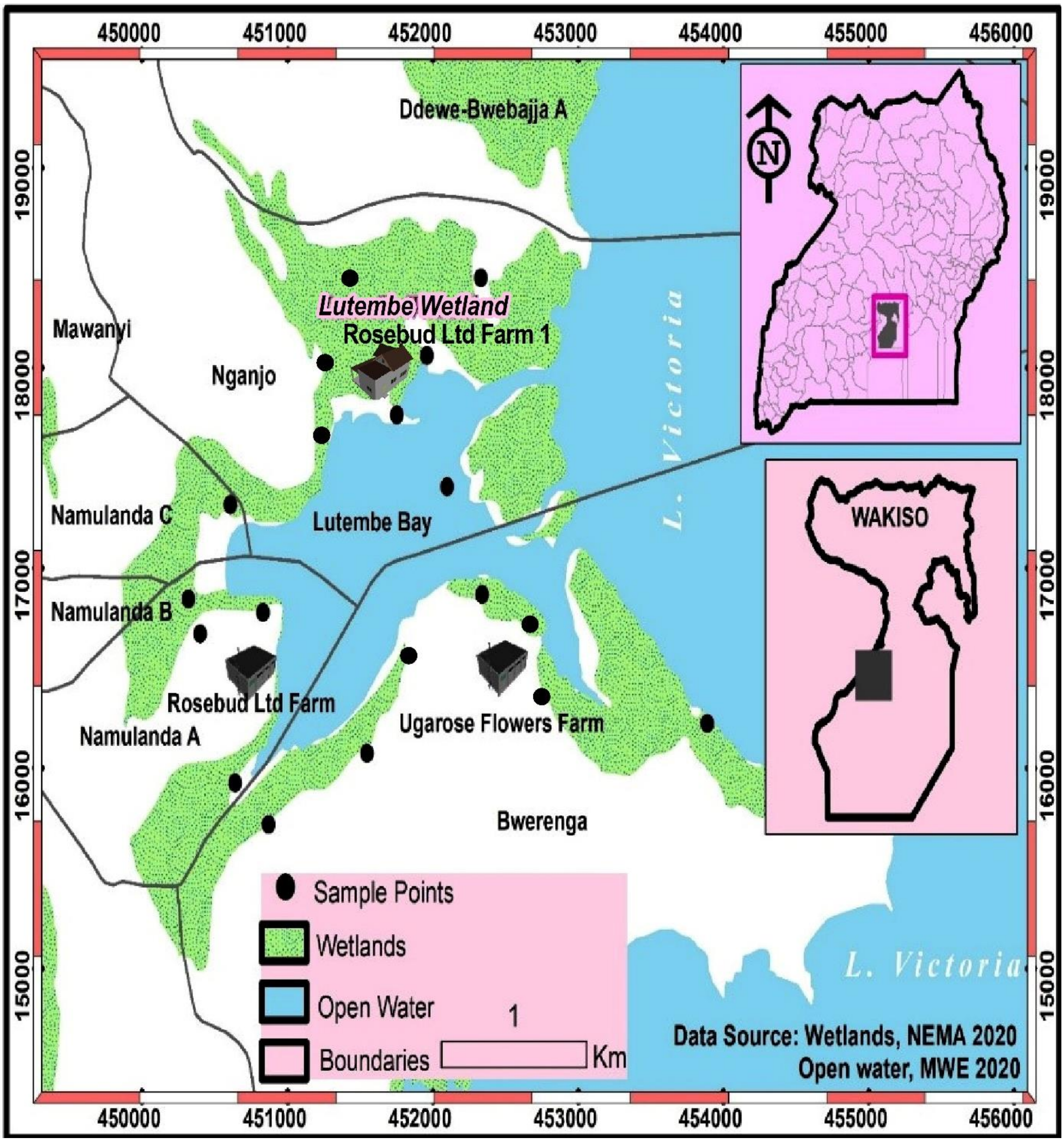


Figure 3 1: Map showing the Lutembe wetland in Namulanda, Wakiso District Uganda

3.3 Research Design

This study employed a mixed methods research design, integrating both quantitative and qualitative approaches. By combining these methods, a more comprehensive understanding of the research topic can be achieved. The quantitative aspect of the study focused on collecting quantifiable data and performing statistical and mathematical computations. It adopted a causal-comparative research design, specifically a quasi-experimental approach.

The independent variable under investigation was the usage of pesticides in flower farms, while the dependent variables included wetland pesticide load, nutrient load, and vegetation cover.

To gather data on water quality in the Lutembe Bay wetland and surrounding villages, water samples were collected from selected sites as indicated in Figure 1. The collected samples were subjected to measurements of physico-chemical parameters, enabling an assessment of the water quality within the wetland.

In addition to the quantitative measurements, image analysis of vegetation cover was conducted to understand the land use and land cover changes over time in relation to vegetation cover. This component of the study provided valuable qualitative information.

By incorporating both quantitative and qualitative approaches, this mixed methods design allowed for a more comprehensive investigation of the relationships between pesticide usage in flower farms and the wetland's pesticide load, nutrient load, and vegetation cover.

3.4 Materials and methods

3.4.1 Sampling

The study utilized a purposive random sampling method to select the sites for data collection. The sampling process took place in two seasons, namely the hot and wet seasons; twelve sites were included in the sample, and the selection of these sites was based on purposive random sampling. The specifically targeted areas were those surrounding floriculture farms; the selection of the farms was based on their significance in the floricultural industry in the area, availability of permission for research access, or collaboration with the farm owners or relevant authorities. (i.e. Rosebud Ltd Farm 1, UgaRose Flowers Farm, and Rosebud Ltd Farm). Purposive random sampling involved selecting four sites based on a predetermined set of criteria around each farm. In this case, the criteria were focused on proximity to floriculture farms to examine the impact of pesticide usage on the wetland. The sampling process involved a random selection within the eligible sites that met the predetermined criteria. This sampling method enabled the gathering of data from specific locations that were likely to be affected by pesticide usage in the flower farms, providing relevant and targeted information for the study. Sites chosen in this criterion where site 1 – 12 as shown on the map in Figure 3.1.

3.4.2 Vegetation cover changes

Assessments were conducted using remote sensing techniques to determine the extent and potential threats of land use activities within the bay. These assessments were facilitated by tools such as Quantum-GIS and Arc-GIS, which were used to create Land Use (LU) and Land Cover (LC) models with help of a GIS specialist.

To track changes in vegetation cover over time, image classification of remotely sensed data was employed. Specifically, satellite images from the years 2020, 2015, and 2010 were compared. These images were obtained from Landsat-5 TM and Landsat-8, both offering a spatial resolution of 30 m. The images were freely available from Open Street Mapping (OPM) and Google Earth (USGS) and were used for the spatial analysis of vegetation change.

Georeferenced GPS points were randomly generated using Arc Map 10.7 version for ground truthing and navigation. An existing Toposheet map of the Lutembe wetland was analyzed during a reconnaissance survey to estimate the total study area. A random sampling method was adopted to categorize land use activities within the wetland into distinct classes.

During ground truthing at these randomly selected GPS points, land use activities within an acre were recorded and subsequently classified and quantified. The extent of vegetation cover in the Lutembe wetland for the years 2020, 2015, and 2010 was estimated using Landsat TM or Operational Land Imager (OLI) images. To ensure accuracy, images with minimal cloud cover were selected and radiometric and atmospheric corrections were conducted.

3.4.3 Water quality assessment

Water quality assessment was undertaken from water samples collected from randomly selected sites “monitored for over a period of three (3) months. This involved collection of water samples from designated sites around the commercial intensive horticulture sites to obtain samples for laboratory analysis. At each sampling site, grap samples were extracted using a two (2) liter Van dorn sampler from the sample point. The collected sample was sub-sampled with thorough mixing and 150ml aliquot taken for TP, TN and COD analysis. The other portion was resampled for BOD analysis. This analysis was undertaken at National Water Quality Reference Laboratory Entebbe. The samples were analyzed for total nitrogen (TN), total phosphorus (TP), five-day biochemical oxygen demand (BOD5), chemical oxygen demand (COD), orthophosphate, ammonium and nitrate concentration as described below.

3.4.3.1 Biochemical Oxygen Demand (BOD5) determination

The BOD test was used to measure pesticide waste loads, and determine wetland treatment efficiency (in terms of BOD removal). It was used to determine the effects of pesticide discharges on receiving environment (Lutembe wetland). Because the test is performed over a five day period at 20 0C, it is often referred to as a “Five Day BOD”, abbreviated as BOD5

In the presence of free oxygen, the aerobic bacteria use the organic matter found in wastewater as “food”. The BOD5 test is therefore an estimate of the “food” available in the sample. The more “food” present in the waste, the more Dissolved Oxygen (DO) was required. The BOD5 test measures the strength of the wastewater by determining the amount of oxygen used by the bacteria as they stabilize the organic matter under controlled conditions of time and temperature

Biochemical oxygen demand employed APHA method 5210 which was revalidated in the laboratory. Based on 11 sets of performance testing data the following the characteristics derived; Method Detection Limit (MDL) of 0.343mg/l Spike recovery of 91.3% at 2.2mg/l, standard deviation of 0.281 of the blank. Samples were brought to room temperature at 20±2 ^{o}C before dilution. Suitable dilutions varied between sites and a minimum of 3 sets of diluted samples from each site, together with Quality Control (QC) standard and blank was incubated to determine the amount of residual oxygen after five days. Measurement of dissolved oxygen concentrations was done using a WTW meter with CellOx 325 sensor. The BOD test was performed by incubating a sealed water sample after addition of dilution water for a period five-days in a BOD incubator at 20^{o}C. The results were calculated as BOD mg/l according to standard methods for Examination of Water and Wastewater 23rd Edition using the formula.

$$BOD = n (d1 - d2 - B) + B \text{ mg/l}$$

Where n = dilution, dl = initial DO, d2 = Final D.O and B = Blank

3.4.3.2 Chemical Oxygen Demand determination

Chemical Oxygen Demand is the amount of oxygen consumed during a chemical reaction in which organic matter is broken down under a controlled condition in the laboratory. The closed reflux method 5220 D (APHA 2005) was used for the determination of COD. The method utilized potassium dichromate reagent mixed with sulfuric acid and mercuric sulfate to mask chloride which consumes the dichromate ions hence giving high false values. The excess dichromate which remains unreacted after a 2 hours of reaction process is either titrated using standard ferrous ammonium sulfate using ferroin as indicator or measured spectrophotometrially.

