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THE EFFECTS OF URBAN DEVELOPMENTS ON WETLANDS IN HARARE

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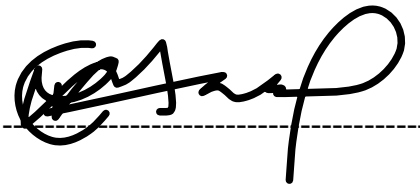
Signature of Supervisor  ----------

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DEDICATION

I dedicate this dissertation to my beloved family, whose unwavering love, patience and support have been the foundation of my journey. To my parents, thank you for instilling the values of hard work and perseverance. This work is also dedicated to my uncle for his concern during my field work. Thank you, uncle for being there for me.

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ABSTRACT

This study investigates the threats and challenges to wetland conservation and management in Harare, Zimbabwe, with a focus on three suburbs representing different residential densities: Budiriro (high -density), Monavale (medium- density) and Borrowdale (low-density). The research had three main objectives: (1) to identify the predominant issues to urban wetlands in selected suburbs; (2) to evaluate the challenges of wetland management including how-sociodemographic factors influence awareness and perceptions; and (3) to analyze the temporal and spatial changes in wetland size between 2013 and 2023 employing Geographical Information System (GIS) and remote sensing.

The study utilized both qualitative and quantitative approaches including, household surveys, key informant interviews and satellite image analysis. Findings revealed that the most significant threats to wetlands include residential expansion, urban agriculture, land use competition and poor enforcement of environmental regulations. Population variables such as education level, age, and gender were found to influence awareness of wetland conservation laws, with respondents from low-density suburb (Borrowdale) showing higher level of awareness compared to those in Budiriro (high-density suburb) and Monavale (medium density suburbs).

GIS analysis indicated a significant decline in wetland size across all three suburbs: Budiriro lost approximately 70% of its wetland area, Borrowdale 54.1% and Monavale 21.5 % between 2013 and 2023. The results suggest that urbanization pressures, weak institutional coordination and limited public awareness are key drivers of wetland degradation in Harare.

The study concludes by recommending stronger policy enforcement, increased environmental education and integrated urban planning that incorporates wetland conservation. Lessons can be drawn from countries such as Kenya and South Africa, where multi-stakeholder approaches have yielded more sustainable wetland management outcomes.

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ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
CEMU	City of Environmental Management Unit
COD	Chemical Oxygen Demand
COSMO Trust	Conservation Society of Monavale Trust
DN	Digital Number
EIA	Environmental Impact Assessment
EMA	Environmental Management Agency
ETM	Enhanced Thematic Mapper
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographic Information Systems
LTM	Landsat Thematic Mapper
MEA	Multilateral Environmental Agreements
MODIS	Moderate Resolution Imaging Spectro-radiometer
MoENRM	Ministry of Environment and Natural Resources Management
MSS	Multi Spectral Scanner
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NEP	National Environment Policy
NGOs	Non -Governmental Organizations
OLI/TIRS	Operational Land Imager/ Thermal Infrared Sensor
QGIS	Quantum Geographic Information System
QUAC	Quick Atmospheric Correction

SPOT	Satellite Pour l'Observation de la Terre
SPSS	Statistical Package for Social Scientist
UTM TF	Universal Transverse Mercator Transformation File
WISA	Wetlands International South Asia
WWD	World Wetlands Day
ZimStat	Zimbabwe National Statistics Agency

CHAPTER 1

1.0 INTRODUCTION

1.1 RESEARCH BACKGROUND

Wetlands are among the most threatened ecosystems in the world, yet they are also among the most productive and delicate ecosystems, (Okruszko et al., 2005, Keddy 2010). In accordance with the Ramsar Convention (1971) wetlands refers to "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." Important ecosystems, wetlands have been utilized for a range of social, economic and environmental purposes.

For instance, local communities in Uganda are harvesting *cyperus papyrus* to make mats and baskets and also in Okavango Delta roots, palm *Hyphae*, *phragmites* and pam heart were harvested for subsistence food and wine (Halls, A.J. (ed), 1997). In addition to this, wetlands have the potential to reduce overflow and mitigate flooding, and eliminate harmful pollutants from sewage because of its diverse vegetation and distinctive soils, (Kadlec and Knight, 1996). It has great significance for one to recognize certain values and purposes, particularly when considering how to use the wetlands, (Silvius *et al*., 2000). More than one hundred million people in Sub-Saharan Africa, including those in Malawi and Zimbabwe, rely on wetlands, Duku et al., (2022).

Wetlands play a crucial role in supporting local communities through the provision of goods and services, such as water, food, and materials, which contribute significantly to livelihoods and local economies (Adekola et al., 2008). Despite their importance, wetlands are increasingly under threat from urban expansion, pollution, and unsustainable land use practices. The loss of wetland areas not only diminishes biodiversity but also undermines the socioeconomic benefits they provide, highlighting the urgent need for effective management and emergency response strategies (Adekele, 2022)

According to the Ramsar Convention (2021), 35% of wetlands have been lost worldwide since 1970, with an estimated 30% of that loss occurring in developing nations, (Chenje and Johnson, 1999). The annual rate of wetland loss in Southern Africa is estimated to be 2% (Adeeyo et

al.,2022) and South Africa ranking highest in this reliance. According to the United Nations and FAO, Nigeria has experienced a significant reduction in wetland areas, with an estimated loss of 35% between 1993 and 2017. The rapid decrease threatens biodiversity, deteriorates water quality and the livelihoods of populations relying on wetland resources. For South Africa in particular, 48% of wetland are critically endangered and the country has lost 50% of its original wetland area. The research by the non-governmental group Wetlands International South Asia (WISA) found that during the past forty years, pollution, agricultural growth, and urbanization have led India to lose about one third of its natural wetlands.

Zimbabwe as part of the Sub-Saharan in Africa is also facing the same challenges in Harare due to urbanization. Urbanization and urban agriculture are key anthropogenic factors endangering wetlands, given that wetlands serve as extensive open areas in urban settings (Kentula *et al*., 2004; Nhapi, 2008). In Harare, wetlands are diminishing at a faster rate than forests. Using consistent satellite imagery from Goggle Earth for ten wetlands throughout the city, it was found that wetland areas declined by an average of 50% between 2007/2019 (Moyo & Cunliffe, 2020). This situation demands immediate and resolution action so as to address these wetland issues because the majority of people are much concerned about the benefits that they get from wetlands, without bearing in mind about the implications of their actions, which will lead to hydrological disruption, loss of biodiversity and soil degradation.

This study aims to explore the impact of different land use types, especially agriculture and infrastructural development are affecting the ecological functioning of the wetland. This study will primarily concentrate on Budiriro wetland (high density), Borrowdale wetland (low density) and Monavale vlei (medium density) because these are of the most threatened wetlands and yet they are areas of National importance (Ramsar Site) which is the forage of different species like flora and fauna.

1.2 PROBLEM STATEMENT

Wetlands are depleting at an alarming rate due to anthropogenic activities mainly agriculture and urbanization. These activities exert significant pressure on the land, impair its ecological functions and lead to degradation. There is a significant reduction in hydrological systems as result of degradation of wetlands. Currently, Harare is experiencing an acute water crisis, with the city struggling to ensure consistent supply of clean water to its residents and this is increasing

high levels in water related problems cholera and diarrhea, particularly for marginal communities. Hence the degradation of wetlands is causing a shift in water balances which is resulting in water scarcity and this have got some implications to Harare residents especially to wetland areas like Borrowdale and Belvedere wetlands, which are no longer rely on water from municipal sources.

1.3 AIMS

The aim of this research is to explore the extent of wetland degradation linked to urbanization in areas of varying population density, from 2013 to 2023 using GIS and remote sensing data.

1.3.1 SPECIFIC OBJECTIVES

1. To identify threats to wetlands in Harare's selected neighborhoods categorized by high, medium and low- density areas in Harare.
2. Identifying challenges to wetland management in selected high, medium and low- density areas in Harare.
3. Determining the changes in wetland size from 2013 and 2023 using GIS and remote sensing in selected high, medium and low-density areas in Harare.

1.3.2 RESEARCH QUESTIONS

The research process was directed by the following research questions:

1. What are the impacts of urban development on wetlands in selected residential zones (high, medium and low- density) within Harare?
2. What are the challenges to wetland management on selected high, medium and low-density areas in Harare?
3. What are the major changes in wetland size from 2013 to 2023 on selected residential zones (high, medium and low -density areas) in Harare?

1.4 JUSTIFICATION

The purpose of this research is to generate relevant data on urban wetland degradation, an area currently lacking sufficient documentation. The findings are intended to support the City of Harare, Environmental Agency, Zimbabwe Birdlife and other stakeholders in implementing

effective strategies to curb wetland loss and to design more robust and sustainable conservation programs. Additionally, the insights gained from this study will assist local government officials, such as district administrators and officers, in formulating actions plans aimed at enhancing the management of wetland resources at the community level. This would also encourage active public participation in conservation efforts. Furthermore, the research will provide urban planners with guidance for promoting development that not only meets human needs but is also ecologically responsible and sustainable.

1.5 LIMITATIONS OF THE STUDY

This study only focuses on the human perceptions, views, knowledge and understanding regarding how they value wetlands. There is a limitation to access primary data from the environmental authorities about the wetland encroachment. There is also a limitation in collecting data using GIS and Remote Sensing for instance Landsat's 30-meter resolution may not detect small or narrow wetland features, leading to underestimation of degradation. Frequent cloud cover, especially in wet seasons, can obscure imagery and reduce the number of usable images.

CHAPTER 2: LITERATURE REVIEW

2.1 DEFINITION OF WETLANDS

In accordance with Ramsar Convention (1971) wetlands refers to “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.”

2.1.1 FUNCTIONS OF WETLANDS AND THE BENEFITS THEY PROVIDE

The relationship among the physical, chemical, biological elements of wetlands, such as soils, water, plants and animals, they play a significant environmental, economic and social functions (Smith et al.,1995; Finlayson et al.,1999). By providing goods and services, they are able to meet human wants, (De Groot *et al*., 2002). A study conducted by Hansen *et al.*, (2021) showed that wetlands are essential in preserving natural cycles and groundwater sapping.

It is essential to note that wetlands are very important in nutrient cycling. A study carried out by Faulkner and Richardson (2020) highlighted that, since oxygen permits chemical changes in nitrogen, they also play a significant role in nitrogen cycling. In urban settings, wetlands can be utilized to retain nitrogen and phosphorus and treat sewage. The abundance of vegetation and fauna in wetlands, permits nutrients to build up and lowers sewage water flow, (Bolund and Hunhammar, 1999).

Numerous models have been used to evaluate the wetlands’ environmental condition and the sustainability of the roles they play, (Hruby *et al.*, 1999). Wetlands act as natural filters and enhancing the quality of water thereby reducing pollution. They can also be used to remove contaminants such as heavy metals that emanate from mining and industry (Kotze, 2020). According to Smith *et al.*, (2021), wetlands provided benefits by managing ground (recharge and outflow), preventing flooding (attenuation), and protect wildlife habitat. This is due to plant species like *Typha latifolia* that possess the capacity to biologically and physically remove pollutants.

Hence, the more species that are identified, the greater the advantage of a particular wetland over a larger area (Tognettii *et al*., 2008). Despite the fact that wetlands are delicate ecosystems, they

are very important because of the way they work in concert with habitats to support aquatic plants and animals.

Furthermore, one activity that draws tourists to well-known Ramsar locations like Harare's Monavale Vlei is bird watching (Murugweni, 2013). In addition of being economically significant as tourist destinations that brings in money, wetlands have been appreciated for their cultural and artistic value. However, despite the fact that tourism offers various opportunities, it can result in pollution of the natural resources (Turner *et al*., 1997). Bolund and Hunhammer (1999), highlighted that wetlands are therapeutic in nature.

Wetlands also provide advantages for agriculture. The more than half a million people living in Palisa District, Uganda, profit from agricultural pursuits like growing rice cultivation, and grazing for subsistence, according to study conducted in Uganda. Wetlands have been utilized for fishing, handicrafts, transportation and the acquisition of medicine. Economic analysis estimates that the several food suppliers that come from Palisa District's wetlands generate up to $34 million throughout the year. Since an average of $500 per hectare is achieved, these wetlands help district residents on a household level (Emerton et al., 2004).

Wetlands are economic development sources for the subsistence framers and families and have been supported thereby. Hence, the preservation and the foundation of sustainable wetland management should be based on total wetland and not economic value alone. The community is supposed to preserve wetlands by reducing pollution and avoiding the construction of buildings on wetlands.

2.2 URBAN AREAS AND HOUSING DEMANDS

Broad-scale wetland decline resulted from population growth, particularly in developing countries. Chirisa (2010) claim that affordability and housing demand are related. The greater part of urban populations living in slums areas for instance, are low-income individuals who therefore require affordable housing. The emergence of informal settlements is largely driven by low-income earners, many of whom work in the informal sector as traders, frequently occupy low-cost land.

The demand for housing in cities has been significantly influenced by family relocation patterns. According to Ahmed et al. (2010), employment-driven in-migration, has become intensified

pressure on urban land, complicating efforts to allocate sufficient space for housing. Two population growth scenarios in African nations are explored in subsequent discussion, based on the work of Byamukama, Carey, Dyszynski, and Warnest (2011).

Furthermore, urbanization has led to a rise in housing demand in China as well. From 1995 to 2000, China's low elevation coastline region experienced an in-migration level of about seventeen million people (McGranahan, Balk, and Anderson, 2007). Economic opportunities in coastal locations are the key factors driving population concentration in these areas. The demand for housing has expand as a result of the population growth. Another example is the case of Gujarat, an Indian state that is experiencing rapid population growth as a result of urbanization. Therefore, because of the mobility in the Gujarat region, the coastal land is susceptible to housing demand (Revi, 2008). The scenarios including China and India illustrated the possible strain on wetlands in cities as a result of population increase.

Wetlands have been impacted by urban agriculture, sand abstraction, recreation, forest products, water supply and the construction of superstructure and infrastructure. Boyer and Polasky (2004) research showed that the need for the construction of urban housing has exceeded that of agriculture and urbanization has been a key factor in the demand for both commercial and residential real estate as well as infrastructure that goes along with it. Thus, cities have contributed to environmental destruction (McInnes, 2009).

It is essential to remember that urbanization is causing Zimbabwe to lose its wetlands. For instance, in response to housing demand, homes were built on marsh areas in Chitungwiza Town. Homes were placed on wetland regions by the local government (Chitungwiza Municipality), and the ecosystem was disturbed. As a result of increased demand for residential space and commercial space, waste disposal and wetland erosion were both visible (Masara, 2012).

2.2.1 DEMAND FOR LAND AND URBANIZATION IN AFRICA

Population growth is typically linked to urbanization, which undoubtedly puts pressure on the demand for public and private commodities (Boadi, Kuitunen, Raheem, and Hanninen, 2005). In certain cases, land use change is a result of activities like development that are linked to population growth.

Furthermore, urbanization may have an impact on the land's biotic features, such as its vegetation, fauna and hydrology (both surface and subsurface), according to Azous (1997). These traits are typical of sensitive ecosystems, including wetlands, which can be found in some metropolitan settings, such as the ones being studied in Zimbabwe. Urbanization is one of the main drivers of wetland depletion, according to research conducted in Nigeria. The farming practice that are practiced in the Lagos metropolitan area are a major contributor to the depletion of wetlands. In turn, agricultural practices lead to the introduction of invasive foreign species, such *Lantana camara* into wetland areas (Ajibola, Adewale, and Ijasan, 2012). Conversely, unsustainable harvesting of forest resources and chemical contamination in wetland areas further accelerate wetland depletion.

Zimbabwe has also experienced in-migration as a result of its ongoing economic difficulties. According to the Zimbabwe Statistics Office, Harare's population was 700, 000 in 1982, whilst 2, 098, 199 people were counted in 2012 census (Zimstat, 2012). There is need for land for housing as a result of urban population growth and significant urbanization. The demand for space has increased due to the inflow of people in Harare, which is at the epicenter of socio-economic activity. Informally, several families have taken up residence in the Epworth and Hopely neighborhoods. Hopely is an unplanned neighborhood south of Harare and Epworth is suburb south-east of Harare.

2.2.2 IMPACTS OF URBAN DEVELOPMENT ON WETLANDS

Wetlands are typically adversely affected by urban development from both an underground and surface standpoint. Wetlands in Lagos, Nigeria, have been found to be impacted by the city's ongoing development projects. It was discovered that construction operations lead to habitat loss, indirect hydrological system modification and changes in water quality (Ajibola *et al.*, 2012)

It is also crucial to remember that urbanization of wetlands has a detrimental effect on human health. According to Goredema and Sithole (2013), the presence of water in homes causes infections to spread. They point out that because wetland regions are considered open and unused spaces, garbage gets disposed there. Diseases are spread by the dumping of rubbish because it attracts flies and scavengers. Among other illnesses, diarrhea, cholera and dysentery are prevalent in places that have been flooded.

Another source of pollution that might find its way into urban wetlands is malfunctioning sewer reticulation systems. This has been the case with the City of Harare's current sewer reticulation system. Due to the sewer system's age, overload and lack of maintenance over time, the city has been having sewer bursts (Moyo,2005). As a result, sewage that would have been dumped into wetland regions end up sinking in the wetland areas. Wetlands that eventually gather nutrients due to sewage components' eutrophication impact see a rise in the water quality's COD.

Finally, it is well known that urban agriculture has a role in the degradation of wetlands. The cultivation of maize, yams, sugarcane and vegetables is likely to occur when land is allotted in locations that overlook waterways. When fertilizers are applied to wetlands, chemical reactions with the water they contain eventually cause eutrophication and high acidity. As they inherit from their ancestors and other city fathers, this culture appears to be ingrained in majority of households (Shine and Klemm, 1999).

2.3 THE USE OF GIS AND REMOTE SENSING IN WETLAND STUDIES

In order to better understand the shifting dynamics in wetlands, GIS and remote sensing have become standard tools in wetland research for inventory of mapping land cover and tracking changes in land use (Franke *et al*., 2009). The use of GIS and remote sensing to collect data on wetland characteristics, distribution and type for appropriate preservation measures has grown globally. The reason for this is that the majority of nations worldwide lack reliable wetland inventories (Finlayson and Spiers, 1999). Wetlands in Sri Lanka were mapped using GIS and satellite data on wetland characteristics, distribution and type for appropriate preservation measures has grown globally. The land cover and land use of Sri Lanka's Muthurajawela marsh were recorded using Landsat imagery between 1992 and 2002. The changes in wetland cover revealed a loss of marsh, mangroves and water area due to sedimentation, plant removal and housing building (Rebelo *et al.*,2009). Urbanization and industrialization were the primary causes of the shrinkage of Muthurawajela a marsh's area (Rebelo *et al.,* 2009). Wetlands in Sri Lanka have benefited from this information's appropriate management, restoration and conservation.