The spectrophotometer (DR 2800, Hach USA) was used to measure COD at 620 nm in all samples. The method was re-validated and based on the data a method detection limit of 22mg/l (below the 23mg/l by the original Method) was obtained, method recovery will be about 93.63% at 30mg/l with standard deviation of 9.92%.

In this method, 2mls of each water sample was pipetted and put into a digestion tube. The tubes were caped tightly and gently mixed. They were then placed in a digestion block maintained at 150^{o}C for 2hours. After the tubes were removed, swirled to mix and then cooled at room temperature. The results were measured spectrophotometrically on a DR 6000(Hach USA) at a wavelength of 620nm.

3.4.3.3 Nitrate-N and Total Nitrogen

Determination of Nitrate-N and Total Nitrogen followed the method APHA 4500F standard methods. Samples for the individual nutrient parameters were treated separately under different experimental conditions to convert the different chemical forms to Ammonium ion which were then determined spectrophotometrically at 420nm. Total Nitrogen samples were digested using the Koloreff's' method utilizing potassium pursulfate as the oxidizing reagent. Nitrate and nitrite were reduced on zinc and cadmium columns respectively and determined by the Berthellot reaction method (APHA 2005).

3.4.3.4 Ortho-Phosphate and Total Phosphorus

Ortho-phosphates and total phosphorus were measured using the Ammonium molybdate method APHA 4500-P B5 (APHA 2005). The Ammonium molybdate and antimony potassium tartrate were reacted in an acid medium with dilute solution of orthophosphate to form an intensely colored antimony-phospho-molybdate complex. This complex was reduced to an intensely blue-colored complex by ascorbic acid which absorbs at 880 nm. The orthophosphate chemical species freely available and those converted through pursulfate digestion was measured from a standard curve drawn from predetermined standard solutions.

3.4.4 Pesticide concentration analysis

Water samples were collected in 2-litre glass bottles and solid phase extracted within 24 hours of sampling for further analysis at the Water Quality National Reference Laboratory. The pesticide residues in the collected water samples were analyzed in the laboratory following standard international procedures as described by Leong et al., (2007).

Upon arrival at the laboratory, collected water samples were removed from the cool boxes and filtered with glass fiber filters 0.1mm to remove any debris. 500 mL of each collected water sample were transferred into a 2 L glass-separating funnel and 100µL of internal standard (diazepam at 2ug/mL) was added and thoroughly mixed by inverting the flask three to four times. Hydrochloric acid was then added to adjust the pH to about 2-3, as confirmed by a pH meter (Model H199163 Meat). Then, 30 g of sodium chloride was added to produce a salt out effect. The sample was extracted twice with 50 mL dichloromethane: ethyl acetate mixture 146 (50:50); shaken for 10 min each time.

The combined organic phase was then dried by passing it through anhydrous Na2SO4. The organic phase was then concentrated to 3-5 mL in a vacuum rotary evaporator and further dried under a gentle stream of nitrogen. The sample was reconstituted in 100 µL of dichloromethane and 1µL of the aliquot was analyzed by liquid chromatography-mass spectrometry.

The gas chromatograph was programmed from an initial temperature of 80^{o}C, held for 0.5 min, followed by a temperature increase at 12 ^{o} C min-1 up to 180^{o}C, held for 4 min, then increased to 220^{o}C at 8^{o}Cmin-1 and finally up to 300^{o}C at a rate of 45^{o}Cmin-1 and held for 2 min. The total run time was 22 min. The temperature the injector and interface was 280^{o}C and 300^{o}C respectively. Helium was used as the carrier gas at a flow rate of 1.2 ml min-1. The mass spectrometer was operated in the electron impact (70 eV) selected ion monitoring (SIM) mode.

The mean recoveries of the pesticides were estimated at three concentration levels: low (0.01 mg/L), medium (0.1 mg/L), and high (1 mg/L). The limit of quantitation for these compounds was determined experimentally by analyzing a series of diluted samples with known concentrations until the signal-to-noise ratio reached 10:1.

3.4.5 Ecological and Environmental Implications of Floricultural Activities Assessment

The vegetation cover in areas with and without floricultural activities was assessed. The comparison helped in determining whether floricultural activities were causing changes in plant species composition, diversity, and abundance.

Water samples from the wetland were collected and analyzed for various parameters, such as nutrient levels and the presence of pollutants. The comparison of these parameters between areas with and without floricultural activities helped in identifying any negative impacts on water quality. Changes in habitat structure and function due to floricultural activities were evaluated. This included alterations in hydrology, soil composition, and the presence of invasive species. The effects of floricultural activities on the local fauna, including pollinators, birds, and aquatic species, were investigated. Areas where floricultural activities had caused significant ecological and environmental damage were identified, and the potential for habitat restoration was assessed.

3.5 Data Analysis

Key statistical tests were run in R Studio version 3.6. Prior to statistical tests, the data was checked for normality using the Shapiro test. To determine variation of statistical differences across sampling campaigns, a simple pairwise t-test was run to establish variations. Analysis of variance (ANOVA) was used for all statistical comparisons of means between factors. Subsequently, significant differences in means was tested using the Tukey Post-hoc HSD test at 95% confidence interval. The results from the Tukey post-hoc test was reported as "mean ± standard error" unless stated otherwise. Box plots were used to graphically show the distribution of different pesticides and nutrients in the water samples collected from the different floricultural farms studied.

CHAPTER FOUR: RESEARCH FINDINGS AND DISCUSSIONS

4.1 Introduction

This section presents obtained data summaries and results. It further explains the data rather than drawing interpretations and conclusions. Here the findings are presented and analyzed based on the research questions and specific objectives. It includes use of figures and tables where appropriate.

4.2 Pesticides along selected sites in Lutembe wetland

A total of 114 pesticides were detected in the water samples collected from wetland sites close to the selected flower farms in Lutembe wetlands as summarized in Table 2. At the individual level, 13 pesticides had higher concentrations and these included Allidochlor (36.7234902mg/kg), Dichlorobenzonitrile (29.02684314 mg/kg), Biphenyl (22.42586275mg/kg), Acephate (13.18321569 mg/kg), Dichloroaniline (10.49592157 mg/kg), Pebulate (6.650156863 mg/kg) Captan (3.693803922 mg/kg), N-(2,4-dimethylphenyl) formamide (3.54472549 mg/kg), Methacrifos (3.039254902 mg/kg), 2-Phenylphenol (1.976 mg/kg), Carbaryl (1.560686275 mg/kg), Tecnazene (1.202745098 mg/kg) and Propachlor (1.17272549 mg/kg). A list of all pesticide types detected are as shown in the table below;

Table 4. 1: Concentrations of different pesticide types deterred from water samples collected close to floriculture farms in Lutembe wetland

Pesticide Identity	ROSEBUD 1 Mean	ROSEBUD 2 Mean	UGAROSE Mean	F-value	P-value
Allidochlor	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Dichlorobenzonitrile, 2,6-	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Biphenyl	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Acephate	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
3,4-Dichloroaniline	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Pebulate	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Captan	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
N-(2,4-dimethylphenyl)formamide	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Methacrifos	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
2-Phenylphenol	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Carbaryl	**0.001±0.000[a]**	**0.001±0.000[a]**	**1.245±0.522[b]**	**3.98**	**0.041***
Tecnazene	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Propachlor	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Diphenylamine	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Cycloate	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Chlorpropham	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Ethalfluralin	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Diniconazole	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Trifluralin	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Benfluralin	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Sulfotep	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Diallate I	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
BHC-alpha (benzene hexachloride)	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Diallate II	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Hexachlorobenzene	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Dichloran	0.001±0.000[a]	2.087±1.129	0.001±0.000[a]	0.706	0.499
Atrazine	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499

Clomazone	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
BHC-epsilon	**3.297±2.098^{b}**	**3.037±2.069^{b}**	**0.001±0.000^{a}**	**4.321**	**0.021***
BHC-beta	**8.370±2.379^{b}**	**7.877±3.072^{b}**	**0.001±0.000^{a}**	**3.861**	**0.032***
Terbuthylazine	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Terbufos	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Diazinon	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Terbacil	**0.001±0.000^{a}**	**3.985±2.810^{b}**	**0.001±0.000^{a}**	**3.77**	**0.032***
BHC-delta	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
BHC-gamma (Lindane, gamma HCH)	**1.888±1.285^{a}**	**5.079±2.007^{b}**	**9.697±4.479^{c}**	**5.625**	**0.0144***
Isazofos	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Pentachloroaniline	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Propanil	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Dimethachlor	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Acetochlor	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Acetochlor	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Transfluthrin	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Tolclofos-methyl	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Alachlor	**14.941±4.541^{a}**	**16.050±5.260^{b}**	**2.800±1.929^{c}**	**6.540**	**0.0167***
Metalaxyl	**23.855±5.370^{b}**	**20.370±4.120^{b}**	**0.001±0.000^{a}**	**5.412**	**0.0124***
Chlorpyrifos-methyl	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Pirimiphos-methyl	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Dichlofluanid	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Malathion	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Anthraquinone	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Aldrin	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Metolachlor	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Fenitrothion	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Bromophos	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499
Chlorpyrifos	**46.611±8.753^{b}**	**45.130±9.726^{b}**	**37.599±5.313^{c}**	**5.514**	**0.0113***
Triadimefon	0.001±0.000^{a}	0.001±0.000^{a}	0.001±0.000^{a}	0.706	0.499