Wetlands inventories and monitoring can benefit from the use of GIS and remote sensing, particularly in developing nations where data on the pace of wetland degradation and the various land use surrounding wetland regions is scarce. Using the spectral reflectance of the vegetation

of a wetland, remote sensing and GIS can also be utilized to monitor the vegetation. Australia's Dalhousie Springs Complex wetlands have seen an increase in knowledge and inform action due to the use of MODIS (Moderate resolution Imaging Spectroradiometer) medium resolution pictures to monitor and quantify vegetation activity and changes (Petus *et al.*, 2012). In order to determine the NDVI and map the natural vegetation changes within the wetland, MODIS photos from July 2002 to May 2010 were utilized as a change detection tool to map natural vegetation within the wetland (Petus *et al.*, 2012).

Wetlands have been identified, categorized, mapped and modeled using earth derived data in a variety of ways worldwide. Multi-temporal data enhances the categorization of wetlands, despite the fact that wetland classification can be challenging because of spectral confusion with other landcover groups (Ozesmi and Bauer, 2000). Additional information about wetlands is also provided by the analysis of various spectrum mixtures, fuzzy and subpixel classification and the spatial resolution of satellite remote sensing systems (Ozesmi and Bauer, 2000). For the sustainable management of wetland vegetation, remote sensing technologies offer relevant, up-to date and comprehensive wetland information (Adam *et al.*, 2010).

Due to the use of high-resolution satellite photography that expands the viewable region of wetland, quantifying remote sensing data has made additional information available (Franke *et al.*, 2009). In wetland studies, other indexes have also been proposed using quantitative methods. A landscape area, a landscape diversity index and a landscape fragmentation index were developed as a result of mapping ecosystem changes in Alpine wetlands in China's Zoige Plateau using remote sensing and GIS (Junhong *et al.*, 2008). Munyati (2000) used high quality Landsat TM imagery to identify wetland change in Zambia's Kafue Flats floodplain wetlands.

Nevertheless, there are still issues with how to use the information gathered from processing images (Munyati, 2010). In Zimbabwe, both rural and urban wetlands have previously been studied using GIS and remote sensing. The evapotranspiration rate in Zimbabwe's Seke Chihota wetlands was investigated using Landsat TM thermal infrared data (Lupankwa *et al.*, 2000). Some dambos were classified hydrologically using Landsat Thematic Mapper, which can identify moisture content. In order to use them for agriculture, this was done to choose dambos that would be wet during the dry season. High rates of evaporation were seen in dambos with tall, dense vegetation and in places where a lot of water seeps into the soil.

These patterns can be mapped and analyzed using GIS and remote sensing, which are helpful tools for evaluating data that is changing both spatially and temporally (Zhang *et al.*, 2002). However, because it can be difficult to interpret satellite images and appropriate high-resolution data are not always accessible, there isn't much research on wetlands in Zimbabwe utilizing GIS and remote sensing techniques (Chopra *et al.*, 2001).

2.4 REGULATIONS THAT GOVERNS WETLANDS IN ZIMBABWE

Ramsar Convention, which was signed at Ramsar, Iran, on February 2, 1971, serves as a global framework for wetland conservation. In order to raise awareness conservation and sustainable usage, this convention also creates World Wetlands Day (McInnes, 2010), Zimbabwe has seven Ramsar sites after ratifying the Convention in May 2013 (Zimbabwe Wetlands Policy, 2020). Environmental groups, NGOs and government agencies are constantly educating the public about the importance of wetlands and their sustainable usage. The Ramsar Convention encourages and requests commitments from participating nations to guarantee that wetlands are planned for and used sustainably. Despite not having a formal connection to United Nations (UN) system of Multilateral Environmental Agreements (MEA), the Ramsar Convention is widely recognized in biodiversity management treaties (McInnes, 2010).

Over the years, the Zimbabwean government has taken action to address environmental challenges. The Environmental Management Act (Chapter 20:27) 2002, include year or chapter which tackles environmental challenges holistically, was enacted. Protecting wetland regions from human activities such as removing soil or water from wetlands, was the primary goal of the 2022 wetland map gazetted, which was made possible in large part by Environmental Management Act. According to project prescribed by the Environmental Management Act, EIAs must be completed before any development is carried out. The First Schedule of the Environmental Management Act (Chapter 20:27) specifies, projects that necessitates the completion of EIAs prior to the implementation of any development.

A legal tool for protecting ecosystems was prepared to manage the environment at large. Environmental Impact Assessment and Ecosystem Protection Regulations, Statutory Instruments No. 7 of 2007, addresses the Environmental Impact Assessment process and ecosystem protection. In essence, the Environmental Management Act of 2003, Chapter 20:27, Section 4, provides for several environmental rights from a citizen's perspective, demonstrating that every

citizen of Zimbabwe has the right to clean environment, access to information and preservation of the environment for the benefit of future generations, among other rights.

Wetlands protection is another duty of the local government offices. By conserving natural resources, safeguarding recreational facilities and establishing open spaces throughout the planning stages, local governments promote environmental management, claims Mushamba (2010). A number of laws, including the Regional Town and Country Planning Act (Chapter 29:12), the Urban Councils Act (Chapter 29:15) and the Rural District Councils Act (Chapter 29:13), regulate local governments. The purpose of these Acts is to encourage environmental sustainability everywhere. However, in order to guarantee sustainable land use, the Ministry of Environment created the National Environmental Policy (NEP), that offers an integrated land use planning approach. The Ministry of Environment promotes, as part of the Policy raises awareness on issues relating to wetland research as well as strategies of rehabilitating degraded land (Government of Zimbabwe, 2009).

The laws in place, only needs a permit to build on a wetland, as the Environmental Management Act of 2003, Section 113, prohibits building or farming on wetlands without a permit, stating that "the minister may declare any wetland to be an ecologically sensitive area and may impose limitations on development in or near a wetland." But it, also requires extensive public consultation to be conducted, but if the Agency is not satisfied with the consultation among stakeholders, it then does not issue a license for that development.

CHAPTER 3: METHODOLOGY

3.1 DESCRIPTION OF THE STUDY AREAS

Budiriro 5 wetland

Budiriro 5 wetland is situated in Harare, Zimbabwe, near Highglen Road. It is situated in the high- density suburbs of Budiriro, which is close to Aspindale Park, Mufakose, Budiriro 4 and Marimba Park (Figure 3.1). The study area is geographically situated between **-17° 52' 44" S latitude and 30° 55' 24" East** longitude (UTM TF72). Budiriro 5 wetland is approximately **238.1 hectares**. According to the Zimbabwe Population Census (2022) preliminary results, Budiriro 5 has a population of approximately 89, 287 people, making it the most populated ward in the country. The rainfall pattern in Budiriro 5 wetland follows the typical climate of the central region of Zimbabwe, influenced by a distinct bimodal rainfall pattern. According to the Meteorological Services of Zimbabwe, the rain season typically spans from November to March, with peak rainfall occurring between December and February. During this period, the area receives moderate to heavy rainfall, which can range from 700mm to 1000mm annually, although this can vary.

The types of soil found at study area is typically hydromorphic and alluvial influenced by the periodic waterlogging and seasonal flooding in the wetland area. The soils are often clayey or loamy, with high moisture retention. According to Moyo, N.A.G (2013), Budiriro 5 is a Dambo ecosystem which is characterized by unique vegetation types such as grass species, which are *Pennisetum* (fountain grass) and *Cyperus* (sedge species). Mukute tree (*Mimusops zeyheri)* is also found, this is an indicator of shallow groundwater tables and can be found in areas with high water table. According to Zimbabwe National Hebarium, *Acacia nilotica* (Egyptian Thorn) and *Acacia sieberiana* (Paperbark Thorn) are also found at Budiriro 5 wetland.

Monavale Wetland

Monavale Vlei (figure 3.1) is located in Northwest Harare, Zimbabwe, a few kilometres from the city centre. The area is bordered by Avondale Stream to the South, Marimba Stream to the West

and Fenella Drive to the East. According to (COSMO Trust), the area covers approximately **305.3 hectares** in extent and is situated at coordinates around **17° 48'0.20"S and 17° 48'59.0"S latitude and 31° 00'24.8E" coupled with 31° 00'50.4E" longitude (UTM Zone 36 South).** There are no buildings on the site. The entire Ramsar Site is 507 hectares. Monavale Vlei lies in the jurisdiction of the City of Harare. The combined areas of Belvedere, Milton Park and Ridgeview in Ward 5 have an estimated population of 16, 641, distributed across 5, 289 households, with an average of 3.1 individual per household (Zimstat 2022). This makes Monavale to be a medium density suburb.

Monavale Vlei has a subtropical highland climate. The rainfall pattern in the area is typical of much of Zimbabwe's central and northern regions, with a distinct wet and dry season. According to Bohle et al. (1994) the study areas lies in Agro-Ecological region II and receives between 800 mm and 1000 mm of rainfall annually. The vlei is located on greenstone terrain and soils belong to the fersiallitic group (SWT, 2006), which according to Nyamapfene (1991), are classified as 5E.2. Fersiallitic soils are the predominant soil group across much of Zimbabwe and a significant of country's maize production belt within the areas covered by these soils (Nyamapfene, 1991).

It is a seasonally inundated wetland ecosystem dominated by open grasslands and lacking tree cover, characteristics of the Mashonaland Plateau watershed. Monavale is a short grassland wetland ecosystem characterized by miombo woodlands. According to COSMO trust, despite that Monavale is grassland ecosystem, it is bordered by patched of forest including Zimbabwean Teak (*Baikiaea pluriuga*) and Mopane (*Colophospermum mopane*). Around wetland margins, species such as Acacia and *Commiphora* are found in the more arid, higher ground surrounding vlei. The site hosts around 120 species of wetland-adapted plants, primarily orchids and grasses with scattered trees occurring along the periphery. A total of over 244 bird species have been documented, including breeding migrant species such as the Striped Crake and Streaky-breasted Flufftail, both of which are dependent on grassland wetland habitats.

Borrowdale wetland

The vlei (figure 3.1) is situated 10.5 km north of Harare. It is located between **17° 49'15"S and -17.82083°S latitude and 31° 02'57°E and 31.04917°E longitude.** Borrowdale wetland is approximately **189.2 hectares**. Borrowdale wetland is bordered Ballantyne Park residential area to the West, Dandaro village and Old People's home to the south and Borrowdale residential

areas to the North and Whitwell roads. The preliminary results of the 2022 Zimstat Population Census show that Borrowdale is a low-density suburb, with a total population of 18, 486 living in Ward 17 (Mount Pleasant, Northwood, Arundel, Groombridge, Mt Pleasant Heights, Vainona, Borrowdale West, Pomona) and 6 504 households, with an average household size of 2.8 per house. The rainfall pattern of Borrowdale wetland is similar to that of other areas in Harare, with distinct wet and dry seasons. Additionally, the Borrowdale area is covered in sandy loams, vertisol soils, and greenstone (Harare Shamva greenstone), (Nyamapfene, 1991; Anderson et al., 1993; FAO, 1994). Vegetation found on vlei include reeds (*Phragmites australis*), these tall grass-like grow in the edges of wetlands and help stabilize the soil, preventing erosion. *Panicum* grass species and *Commiphora* shrub species are also found.

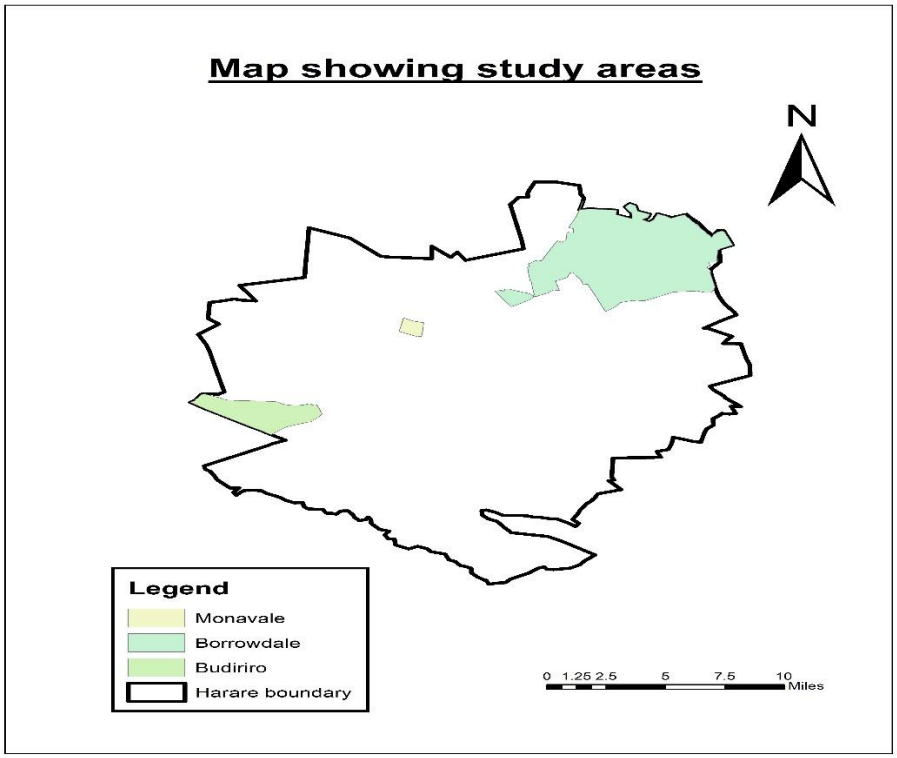

Figure 3. 1: Map showing study area

3.2 RESEARCH DESIGN

A mixed research method was conducted which involved both quantitative and qualitative data. Due to the variety of methodologies used, which allowed for the interpretation of data of various kinds, mixed methods proved to be quite efficient in gathering information regarding specific

concepts on wetlands. A more insightful method of examining and evaluating the natural ecosystems in the wetlands is to combine quantitative data from GIS and remote sensing with qualitative data from community perspectives to ascertain changes in wetland size. This is due to the fact that the wetland's various attributes, condition and ecological health may be examined from both human and physical standpoint (Mutisi, 2014). While qualitative approaches aggregate data from GIS and remote sensing images of 2013 and 2023 to show the truth of the investigated phenomenon, most qualitative methods promote participation, so the data obtained will be modified by people's experiences and opinions.

3.3 SAMPLING AND SAMPLING PROCEDURE

Questionnaires

Through convenience sampling, the questionnaires (Appendix C) were given to the residents of Borrowdale, Monavale and Budiriro as well as those who were employed in wetlands. The most suitable sampling technique for gathering data from Budiriro, Monavale Vlei and Borrowdale was convenient because it is difficult to reach the people living in these three residential areas, (Borrowdale is a low-density area, Monavale is a medium-density area and Budiriro is a high-density area). Therefore, as result of convenience sampling that was used to select respondents from study areas, 30 respondents were found at Borrowdale, 50 respondents for Budiriro and 36 respondents at Monavale vlei.

The questionnaire was designed to use five-point Likert scale questions. Consistent scales the range from strongly agreeing to categorically disagreeing with this notion were employed to quantify the items on the instrument. The initial section of the questionnaire asked about the demographics of the respondents. Both closed-ended and open-ended questions were included in the questionnaire's second section. The research goal was to address the difficulties in managing wetlands using both open-ended and closed-ended questions. The environmental laws that control wetlands in Zimbabwe were also covered in the questionnaire. Open-ended questions allowed for an infinite number of responses that could be compared and asked respondents to share any personal experiences or tales pertaining to wetlands. This included inquiries on wetland dangers, observed changes in wetland size and potential solutions to wetland problems.

3.4 INTERVIEWS

The interviews were done within City of Harare Department of Housing, Department of Works as well as the City of Harare Environmental Management Unit (CEMU), as the targeted population. To provide a good representation of management and staff, respondents were grouped into stratums using stratified random sampling. Judgemental sampling was employed to purposively select managerial personnel whose expertise and roles were considered essential for providing relevant information on wetland management. This method was deemed appropriate as it allows the researcher to intentionally target respondents with specific knowledge and experience, thereby minimizing potential bias in data collection. Using this approach, a total of 263 respondents were included in the study.

According to Cooper and Schindler (2014), a sample size of 10% to 30% is a good representation of the target population and is sufficiently large to account for reliable examination data. Using equation, which was obtained from Kothari (2014), a sample size of 263 was determined by determining the objective population of 1139 with a 95% certainty level and an error of 0.05. According to Mugenda (2012, sampling techniques encompass all the tactics or processes used to get a sample from the population under study. Based on occupation, the target audience was divided into two classes: general employees and management and respondents were then selected from each stratum.

Table 3. 1: Target Population

Department	**Frequency**		
	Management	**Employees**	**Total**
Town Clerks	25	95	**120**
Urban Planning	25	531	**556**
Works	19	444	**463**
Total	**69**	**1070**	**1139**

Source: HC Records (2023)

The respondents' distribution is displayed in the above table. There were 120 from Town Clerks, 556 from Urban Planning and 463 from Works.

Sample Size

The sample was taken from Town Clerks, Human Capital, Harare Water and Works in City of Harare the formulas utilized are listed below.

$$n = \frac{z^2.N.\partial_p^2}{(N-1)e^2 + z^2\partial_p^2}$$ Equation 1

Where, n = Size of the Sample

N = Size of the population and given as 1139,

e = Acceptable error and given as 0.05,

∂p = the standard deviation of the known population and given as 0.5 where not known,
Z= Standard variance at a certainty level given as 1.96 at 95% certainty level.

Interviews were conducted within City of Harare, and 10 respondents were interviewed from Department of Works, 5 respondents from the Environmental Management Unit under Town Clerks and 15 respondents from the department of Urban Planning were interviewed. The study also interviewed 3 members of Birdlife Zimbabwe (COSMO Trust).

3.5 DETERMINING CHANGES IN WETLAND SIZES IN HIGH, MEDIUM AND LOW DENSITIES

The study employed a retrospective analysis of satellite images to determine the changes in wetland size over a 10-year period (2013-2023). The USGS Earth Explore website provided the Landsat 8 OLI/TIRS (2013) and Landsat 9 OLI/TIRS (2023) images. The images were selected based on their spatial resolution (30 meters), spectral bands and minimal cloud cover. Viewing the ecological elements of the wetland ecosystem in more detail is made possible by high

resolution photographs, such as Landsat images, which expand the viewing field of the land (Betbeder et al., 2014). The Department of GIS of the City of Harare provided additional auxiliary datasets, such as vector or data for towns, roads, water bodies and administrative borders. In order to minimize drastic changes in land cover reflectance and to obtain images with less clouds, the Landsat photos were taken during the dry season, which run from August to December. Following the conversion of acquired information from DN values to radiance, atmospheric correction was carried out during the pre-processing step using the Quick Atmospheric Correction (QUAC), which is frequently used for circumstances like thick haze, smoke or under cloud cover. QGIS was used to trim images to the research region. Each Landsat image's Normalized Difference Water Index (NDWI) was determined using the Raster Calculator in QGIS. Wetland areas were classified using a threshold of NDWI readings. Wetland areas were computed using QGIS Vector Geometry tool for each of the years 2013 and 2023. The wetland areas from 2013 and 2023 were compared in order to identify changes in wetland size. The area covered by each class for each image was calculated to identify changes, and the rise or reduction in the area displayed on the photographs was used to determine the changes from year to year (Munyati, 2000).