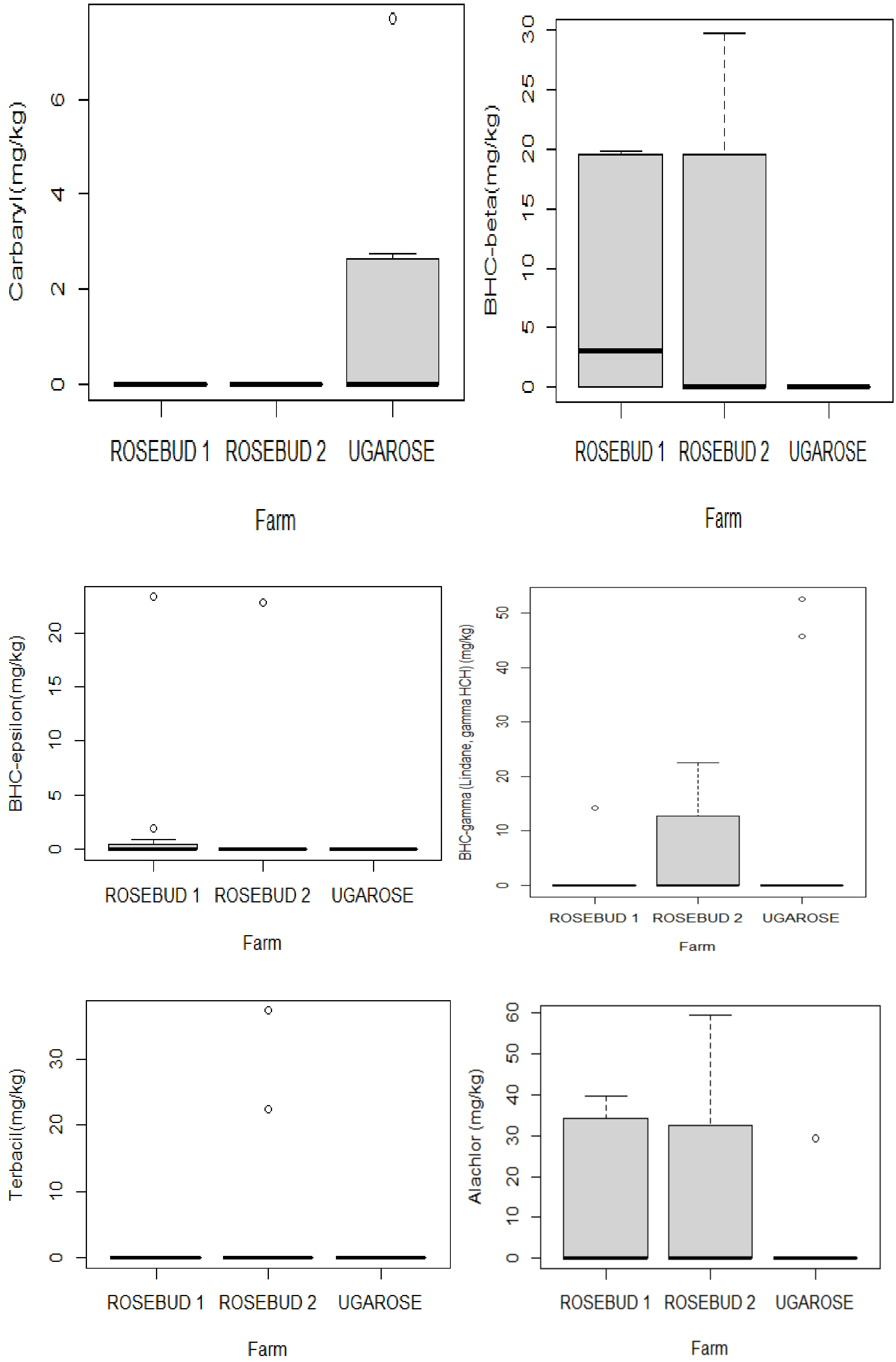
Oxyfluorfen	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Diphenamid	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Pirimiphos-ethyl	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Isopropalin	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Metazachlor	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Penconazole	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Chlorfenvinphos	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Fipronil	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Triadimenol	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Quinalphos	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Procymidone	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Paclobutrazol	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Flutriafol	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Fenamiphos	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Flutolanil	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Prothiofos	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Profenofos	-	-	-	-	-
Pretilachlor	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Dieldrin	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Oxadiazon	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Myclobutanil	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
DDT-p,p'	**0.656±0.446[a]**	**9.024±3.831[b]**	**117.082±77.559[c]**	**4.415**	**0.0165***
Fluazifop-p-butyl	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Endrin	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Chlorobenzilate	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Linuron	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Ethion	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Carbophenothion	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Norflurazon	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Hexazinone	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Tebuconazole	**1.838±1.252[a]**	**2.505±1.706[b]**	**1.006±0.692[a]**	**6.117**	**0.0101***

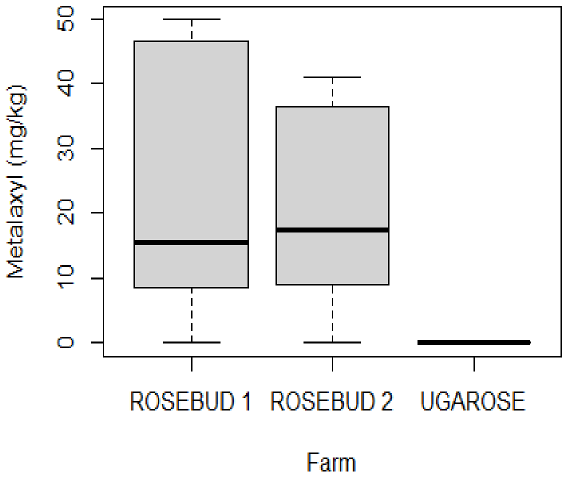
Propargite	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Bioresmethrin (Resmethrin-trans)	**1.204±0.819[b]**	**0.001±0.000[a]**	**2.263±0.790[c]**	**7.424**	**0.0123***
Pyridaphenthion	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
EPN	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Bifenthrin	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Fenpropathrin	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Phenothrin I	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Azinphos-methyl	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Phosalone	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Cyhalothrin (Lambda)	**6.393±2.853[c]**	**2.868±1.953[b]**	**0.001±0.000[a]**	**5.565**	**0.0015***
Acrinathrin	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Fenarimol	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Pyrazophos	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Azinphos-ethyl	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Permethrin, (1R)-cis-	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Permethrin, (1R)-trans-	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Pyridaben	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Coumaphos	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Prochloraz	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Cyfluthrin I	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Ametryn	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Cypermethrin I	-	-	-	-	-
Flucythrinate I	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Fenvalerate I	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Fluvalinate-tau I	0.001±0.000[a]	0.001±0.000[a]	0.001±0.000[a]	0.706	0.499
Deltamethrin	**31.089±14.432[b]**	**37.373±12.464[b]**	**0.872±0.601[a]**	**4.405**	**0.0175***

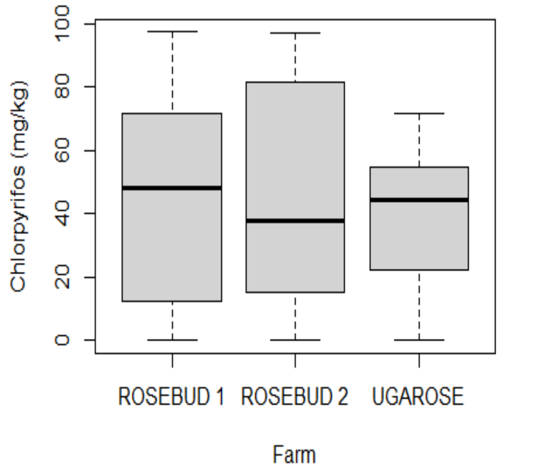
*Note: Different letters imply significantly different; "**": significant at 1%, "*" : significant at 5%.*

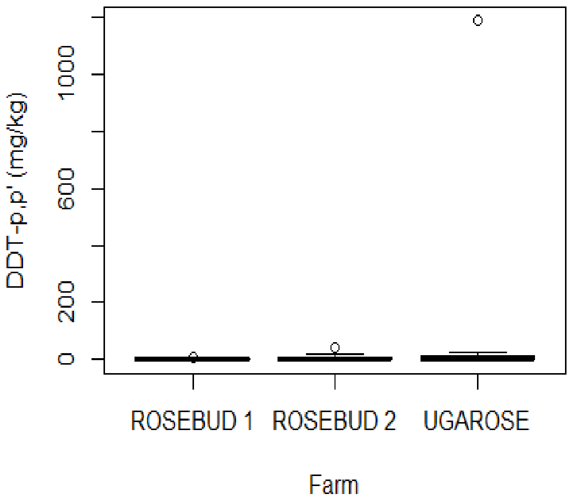
*Note: Different letters imply significantly different; "**": significant at 1%, "*" : significant at 5%.*

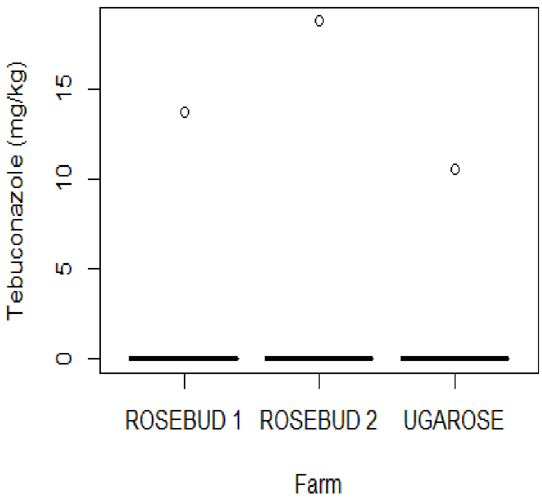
Figure 4. 1: Distribution of the different pesticides compounds in the water samples from different flower farms