3.5 DATA ANALYSES

Data on threats and challenges to wetland management was coded and analyzed in SPSS (IBM) version 30, to identify the key trends, relationships, and patterns affecting wetland conservation. The wetland area data was summarized using descriptive statistics (mean, standard deviation). Wetland management issues, risks to Borrowdale, Budiriro and Monavale vlei wetlands, and changes in wetland size over time were all examined using inferential statistics (t-test, ANOVA).

CHAPTER 4: RESULTS

4.0 INTRODUCTION

4.1 RESPONDENT'S SOCIODEMOGRAPHIC ATTRIBUTES

Table 4.1 shows the socio-demographic details of the study respondents. Most of the people who responded were from Budiriro residential suburb (43.1 %), Monavale had (31%) whereas the lowest were from Borrowdale (25.9 %). In Borrowdale, most respondents were male (53.3 %), were aged above 35 years (60.0 %), and had attained tertiary level education (66.6 %). Participants from Budiriro were mostly female (72.0 %), were aged between 25-34 years (38.0 %), and attained secondary level education (60.0 %). The majority of respondents from Monavale were male (55.6%), were aged above 35 years (61.2 %), and had attained tertiary level education (44.4 %).

Table 4. 1: Socio-demographic attributes of study respondents (n = 116)

Variable	Category	Frequency (%)			Total
		Borrowdale	Budiriro	Monavale	
1. Number of participants		30 (25.9)	50 (43.1)	36 (31.0)	116
2. Gender	Male	16 (53.3)	14 (28.0)	20 (55.6)	50
	Female	14 (46.7)	36 (72.0)	16 (44.4)	66
3. Age class	18 - 24 years	5 (16.7)	6 (12.0)	5 (13.8)	16
	25 - 34 years	7 (23.3)	19 (38.0)	9 (25.0)	35
	35 - 44 years	9 (30.0)	11 (22.0)	11 (30.6)	31
	45^{+} years	9 (30.0)	14 (28.0)	11 (30.6)	34
4. Educational level	Primary	2 (6.7)	8 (16.0)	5 (13.9)	15
	Secondary	8 (26.7)	30 (60.0)	15 (41.7)	53
	Tertiary	20 (66.6)	12 (24.0)	16 (44.4)	48

4.1.1 DISTRIBUTION OF RESPONDENTS BY SUBURB

Budiriro's greater percentage of respondents (43.1%) probably reflects both the area's higher population density and the fact that are more individual living there than there are in low

densities. High- density suburbs tend to have more residents per unit area, which increase sampling accessibility. Conversely, Borrowdale (25.9%) has a lower population density and potentially lower accessibility or interest in such studies.

4.1.2 GENDER DISTRIBUTION

The dominance of female respondents in Budiriro (72.0%) may indicate women's greater involvement in domestic and community-level environmental issues, possibly due to their traditional roles in household water management and urban agriculture. In contrast, the higher male participation in Borrowdale and Monavale could reflect differences in who engages with civic or environmental issues in these more affluent suburbs or simply a gender imbalance in respondent variability.

4.1.3 DISTRIBUTION OF AGES

While the majority of respondents in Borrowdale were 35 years of age or older (60%) and Monavale were 35 years of age or older (61.2%), the majority of respondents in Budiriro were 25-34 years of age and older (38.0%). Budiriro's younger demographic may be linked to population structure trends in high -density areas, where young families and working-class residents are more prevalent. The older age distribution in Borrowdale and Monavale suggest a more established, possibly wealthier and longer-term resident population. Older age may also correlate with greater experience and potentially higher environmental awareness, although that also depends on education and exposure.

4.1.4 EDUCATION LEVEL

Budiriro respondents had attained secondary level education (60.0%) whereas Borrowdale respondents attained Tertiary level (66.6%) and Monavale respondents had mixed secondary and tertiary each at (44.4%). The lower education attainment in Budiriro could contribute to lower awareness and engagement in wetland conservation, as education often correlates with environmental literacy. In contrast, higher levels of tertiary in Borrowdale and Monavale suggest better access to environmental information, possibly enhancing awareness of wetland policies and threats.

4.2 THREATS TO WETLANDS IN HARARE

Respondents from Budiriro (5%) argued that the wetland was threatened by industry and (20%) of the respondents indicated that Budiriro wetland is also threatened by residential buildings. The respondents (21%) from Monavale suburb said that, the wetland was mostly threatened by urban agriculture and was neither threatened by road development, industry nor commercial buildings. On the other hand, respondents (14%) from Borrowdale suburb said that the wetland was mostly threatened by urban agriculture. Overall, the major developmental activities threatening wetlands in Harare were urban agriculture and residential buildings. Only (10%) of the respondents were from Borrowdale argued that the development activities taking place on Borrowdale wetland were residential buildings. Some of the respondents (3%) said that Borrowdale wetland was being affected by construction of roads and commercial buildings. One respondent said:

Since 2003, the Borrowdale wetland was very fertile and they were no construction activities that were taking place. From 2019 up to until now, people are constructing buildings in wetland and the illegal sand poachers have constructed their squatters within the wetland. The Government officials sold the other part of Borrowdale wetland to the Chinese and that part is well fenced and this had reduced the size of the wetland, (Borrowdale respondent 3).

These individual responses are relevant to the whole study, since it gives first hand, lived experience of wetland transformation in Borrowdale thereby highlighting historical contexts (since 2003) showing a significant shift from undisturbed to degraded conditions. It is also supporting GIS findings that showed a 54.1 % reduction in Borrowdale wetland area from 2013 to 2023. The respondent's account supports the spatial evidence with specific socio-political drivers.

Some of the respondents of Monavale (21%) argued that they rely much on urban agriculture. One of the responded said:

We don't go to work since we don't have enough money for food and therefore, we view this wetland as means of our survival through urban agriculture. We need food and money to pay school fees for our children therefore some our crop produces we sell them. (Monavale respondent 4)

This response from Monavale respondent is highly relevant and insightful and it directly supports the objectives of the whole study by highlighting the socioeconomic drivers of wetland degradation. The respondent acknowledges deliberately encroachment into the wetland, but frames it as a livelihood necessity, nor mere ignorance or disregard. It supports quantitative findings of this study that urban agriculture is present in Monavale (21% of respondents agreed), this validates GIS findings that show increased agricultural land cover between 2013 and 2023. The response is also touching on critical socio-economic constraints to wetland management such as poverty, unemployment and lack of alternative livelihoods. These factors explain why regulatory or conservation policies may fail because people prioritize survival over conservation. The respondent reflects a segment of Monavale's population that, despite being in a medium density area, is economically vulnerable. This highlights the nuanced reality that even within more affluent suburbs, pockets of poverty drive wetland use of survival.

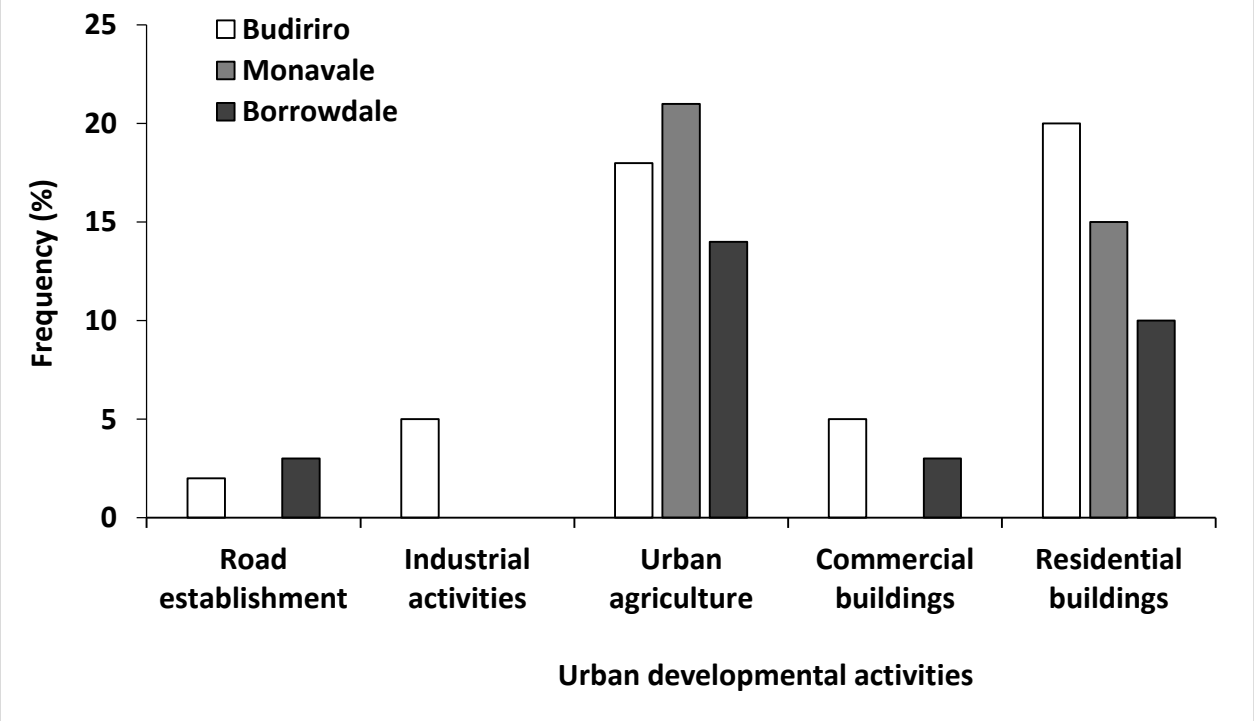

Figure 4. 1: Demonstrates the perceived risks to the research area's wetlands.

4.3 CHALLENGES TO WETLAND MANAGEMENT IN HARARE

The major challenges perceived to hinder successful management of wetlands in study sites are presented in Figure 4.2. The primary issues in Borrowdale were lack of resources (53.3%), and wetland degradation (50.0%), whereas in Budiriro, it was lack of resources (62.0%), and competing land-use (60.0%). On the other hand, in Monavale, it was opined that wetland management was mostly affected by absence of resources, and inadequate application of the law, both attaining a value of 55.6% respectively. Overall, the three major challenges to managing wetlands were lack of resources, competing land-use, and, weak legislation and enforcement.

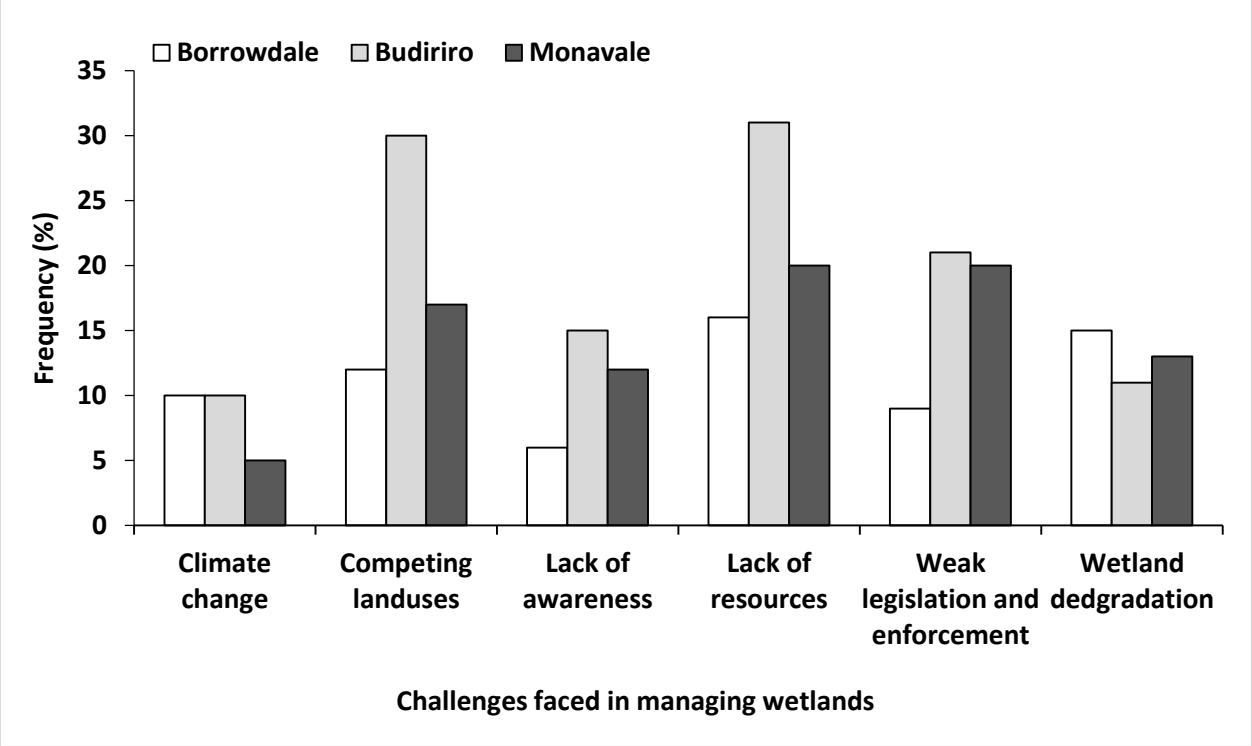

Figure 4. 2: Challenges faced in wetland management

4.4 FACTORS INFLUENCING AWARENESS ON WETLAND CONSERVATION LAWS AND POLICIES

The factors influencing knowledge on wetland conservation are shown in **Table 4.2**. A total of 74 (63.8 %) participants were aware of wetland conservation. Males were more aware of wetland conservation than females in Borrowdale (60.0 %) and Monavale (51.6 %) and Budiriro had

(39.4%). Participants aged between 35 - 44 years were more aware of wetland conservation in Budiriro (48.5 %), whereas in Borrowdale (50.0 %) and Monavale (35.5 %), it was those aged over 45 years. Respondents who attained tertiary level education (60.0 %) were more aware of wetland conservation in Borrowdale, whereas in Budiriro it was those that attained secondary level education (48.5 %). However, in Monavale both secondary level (41.9 %) and tertiary level (41.9 %) education achievers were equally aware of wetland conservation. Overall, residential suburb ($X^2 = 29.8$; $p < 0.001$), age ($X^2 = 13.98$; $p < 0.05$), and educational level ($X^2 = 0.527$; $p < 0.05$) were significantly associated with awareness on wetland conservation. However, gender did not influence awareness on wetland conservation ($p > 0.05$).

Some of the respondents (60% of the male respondents in Borrowdale) were highly aware about the the laws and policies that governs wetlands. This was influenced by the education status, some of them went to school and reached tertiary level. Most of these respondents said:

We are highly aware about the laws and policies that govens wetlands but we seem to ignore this because the government officials are cruel to us, they are failing to manage this wetland. They are leaving the sand poarchers to continue to abstract soil from the wetland and they are aslo giving the Chinese stands to constuct within the wetland at the expense of the Borrowdale residents. We are the ones who suffers the repurcassions, as you can see, we no longer have the municipal water from the City Council and most of our boreholes are drying up. Most of the construction companies are coming to Borrowdale to dump their waste, this has affected our agricultural activities because we no longer have enough space to grow our crops. The government is very selfish, they are leaving us dying poor. (Borrowdale respondent 8)

The Budiriro respondents (18.2%) had attended primary level only and they were not aware about the regulations that governs wetlands. One of the respondents argued that:

Some of us we are not aware about the laws and policies that governs wetlands. We don't have the knowledge and we did not go school. The environmental authorities are failing to give us more knowledge about the imporatnces of wetlands. And we facing challenges of mosquito bites and floods. In 2020, there was a family who had property which was washed away by floods and they failed to rescue their children. (Budiriro respondent 6).

Table 4. 2: Sociodemographic factors influencing awareness on wetland conservation (*Chi-square test*)

Variable	Category	Aware of wetlands	Residential area			X^2 test value	*p – value*
			Borrowdale Freq. (%)	Budiriro Freq. (%)	Monavale Freq. (%)		
1. Participants			10 (13.5)	33 (44.6)	31 (41.9)	29.785	**0.000***
2. Gender	Male	35 (47.3)	6 (60.0)	13 (39.4)	16 (51.6)	2.389	0.303
	Female	39 (52.7)	4 (40.0)	20 (60.6)	15 (48.4)		
3. Age	18-24 years	16 (21.6)	1 (10.0)	1 (3.0)	2(6.5)	13.979	**0.030***
	25-34 years	28 (37.9)	1 (10.0)	5 (15.2)	8 (25.8)		
	35-44 years	16 (21.6)	3 (30.0)	16 (48.5)	10 (32.2)		
	45+ years	14 (18.9)	5 (50.0)	11 (33.3)	11 (35.5)		
4. Education level	Primary	26 (35.1)	1(10.0)	6 (18.2)	5 (16.2)	0.527	**0.011***
	Secondary	26 (35.1)	3 (30.0)	16 (48.5)	13 (41.9)		
	Tertiary	22 (29.8)	6 (60.0)	11 (33.3)	13 (41.9)		

Bold figures indicate omnibus tests of model coefficients that are significantly different (p<0.05).

As shown in Table 3, participants from Budiriro (OR = 0.082; p = 0.002; 95% CI = 0.017 and 0.401), Monavale (OR = 0.031; p = 0.000; 95% CI = 0.005 and 0.179) had been significantly aware of wetland conservation. Also, participants aged between 35 and 44 years were also significantly aware of wetland conservation laws and policies (OR = 0.077; p = 0.007; 95% CI = 0.012 and 0.503). In addition, those who attained secondary level educational (OR = 0.793; p = 0.026; 95% CI = 0.065 and 4.162), and tertiary level educational (OR = 0.618; p = 0.001; 95% CI = 0.074 and 9.705) were significantly aware of wetland conservation.