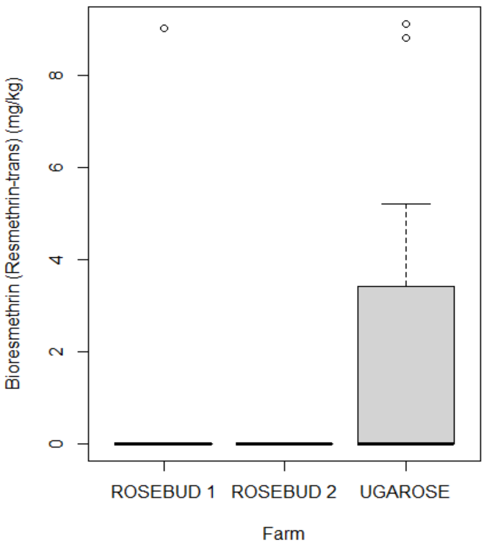


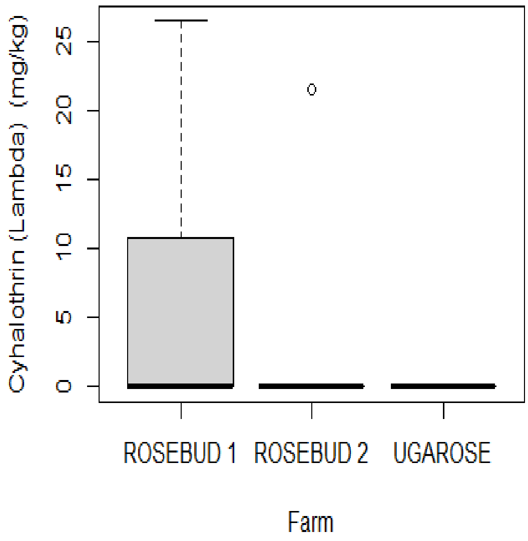

Metalaxyl (mg/kg)
0
10
20
30
40
50
ROSEBUD 1
ROSEBUD 2
UGAROSE
Farm

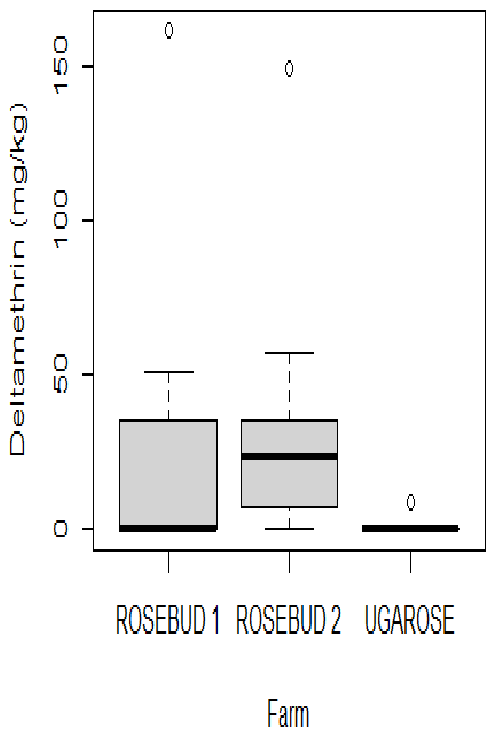

Chlorpyrifos (mg/kg)
0
20
40
60
80
100
ROSEBUD 1
ROSEBUD 2
UGAROSE
Farm


DDT-p,p' (mg/kg)
0
200
600
1000
ROSEBUD 1
ROSEBUD 2
UGAROSE
Farm


Tebuconazole (mg/kg)
0
5
10
15
ROSEBUD 1
ROSEBUD 2
UGAROSE
Farm


Bioresmethrin (Resmethrin-trans) (mg/kg)
0
2
4
6
8
ROSEBUD 1
ROSEBUD 2
UGAROSE
Farm


Cyhalothrin (Lambda) (mg/kg)
0
5
10
15
20
25
ROSEBUD 1
ROSEBUD 2
UGAROSE
Farm



The observed pesticides were categorized according to the World Health Organisation categories for Classification of Pesticides by Hazard. All the classes of Ia, Ib, II, III, O, and U were found in the water samples from the surrounding wetland as shown in the table 2 below.

Table 4. 2: Classification of pesticides by hazards in the Lutembe wetland

Class	Frequency of pesticides	Min	1st Quartile	Median	Mean	3rd Quartile	Max
Ia	4	0.001	0.001	0.001	0.001	0.001	0.001
Ib	10	0.001	0.001	0.001	0.3048	0.001	3.0393
II	54	0.001	0.001	0.001	2.405	0.001	36.723
III	17	0.001	0.001	0.001	0.07169	0.001	1.20274
O	18	0.001	0.001	0.001	0.1002	0.001	1.1727
U	11	0.001	0.001	0.001	0.001	0.001	0.001

As shown above, the moderately hazardous pesticides (II) dominated the wetland with a frequency of 54. This was followed by pesticides that are unlikely to present acute hazard in normal use (O), There were also the slightly hazardous pesticides with a frequency of 17. The active ingredients discontinued for use as pesticides (U) were also identified in the study with a frequency of 11. Lastly, the study also found extremely hazardous of (Ia) and (Ib) pesticides being used in the wetland much as they are few.

A wide range of pesticides were identified in the water samples. This implies that the pesticides used in the floriculture are moderately harzadous. This finding supports previous research by

Poissant et al. (2008) who showed a wide range of pesticides in Fluvial Wetlands Catchments due to Intensive Agricultural Activities. In the same line, Jansen et al., (2007) also observed more than 30 different pesticides with different ranges from samples collected from the effluent drainage area of the lake Ziway of central rift valley where the flower farm discharges its effluent. Of these, 5 of them were classified as high risk pesticides.

The concentrations of pesticides in the effluent water from flower farm were observed occasionally above the threshold. Such concentrations were reported to have ecotoxicological effects on water organisms. Observations from these studies were heavily dominated by Class II pesticides thus a high risk of increased fatality in the ecosystem. This can help us suggest that floriculture activities pose a negative impact on the wetland ecosystem. This is because pesticide causes the mass extinction of local species in a particular area which abrupt the balance of natural ecosystem.

The results of this study have further provided an insight into the levels of agrochemical pesticide residues contamination in wetland soils close to flower farm within Lutembe wetland. From the study, both organochlorides and organophosphates were detected in the water samples from the wetland. There was generally higher mean concentration of organophosphates compared to organochlorides probably due to global ban on most organochloride organic compounds. In all samples, the concentration of the pesticide residues was below the FAO JMPR 2015 MRL permissible level for flower farm soils. However, such pesticide concentrations if not checked may result in pollution of the ecosystem and food chain when left to accumulate. Apart from the potential danger these pesticide residues may pose to water organisms. In addition, water bodies such as the nearby Lake Victoria and streams and wells are prone to pesticide residues contamination via leaching and run offs.

In order for the pesticide loading to be minimized by the flower farms within the wetland, there is agent need to adopt Integrated Pest Management Strategies (IPM) such as replacing some chemical pesticide applications with biological control agents. This approach has been considered for some years by den Belder et al., (2009). However, it argued that not all pests can be effectively controlled using biological control agents, so there is still a need to use some chemical pesticides, however, applications are made based on scouting and there has been a move toward using more selective and less toxic products. This, along with an 80% reduction in the use of chemical sprays (80% biological control) means that risks of worker contamination, pesticide residues on flowers and environmental contamination are considerably reduced (Toumi et al, 2016).

4.3 Vegetation cover changes along selected sites in Lutembe wetland

4.3.1 Land use activities within and around Lutembe wetland

The study observed that Lutembe wetland area is surrounded by over eight (8) different land uses which include commercial and subsistence agriculture, extraction areas, industrial zones, institutional areas, open water, residential section and wetland areas. Among these, subsistence agriculture and residential settings are the most dominant land uses around and within the wetland (Figure 1). Field observations revealed that commercial agriculture within the wetland inform of flower farming is also taking great shape in relation to establishment of great residential sites more so, in Bwerenga sites close to the wetland boundaries. On the other end of Namulanda, commercial activities are subsided by intensive sand mining activities within the wetland boundaries.