Table 4. 3: Influencers of awareness on wetlands conservation laws and policies (*Multinomial logistic regression*)

Influencing variable	Category	Coefficient	Wald	Sig.	Odds ratio	95% CI	
						Lower	Upper
Location							
	Borrowdale	-1.472	7.045	**0.070***	0.052	0.011	0.390
	Budiriro	-2.495	9.560	**0.002***	0.082	0.017	0.401
	Monavale	-3.476	15.085	**0.000***	0.031	0.005	0.179
Age	18 - 24 years	-1.219	1.948	0.163	0.296	0.053	1.637
	25 - 34 years	-.076	0.010	0.920	0.927	0.211	4.065
	35 - 44 years	-2.559	7.187	**0.007***	0.077	0.012	0.503
Educational level	Primary	-2.502	2.803	0.821	0.054	0.013	0.352
	Secondary	-0.319	1.635	**0.026***	0.793	0.065	4.162
	Tertiary	-0.012	0.053	**0.001***	0.618	0.074	9.705

Bold figures indicate omnibus tests of model coefficients that are significantly different (p<0.05).

4.5 SPATIAL AND TEMPORAL SHIFTS IN HARARE'S WETLAND SIZE BETWEEN 2013 AND 2023

Temporal and spatial changes in Harare's wetland size between 2013 and 2023 in Harare are shown in **Figure 4.5 to 4.7**. In Borrowdale, built up area was mostly focused on the suburb's northern, eastern and southern regions, with the wetland covering 189.2 ha **(Figure 4.4a)**. However, by 2023, the built-up area had also covered the central parts of Borrowdale, thus decreasing wetland size by approximately 102.3 ha. In addition, some few patches of agricultural land had been established **(Figure 4.4b).** Overall, the wetland had decreased by 54.1%.

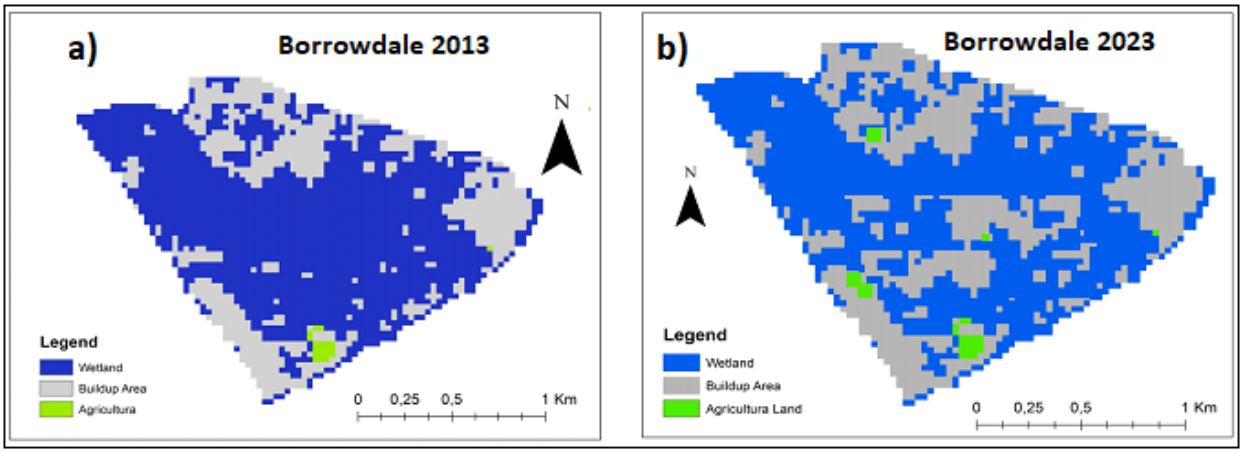

Figure 4. 3: Wetland size changes in Borrowdale for the years 2013 and 2023

In Budiriro, in the year 2013, the wetland covered 238.1 ha and was mainly dominant in the eastern part whereas agricultural land was dominant in the western part of the suburb **(Fig. 4.5a)**. However, by the year 2023, residential area and urban crop cultivation had covered 168.3 ha with built up area mostly in the eastern part **(Fig. 4.5b)**. Overall, wetland size had significantly declined by 70%.

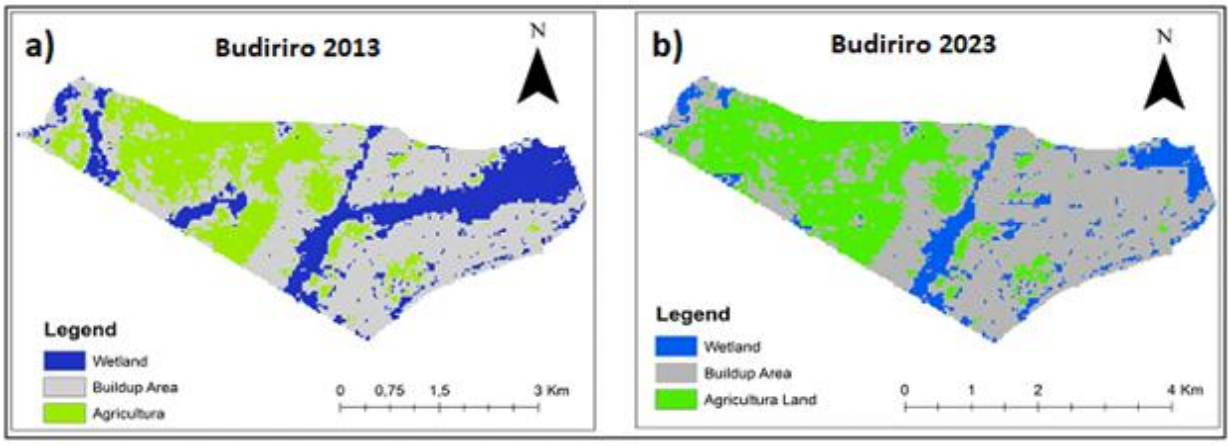

Figure 4. 4: Wetland size changes in Budiriro for the years 2013 and 2023

In 2013, the Monavale wetland covered approximately 305.3 ha with built up area mostly in the western part **(Figure 4.6a)**. By the year 2023, agricultural land and built- up area had significantly increased by 65.8 ha, covering most of the western and eastern parts **(Figure 4.6b)**. This resulted in a decrease in wetland size by 21.5%.

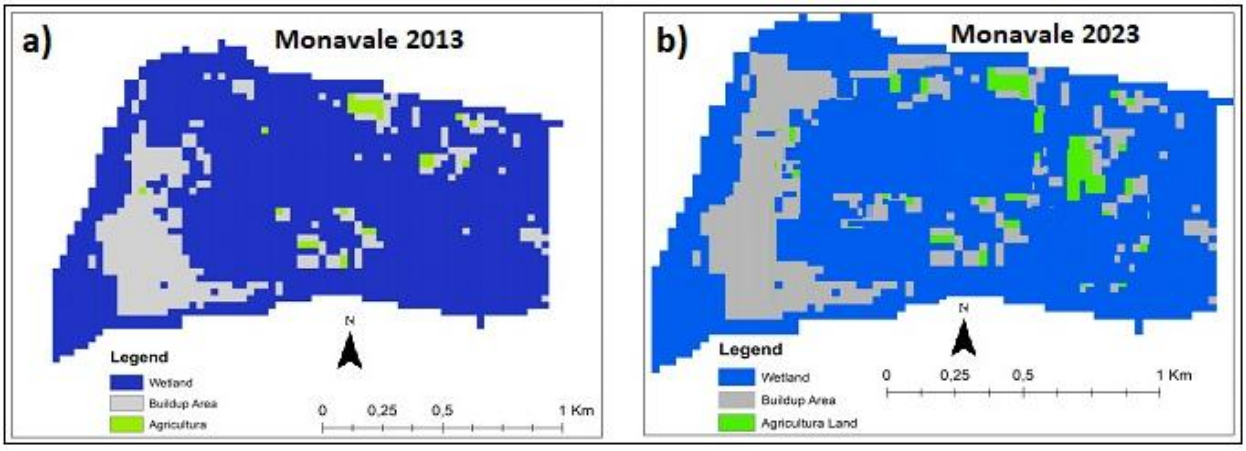

Figure 4. 5: Wetland size changes in Monavale for the years 2013 and 2023

The results from table **Table 4.4** show a clear trend of wetland degradation across all three suburbs. Budiriro experienced the highest percentage loss (70%), followed by Borrowdale (54.1%), while Monavale experienced the least loss of (21.5%). These differences suggest that wetland degradation is more pronounced in high-density areas due to population pressure and informal development whereas medium density areas like Monavale may benefit from more community involvement and regulatory control.

Table 4. 4: Changes in wetlands sizes

Wetland Site	**Wetland Area (2013)**	**Wetland Area (2023)**	**Area Lost (ha)**	**% Decline**	**Dominant Land Use encroachment**
Borrowdale	**189.2 ha**	**86.9 ha**	**102.3 ha**	**54.1 %**	Residential (N, E,S, Center) some agriculture
Budiriro	**238.1 ha**	**71.4 ha**	**166.7 ha**	**70.0 %**	Residential & urban farming (East)
Monavale	**305.3 ha**	**239.5 ha**	**65.8 ha**	**21.5%**	Agriculture & built-up (West &East)

CHAPTER 5: DISCUSSION

5.0 INTRODUCTION

5.1 THREATS TO WETLANDS IN HARARE

The results from chapter 4, **figure 4.1** indicated that respondents from the study sites Budiriro, Borrowdale and Monavale, supported the view that urban agriculture is a threat to wetland management. Despite the fact that Monavale is a designated Ramsar site, urban cultivation is prominent due to nearby residential areas with limited space for food production. In Budiriro, urban agriculture is widely practiced as a livelihood strategy in this high-density area. However, residents may see it as a necessity rather than a threat, thus underreporting its ecological impact. Borrowdale a low density and affluent area revealed lower prevalence of urban farming due to formal land tenure, higher income levels and stricter enforcement and respondents likely do not view farming as a key driver of wetland degradation. These results are supported by a study conducted by Dalu et al. (2013), highlighted that informal cultivation in wetlands in Chitungwiza and Harare disrupts hydrology and increases pollution from fertilizers and pesticides. A study conducted by Drechsel *et* al. (2006) echoes these concerns in other African cities. However, contrasting studies carried by UN-Habitat (2014) suggest that with proper regulation, urban farming can be integrated into sustainable land -use planning. The low perception in Borrowdale may reflect both reduced farming activity and higher environmental literacy, while the higher figures in Monavale and Budiriro underscore the need for better policy enforcement and education on sustainable cultivation.