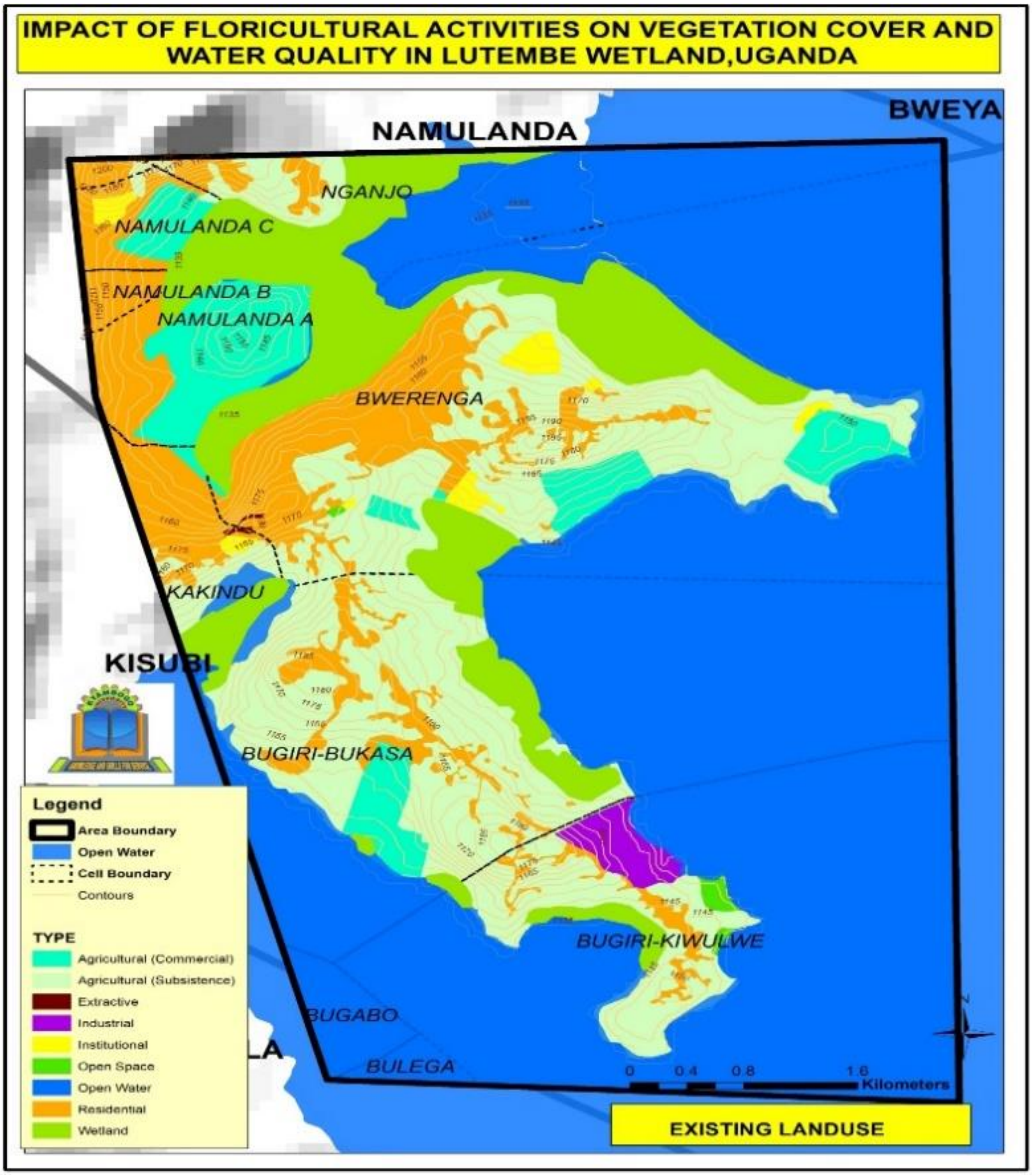
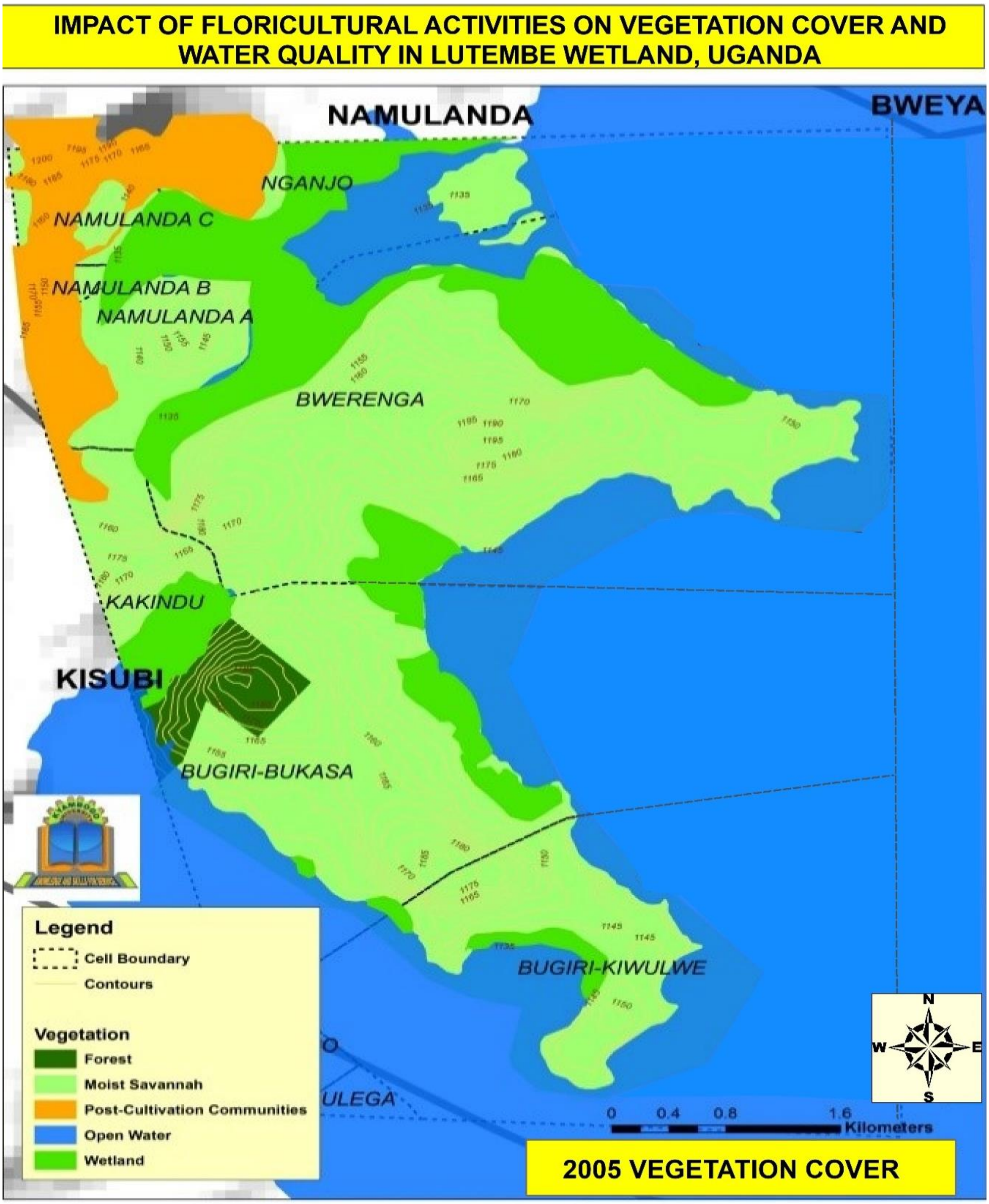


Figure 4. 2: Existing land uses within the Lutembe bay area

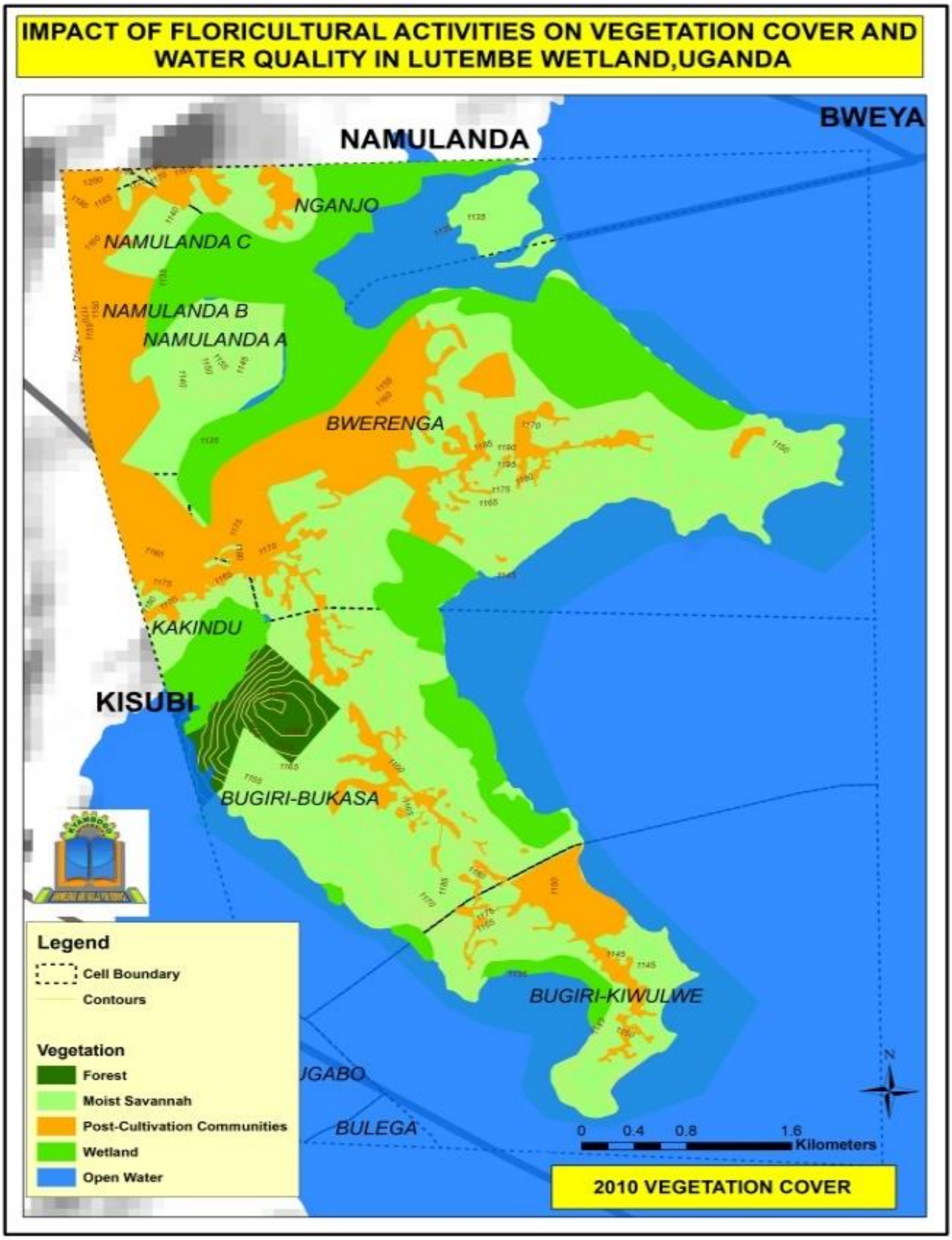
Vegetation cover changes between 2005 to 2021

Map analysis revealed that by 2005, the lutembe bay was dominated by moist savannah and wetland vegetation types (Figure 2 A). However as 2010 moved in, the savannah vegetation had been slowly invaded by post-cultivation communities (Figure 2 B). These set in encroaching small farms mainly for vegetables and quick water dependent yielding plants. These were mostly dominant in areas of Bwerenga and Kakindu but spread southwards towards

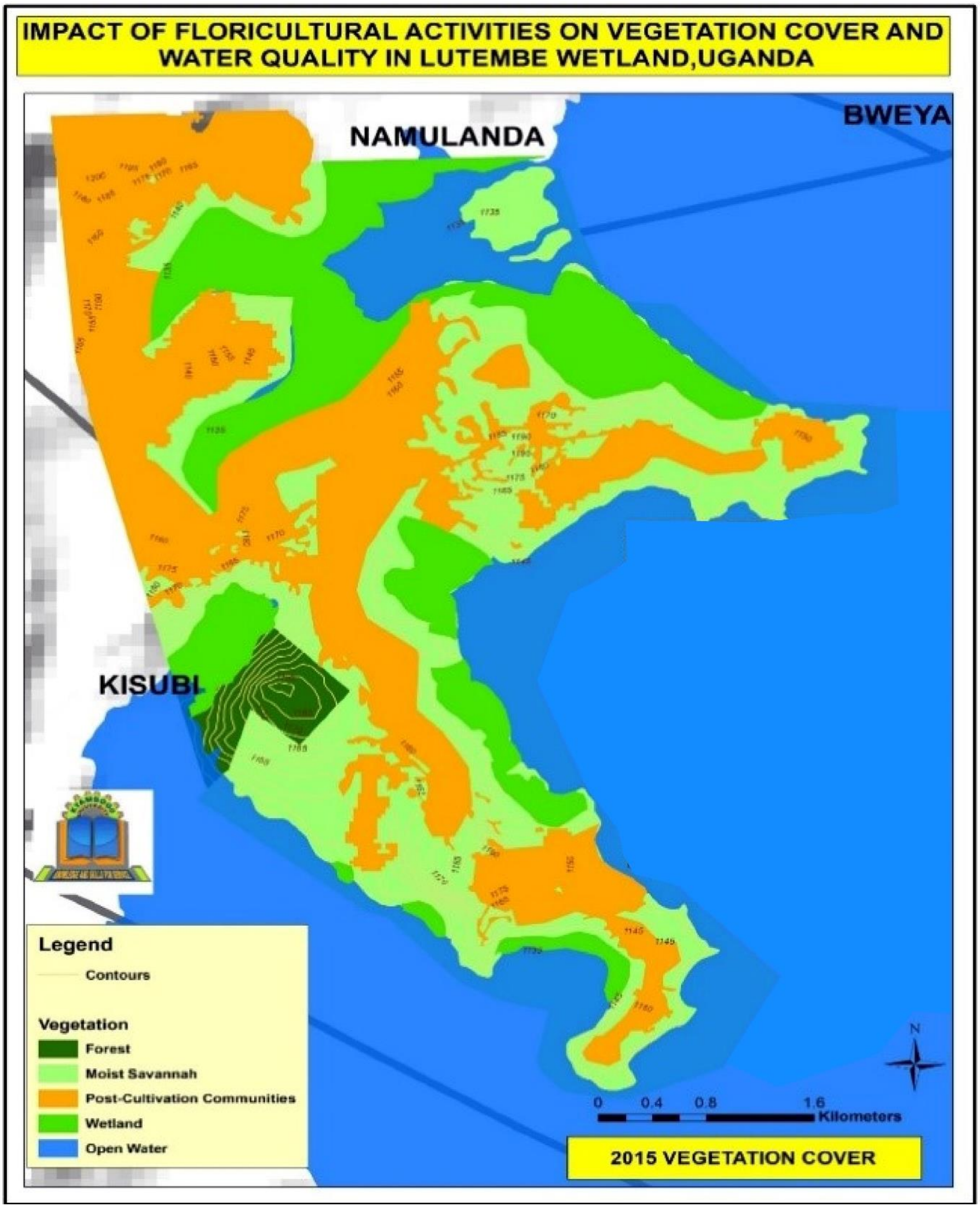
Bugiri-bukasa areas (Figure 2 C). This trend of expansion of actual activities in the savannah area tenuously spread into the all area and by 2021 the all savannah area around the wetlands had been eaten up by the post-cultivation communities. Such activities have even encroached on the core wetland areas in the southern part of the Lutembe bay (Figure 2 D).



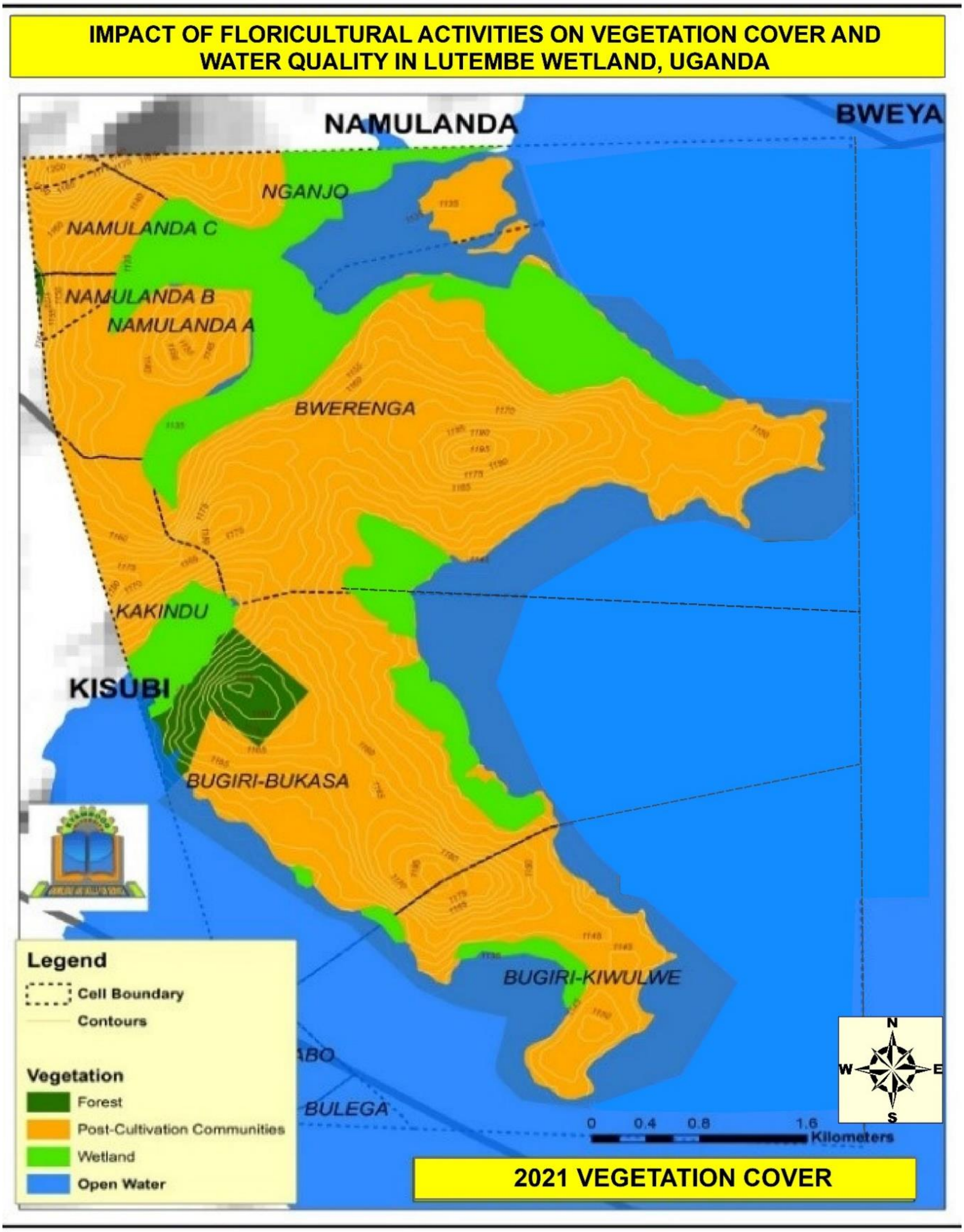
A


IMPACT OF FLORICULTURAL ACTIVITIES ON VEGETATION COVER AND WATER QUALITY IN LUTEMBE WETLAND,UGANDA
NAMULANDA
BWEYA
NGANJO
NAMULANDA C
NAMULANDA B
NAMULANDA A
BWERENGA
KAKINDU
KISUBI
BUGIRI-BUKASA
BUGIRI-KIWULWE
BULEGA
Legend
Cell Boundary
Contours
Vegetation
Forest
Moist Savannah
Post-Cultivation Communities
Wetland
Open Water
0 0.4 0.8 1.6
Kilometers
2010 VEGETATION COVER

B


IMPACT OF FLORICULTURAL ACTIVITIES ON VEGETATION COVER AND WATER QUALITY IN LUTEMBE WETLAND,UGANDA
NAMULANDA
BWEYA
KISUBI
Legend
Contours
Vegetation
Forest
Moist Savannah
Post-Cultivation Communities
Wetland
Open Water
0 0.4 0.8 1.6
Kilometers
N
2015 VEGETATION COVER

C



D

Figure 4. 3: (A-D) Changes in vegetation cover over the years within the Lutembe bay area

The encroachment of the wetland edges has seen clearance of the ordinary wetland cover which has given chance to establishment of invasive species such as *Mimosa piduca*, *Ssebania seseban* and so many others. This may be attributed to the increase and expansion of urbanisation activities in the areas of Katabi that has seen conservation of original farming areas into residential settlement areas. This has seen the primitive agricultural section of the area to resort to clearance of wetland boundaries in search for land for agricultural activities. As agriculture sets in land is set bare through clearance which gives room for the establishment of invasive species in the area. On the other hand, the farmers are key agents of dispersal of invasive plant seeds into the wetland area in that as the indigenous wetland vegetation dies out, the new introduced invasive plants seeds gets room to establish.

4.3.2 Key vegetation components close to different flower gardens within lutembe wetland

A vegetation assessment was undertaken at the purposively selected sites (sites 1 – 12) in proximate with major floriculture sites within Lutembe wetland. A total of seventy-eight (78) plant species were identified overall (**Error! Reference source not found.**) with *Mimosa udica*, *cyperus papyrus, phoenix reclinata*, *Marantachloa sps*, *Lersia hexandra* and *Indiwigia abyssinica* as the most dominate species observed. Whereas *Ficus ovata and Polyscius fulva* were among the least dominant. The area was mostly dominated by grass plant species, then herbs and trees were the least dominant as there were sparsely distributed in the different areas around the wetland boundaries. In addition, the wetland boundaries were heavily encroached for agricultural activities were encroachers grew crops like vegetables, sweet potatoes and yams. Apart from farming, settlements were also in high gear in the different wetland boundaries in additional to other peasant life sustaining activities such as clay brick laying, sand mining and harvesting of animal fodder from the wetland for sale. The study also found invasive species colonizing sites near the flower farm. These covered a significant proportion of 80 percent of the total area in sites with immediate adjacent to the farm. Some of the identified invasive species included *Lantana camara*, *Mimosa Pudica, Mimosa pigra, Sesbania sesbani, Leonotis nepitoflia, and Acanthus pubescenes.*

Table 4. 3: Common plant species surveyed around and close to flower gardens in lutembe wetlands

Plant Species	Frequency	Plant species	Frequency	Plant Species	Frequency
Acanthus pubescenes	1	*Ficus ovate*	1	*Polyscius fulva*	1
Ageratum conyzoibes	1	*Fluggea virossa*	1	*Pseudospondius microcarpa*	2
Albzia zygra	2	*Hibiscus diversifolius*	1	*Psidium guajava*	1
Alchonea cordifolia	4	*Hoslundia opposita*	1	*Rhus vulagaris*	1
Aspilia Africana	1	*Ipomea cairica*	1	*Ricinus communis*	1
Bambusa vulgaris	1	*Ipomea whightii*	1	*Sesbania sesbani*	1
Bothriocline longipes	3	*Kyllinga brevifolia*	2	*Shrakiopisis ellyptica*	1
Canarium schweinfurthii	1	*Lantana camara*	4	*Solanum mauritianum*	1
Centella asiattica	3	*Leonotis nepitifolia*	1	*Sporobolus pyramidalis*	1
Centrosema pubescens	3	*Leersia hexandra*	7	*Stachytarpheta jamaicensis*	2
Chamaecrista kirkii	2	*Ludwigia abyssinica*	5	*Synzium cuminni*	1
Colocasia esculenta	1	*Macaranga schweinfurthii*	1	*Tephrosia nana*	1
Compretum collinum	1	*Marantachloa sp*	6	*Terminalia superba*	1
Conyza bonariensis	1	*Markhamia lutea*	1	*Thyleptenium sp*	2
Cynodon dactylon	3	*Melanthera scandens*	1	*Triumfeta macrophylla*	3
Cyperus distans	2	*Microglossa angolensis*	1	*Typha capensis*	2
Cyperus dives	2	*Milicia excelesa*	1	*Typha latifolia*	2
Cyperus papyrus	9	*Mimosa pudica*	14	*Urena lobata*	2
Cyphostema adenocoule	2	*Misopsis eminii*	1		
Cyphostema cyphopetalum	1	*Momordica foetida*	1		
Cypreus dives	1	*Mytenus heterophylla*	2		
Desmodium canum	1	*Nymphae nochali*	2		
Desmodium ramosissimum	2	*Pennisetum perpureum*	1		
Dicrosephalla integrifolia	1	*Persi sp*	1		
Dicrosephalla sp	1	*Pheonix reclinata*	9		
Dissotis trothae	1	*Phragmites australis*	4		
Elarngea tomentosa	1	*Phyllantus nurirai*	1		
Eleusine indica	1	*Pistia stratiotes*	1		
Eragrostis exasperata	1	*Plectranthus barbatus*	1		
Erythrina abyssinica	3				

A sample independent T-test for vegetation status within and around Lutembe wetland showed that that the number of plant species for sites adjacent to the flower farms and the sites far away from the flower farms are significantly different since $p < 0.003$ is less than our chosen significance level $\alpha = 0.05$ (Table 2). In addition, the mean of the plant species was significantly lower in the sites immediately adjacent to the flower farms compared to their counterparts. This shows the effect of the pesticides from the flower farms on the vegetation along the wetland. The study found a difference in the quality of trees, shrubs, and grasses. In the sites at a distant place from the flower farm had trees in good quality and the grasses and shrubs, most of them were in good quality as they had attained an average height of 54.8 cm compared to their counterparts.

Table 4. 4: A sample independent T-test for vegetation

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Plant species	Equal variances assumed	9.177	.016	4.176	8	.003	16.60000	3.97492	7.43381	25.76619

The number of plant species for sites adjacent to the flower farms and the sites far away from the flower farms are significantly different. This may be attributed to the change in the ecological state of the sites close to the flower garden as effluents are discharged into the wetland form the flower garden change the natural state of the area which makes indigenous plants unable to survive thus giving room to new plants that can cope with the modified conditions to establish in the area. On the other hand, the mean of the plant species was significantly lower in the sites immediately adjacent to the flower farms compared to their counterparts. This in attributed to intensive encroachment activities closer to the flower farms compared to far away from them. This might also be attributed to the effect of the pesticides from the flower farms on the vegetation along the wetland. In that some plants find it hard to withstand the new modified microclimate or environment closer to the flower farms which makes them replaced by other plants

The research findings indicate a significant impact of flower farms on the surrounding vegetation, particularly in areas immediately adjacent to these farms. The use of pesticides appears to be a contributing factor to the reduced biodiversity and quality of plant life in these areas. The number of plant species for sites adjacent to the flower farms and the sites far away from the flower farms are significantly different. This finding is consistent with previous studies. For instance, a study by Patricia et al., (2021) highlighted that although herbicides are the most applied biocides in agriculture, in flower production, pesticides with fungicidal and insecticidal action stand out. These pesticides can be mobilized to water bodies through runoff or leaching to rivers, lakes, and groundwater. Furthermore, effluents from the flower industry can be dumped into water resources without any previous treatment, exacerbating the environmental impact. This is further corroborated by a study by Yin et al., (2023), which found that the ecotoxicity impact of pesticides on ornamental plants is greater than that of field crops. This is attributed to the higher economic value and stricter appearance requirements of ornamental plants, which necessitate the application of high-toxicity insecticides and fungicides to reduce pests and diseases. While these pesticides ensure the high quality and profitability of ornamental plants, they also lead to a significant increase in environmental pressures.

Moreover, Nimona (2020) pointed out that the floriculture industry has both environmental and social health impacts. These include the use of fertilizers and chemicals, intensive use of water resources, conversion of wetlands and farmlands, pollution of rivers and water bodies, and negative health effects on workers. The environmental implications of floriculture include soil degradation, water and air pollution usage and waste disposal, and the negative effects of pesticides non-targeted organisms. The industry also consumes a significant amount of water, leading to water resource depletion and conflicts with local communities. Waste disposal, including empty chemical containers and obsolete chemicals, is another concern.

In conclusion, the studies collectively highlight the significant environmental impact of flower farms, particularly due to the use of pesticides and other chemicals. This underscores the need for more sustainable practices in the floriculture industry to mitigate these effects.

4.4 Nutrient Loading along the selected sites in Lutembe wetland

The water samples to assess the nutrient loading were collected in the months of August (1). October (2), and December (3). Seventeen samples were collected for each month and the results are presented table 5 below. Samples for PO_4 for UGAROSE were on average 0.70*mg/l*, for ROSEBUD 1, it was 0.032*mg/l* and ROSEBUD 2 it was 0.035*mg/l*. Whereas for NO_2 the means were 0.003, 0.009 and 0.003*mg/l* for UGAROSE, ROSEBUD 1 and ROSEBUD 2 respectively. For NO_3 the means were 0.356, 1.783 and 0.631*mg/l* for UGAROSE, ROSEBUD

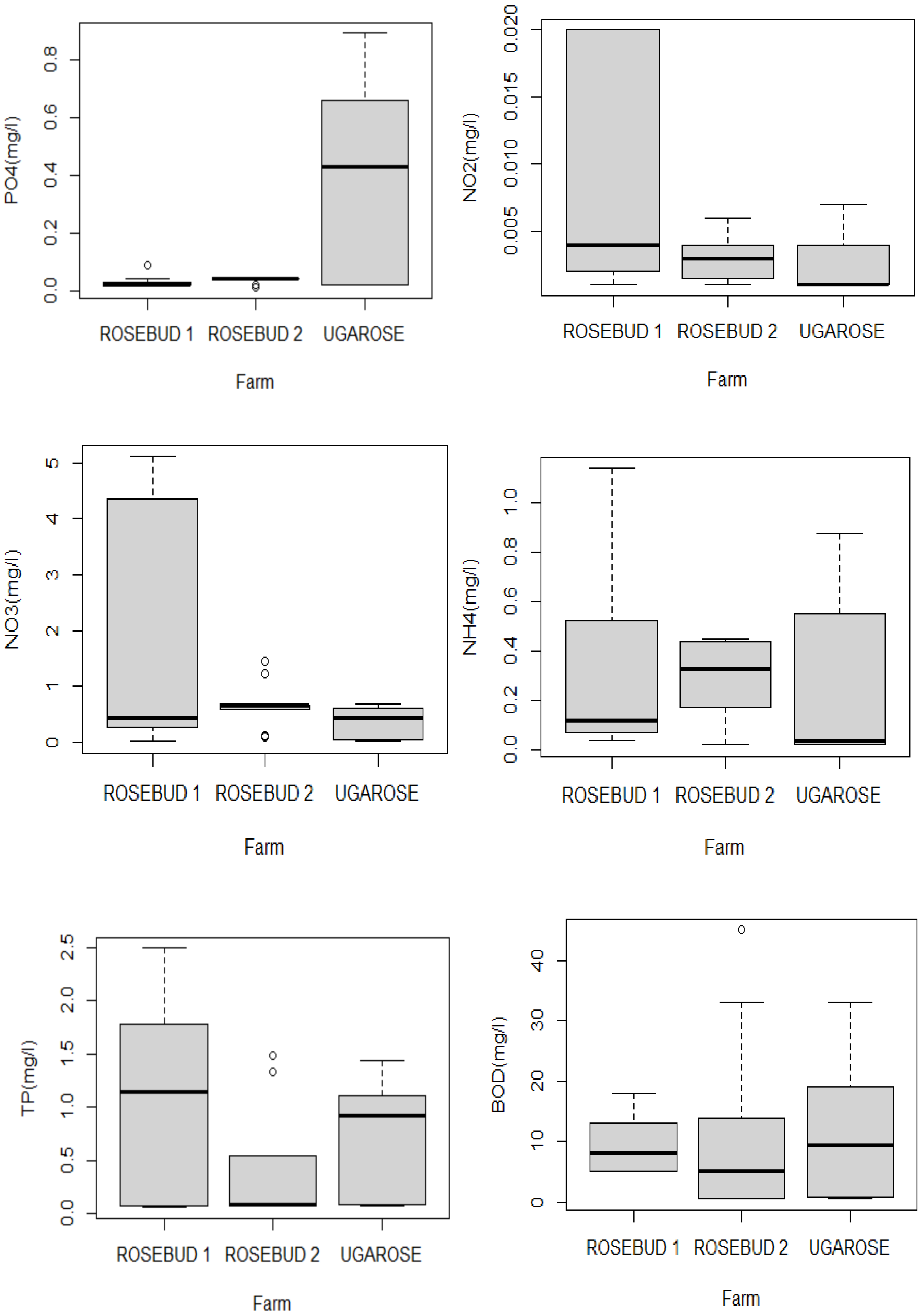
1 and ROSEBUD 2 respectively. Then for the averages of NH_4 they were 0.290, 0.337, and 0.300*mg/l* respectively. For TP the average values were 0.790, 0.954 and 0.450*mg/l* for UGAROSE, ROSEBUD 1 and ROSEBUD 2 respectively. Then for TN the averages were 3.934, 5.916 and 3.757 th3.757*mg/l* for the farms of UGAROSE, ROSEBUD 1 and ROSEBUD 2 respectively. The averages for BOD for the farms of UGAROSE, ROSEBUD 1 and ROSEBUD 2 respectively were 10.904, 9.400, 10.300 *mg/l.* Lastly for COD the farms of UGAROSE, ROSEBUD 1 and ROSEBUD 2 the averages respectively were 22.810, 18.267 and 25.533*mg/l*. All nutrients were below the national maximum permissible limits as shown in column five.

Table 4. 5: The mean±se nutrient content of water from selected flower farms

Variable	ROSEBUD 1	ROSEBUD 2	UGAROSE	UG MPL	F-value	P-value
PO_4	0.370 ± 0.075^a	0.032 ± 0.006^b	0.035 ± 0.003^b	6.1	14.130	<0.0001**
NO_2	0.003 ± 0.000^b	0.009 ± 0.002^a	0.003 ± 0.000^b	10	8.930	0.0005**
NO_3	0.356 ± 0.057^b	1.783 ± 0.561^a	0.631 ± 0.094^b	10	6.538	0.0031**
NH_2	0.290 ± 0.077^a	0.337 ± 0.104^a	0.300 ± 0.039^a	1.5	0.092	0.9120
TP	0.790 ± 0.104^a	0.954 ± 0.243^a	0.450 ± 0.134^a	10	2.319	0.1090
TN	3.934 ± 1.146^a	5.916 ± 1.412^a	3.757 ± 1.253^a	10	0.831	0.4420
BOD	10.904 ± 2.401^a	9.400 ± 1.141	10.300 ± 3.437	50	0.092	0.9120
COD	22.810 ± 4.075^a	18.267 ± 1.697^a	25.533 ± 5.850^a	100	0.660	0.5210

*Note: Different letters imply significantly different; "**'':Significant at 5%., MPL- means Maximum permissible limites*

Using ANOVA, water nutrient content parameters deferred across the different flower farms. For PO4 it was significantly different across the three farms since the p<0.0001 was less than 0.05. Indeed, the HSD test revealed that, the PO_4 values differed significantly at UGAROSE with the other flower farms at ROSEBUD 1 and ROSEBUD 2. For NO_2 and NO_3, they also different significantly across the three flower farms since their p-values were less that 0.05. On further investigation for the above two parameters using Tukey's HSD, it was found out that the farm at ROSEBUD 1 different significantly with the other two farms that's for UGAROSE and ROSEBUD 2. For the other water quality parameters such as NH4, TP, TN, BOD and COD the ANOVA analysis revealed that they were almost the same across all the three farms since their P-vales were not significantly at 5%. The figure 6 confirm the distribution of the above


PO4(mg/l)
0.0
0.2
0.4
0.6
0.8
ROSEBUD 1
ROSEBUD 2
UGAROSE
Farm
NO2(mg/l)
0.005
0.010
0.015
0.020
ROSEBUD 1
ROSEBUD 2
UGAROSE
Farm
NO3(mg/l)
0
1
2
3
4
5
ROSEBUD 1
ROSEBUD 2
UGAROSE
Farm
NH4(mg/l)
0.0
0.2
0.4
0.6
0.8
1.0
ROSEBUD 1
ROSEBUD 2
UGAROSE
Farm
TP(mg/l)
0.0
0.5
1.0
1.5
2.0
2.5
ROSEBUD 1
ROSEBUD 2
UGAROSE
Farm
BOD(mg/l)
0
10
20
30
40
ROSEBUD 1
ROSEBUD 2
UGAROSE
Farm

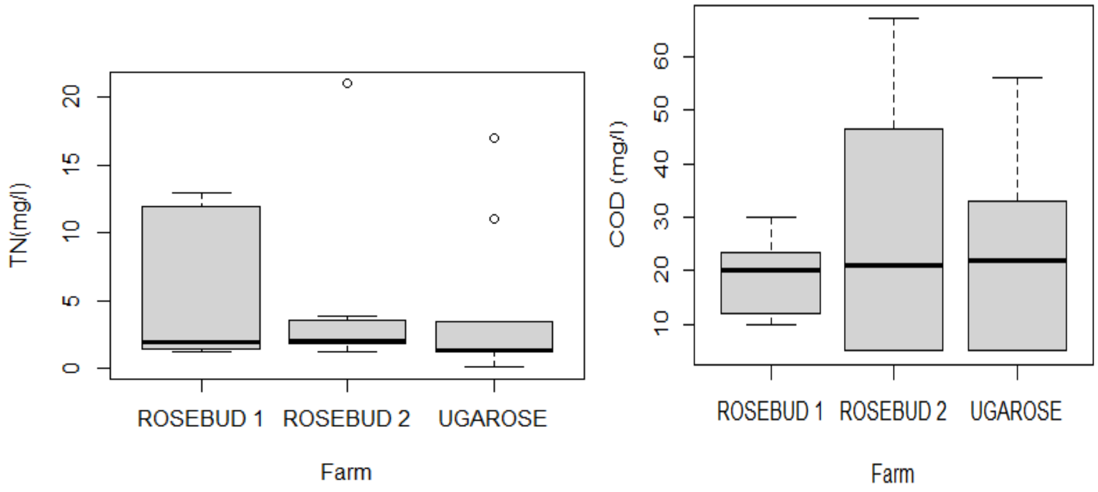


Figure 4. 4: Nutrient load distributions in water samples from different flower gardens in Lutembe wetlands

Analysis results showed that Phosphorus (PO_4), and nitrate (NO_3) concentrations had significant variation at 5% alpha among the flower farms studied. Also NO_2 from Rosebud2 flower farms significantly differed from that of other farms. However, ammonia, total nitrogen, total phosphate, BOD and COD never significantly varied among flower farms and though their concentrations significantly differed over the study time period. The total ammonia of the wetland ranged from 0.1(mg/l) – 0.4 (mg/l) which indicates that wetland is filled with ammonia beyond the standard level of 0.025 mgl/l. In accordance with the present results, previous studies such as Tilahun (2013) have demonstrated that floriculture activities increase ammonia beyond the standard level in water streams. This implies that the floriculture activities significantly impact the wetland ecosystems as excess ammonia makes it difficult for aquatic organisms to sufficiently excrete the toxicant, leading to toxic buildup in internal tissues and blood, and potentially death.

The total phosphate of the water samples ranged from 0.5(mg/l) -1.0 (mg/l) which indicates that it is higher than the standard level of 0.005 mg/l. This study finding accords with that of Tilahun (2013) who found high levels of total phosphate in the stream due to floriculture activities. The possible explanation for this is the deposition of fertilizers from the farms into the wetland by agents such as soil erosion. This is important to note excessive phosphorous facilitates intense growth of algae which leads to depletion of oxygen in the ecosystem affecting aquatic life.

The nitrate (N03) value of the water sample ranged from 0.4 – 1.6 (mg/l) which is lower that optimum N03 of water streams and wetlands of 10mg/l. The result differs from that of Tilahun (2013) who found the nitrate concentrations of Wedecha River at 16.6 mg/l. This inconsistence can help us understand that fertilizers that the farm uses are not discharged into the wetland. This implies that understand that floriculture activities have no effect on aquatic life since the required standard to protect aquatic ecosystems is 10mg/l.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This section is made up of three sub sections that are conclusion and recommendation. The conclusion section presents major deductions drawn from the research findings on the basis of the research questions whereas the last sub section presents recommendations from the study results. It further includes suggestions for further research based on the findings and conclusions generated from the study.

5.2 Conclusions

The following conclusions were drawn from the study;

i. Floricultural activities have significantly altered the vegetation cover in the Lutembe Bay Wetland between 2005 and 2021. This could be due to the use of pesticides and other chemicals, which may have reduced biodiversity and affected the quality of plant life. For example; Studied sites in Lutembe wetland were found containing different pesticide loads with Allidochlor, Dichlorobenzonitrile, Biphenyl, Acephate, Dichloroaniline, Pebulate Captan, N-(2,4-dimethylphenyl) formamide, Methacrifos, 2-Phenylphenol, Carbaryl, Tecnazene and Propachlor; Also vegetation cover components varied significantly within studied sites with subsistence agriculture occupying the previous savannah area and there has been introduction of new land uses such as increased residential settings and floriculture farms in the recent years compared to the situation in 2005. Currently subsistence agriculture and residential settings are the most dominant land uses around and within the wetland; however they have greatly invaded the moist savannah and wetland areas.

ii. Floricultural activities have negatively water quality parameters in the Lutembe Bay Wetland. This could be due to runoff or leaching pesticides into rivers, lakes, and groundwater, as well as the dumping of effluents from the flower industry into water resources without prior treatment. For example; Concentration of nutrients like Phosphorous, Nitrate; total phosphorous and total nitrogen had variations across all the different flower farms studied

iii. Floricultural activities in the Lutembe Bay Wetland have both environmental and social health impacts. These include soil degradation, water and air pollution from chemical usage and waste disposal, and negative effects of pesticides on non-targeted organisms.

5.3 Recommendations

The following recommendations were suggested from the study;

(i) Floriculture industry around and within Lutembe wetland should practice integrated pest and weed management (IPM) practices that mostly include biological measures to reduce on over dependence on pesticides and herbicides which often leach into the water resources and decrease water quality. In addition, the floriculture industry should recycle the wastewater rather than disposing it directly to the environment.

(ii) Floriculture and NEMA as a lead government environmental agency should monitor the compliance of the floriculture industry on environmental regulations such as effluent discharge to ensure that there is reduced harm to the aquatic ecosystem near the industry. This is because the water quality of the wetland was deteriorating which implies that most of the activities may not be complying with the environmental standards.

(iii) Routine monitoring of pesticide residues in the study area should be initiated for the prevention, control and reduction of environmental pollution, so as to minimize health risks to humans.

(iv) Floriculture farmers should be sensitized about the appropriate methods for controlling diseases and other health challenges that might arise from their interface with the floriculture chemicals and pesticides

(v) Area residents more so farmers should be sensitized on safe intensive pesticide use so as to reduce the levels of pesticide residues in soils and in drinking water sources mainly due to poor floriculture practices such as improper disposal of empty pesticides containers.

(vi) An independent research on the welfare and health of floriculture farm workers who interface with these pesticides on a daily basis should be undertaken so as to establish management and control measures in time

(vii) Further research on seasonal and longitudinal effect of floriculture activities on water quality should be conducted. This will provide more insight on how the pesticides and herbicides chemical vary in different seasons.

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