Apart from urban agriculture on wetlands, residential buildings also contributed to a massive impact on Borrowdale, Budiriro and Monavale wetland. In Budiriro, recognition of residential development as a threat appears strongest, likely because informal and high-density housing is more visible, and encroachment can directly lead to flooding and drainage problems. In contrast, awareness in Monavale is more moderate. As a protected Ramsar site, some residents may believe legal safeguards are sufficient, shifting their concern toward other threats such as agricultural expansion. Borrowdale shows the least concern, possibly because residential development there is largely formal and regulated, creating perception that it poses minimal risk to wetland integrity. These variations suggest that perceptions of threat are shaped less by actual

legal or ecological status and more by nature and visibility of development activities within each area. The inverse relationship between wetland degradation and awareness in affluent areas like Borrowdale highlights a policy and communication gap. People may not associate high-end housing development with environmental harm, even when its significant. This contrast sharply with satellite and land use data indicating significant wetland encroachment across all three suburbs. Similar studies conducted by Murwira & Masocha (2006) and Chogugudza (2017), confirmed that residential expansion is a primary driver of wetland loss in Harare, particularly in high- density suburb such as Buririro. Their findings highlight the rapid conversion of wetland areas into housing developments, often driven by population growth and informal urban planning. On the other hand, research by Xu et al., (2022) and Brander et al., (2013) reveals similar results. For instance, Xu et al., (2022) found that the growth of residential infrastructure and urban sprawl were the main causes of wetland degradation, particularly in peri-urban areas, in their study of land use change in China urbanizing regions. This closely mirrors the patterns observed in Harare's expanding suburbs. According to a study by Brander et al. (2013), one of the widely acknowledged causes of the loss in wetland ecosystems is the development of residential land use. However, as observed by Kareem *et* al. (2016), communities often underestimate the impact of residential development, especially when it is formal or perceived as beneficial. This disconnects suggest a need for enhanced public education, integrated urban planning and stronger legal enforcement to ensure wetlands are not gradually lost to housing.

The study revealed minimal concern among residents that roads, industries or commercial buildings pose a threat to wetlands. Borrowdale respondents cited 3% for both roads and commercial buildings, while Monavale recorded 0% across all three categories. Budiriro showed slightly higher concern, with 5% acknowledging threats from both commercial buildings and industry. Budiriro has the highest perceived threat (5%) from both industries and commercial buildings, this might reflect presence of informal industrial activity or roadside commerce and less regulated land use, leading to more visible environmental degradation. These perceptions contrast with findings by Muguti *et* al. (2015) and Chogugudza (2017), who documented the indirect yet significant impacts of urban infrastructure on wetland hydrology and integrity in Harare. Mitsch & Gosselink (2015) and Davison (2014) similarly emphasize the role of infrastructure in global wetland degradation. The gap between local awareness and actual impact

indicates a need for public education and the integration of ecological considerations into infrastructure planning

5.2 CHALLENGES TO WETLAND MANAGEMENT IN HARARE

The findings and results from chapter 4, **figure 4.2** revealed that 33% of Borrowdale respondents identified climate change as a challenge to wetland management, compared to 20% in Budiriro and only 13% in Monavale. This suggest that climate-related concerns are more prominent among better-educated or environmentally informed populations. These findings align with studies by Mazvimavi & Msadala (2016) and Erwin (2009), who emphasized that changes in rainfall patterns and temperature can significantly impact wetland hydrology and function. According to study by Hartig et al., (1997), wetlands are being degraded as a result of increased agricultural activity encroachment due to climate change. However, consistent with Davison (2014) and Chiwaura &Muzondo (2021), might not see climate change as a direct threat in comparison to more pressing issues like shifting land uses, farming, and growth of informal settlements, this highlights a gap in public understanding of the long-term ecological risks posed by climate variability.

The study found that land-use competition is perceived as significant challenge to wetland management, particularly in high density suburbs such as Budiriro (60%), followed by Monavale (47%) and Borrowdale (40%). Budiriro is a high -density area under pressure for residential and urban farming land. The high percentage reflects intense competition for land, driven by rapid population growth and informal settlement expansion. Monavale (47%) is a medium density, this site is ecologically significant (a Ramsar Site), but adjacent urban growth and farming still pose threats. Borrowdale (40%) is a low -density suburb with more formal planning, but ongoing construction and real estate development still challenge conservation efforts. This data competing land demands, especially from residential expansion and informal agriculture are a major factor undermining wetland management, particularly in densely and economically disadvantaged areas.

Studies carried out by Chiwaura & Muzondo (2021), Zingoni *et* al. (2005), who observed that urban expansion and informal cultivation are major pressure on Harare's wetlands. According to

Ramsar (2018) and Davison (2014), observed that the change in land use is the primary global driver of wetland degradation. However, contrasting evidence from the UK (Everard *et*.al, 2012) and China shows that land competition can be effectively managed through zoning and participatory governance strategies that are largely absent in Zimbabwe's current wetland policy framework.

Challenges to wetland management were being caused by lack of awareness. Respondents from Monavale (6%), Budiriro (15%) and Borrowdale (12%) argued that the challenges to wetland management was contributed by lack of knowledge. The findings from this study confirm that lack of awareness is a major impediment to wetland management, particularly in areas like Budiriro where knowledge of conservation laws and ecological value is low. One of the respondents in Budiriro argued that they lack information about the importances of wetland and how to they act as climate regulators. This aligns with the studies by Marambanyika & Beckedahl (2016) and Musasa *et* al. (2018), who emphasized that uniformed communities often misuse wetland resources. Similarly, Ramsar (2018) identifies public awareness as a global weak link in wetland policy implementation. In contrast, Monavale shows how awareness, driven by civil society actors, leads to better protection supporting observations made by Dube & Chakwizira (2013) and Everard *et* al. (2012). These comparative insights highlight the critical role of education and stakeholder engagement in reversing degradation.

Some respondents supported the view that the challenges to wetland management was caused by lack of resources. Both Monavale (20%) of respondents and Borrowdale respondents (16%) agreed with the fact that the challenges to wetland management is exacerbated by lack of resources such as inadequate infrastructure and financial constraints. For example, the lack of up-to-date topographical and digital maps hampers the ability of organizations like the Harare Wetlands Trust to monitor changes in wetlands areas accurately. Poverty is forcing people to invade wetlands, for instance (31%) of the respondents in Budiriro argued they do not have the capacity to purchase better facilities because they are poor and they are succumbed by poor standards of living. Therefore, this study's findings are consistent with other research in Zimbabwe and Sub-Saharan Africa, which has identified limited institutional capacity and resource shortages as major obstacles to effective wetland management (Mapira, 2011; Chiwaura

& Muzondo, 2021; Rebelo *et* al., 2009). Harare City Council often lack the manpower, vehicles and technical tools to monitor and prevent illegal developments, particularly in rapidly urbanizing areas like Budiriro. Internationally, the Ramsar Convention (2018) echoes this concern, highlighting resource scarcity as a global barrier, particularly in the Global South. In contrast, studies from resource-rich contexts such as the U.S. (Mitsch & Gosselink, 2015) and China's Sponge Cities initiative demonstrate that adequate funding and infrastructure significantly improve wetland conservation outcomes.

The challenges to wetland management are as a result of weak legislation and enforcement in Zimbabwe. Interestingly, it should be noted that 21% of the respondents in Budiriro, was unaware of any wetlands-related future plans. Approximately 20% of Monavale respondents stated that they were unaware of any laws governing wetlands, which may be due to problems with enforcement.

Respondents from Borrowdale (9%) agreed that wetlands are deteriorating because of poor enforcement. A similar study which was conducted by Mutisi (2014), indicated that at the moment, municipal officials in Harare are not very aware of wetlands and there is no enforcement. Weak links between government ministries, the City of Harare, EMA, and the Department of the Physical Planning that have not shared responsibility regarding wetland management are the cause of the low knowledge and lack of enforcement. Wetlands policy is unclear in this regard, and if wetlands are to be maintained, environmental policies may need to be considered. In contrast, Chinas's "Sponge Cities" Program (2015-present) illustrated urban planning initiative that integrates wetlands into city infrastructure to reduce flooding while Harare encroaches on wetlands, cities like Wuhan are integrating and protecting them.

Wetland degradation poses significant challenges to wetland management in Harare, Zimbabwe. Borrowdale (15%) of the respondents agreed with the fact that Borrowdale was the worst wetland experiencing a significant shift in terms of wetland degradation as compared to other wetlands like Monavale which had (13%) and Budiriro (11%). In Harare, urbanization, agriculture, agricultural expansion and inadequate regulatory frameworks have been identified as primary drivers of wetland degradation. Consistent with studies by Chiwaura &Muzondo (2021) and Ramsar (2018), this research found that degradation itself poses a major challenge to wetland management. In areas like Budiriro, the loss of ecological features and visible wetland

boundaries has made enforcement difficult, while degraded spaces are increasing viewed as suitable for settlement or agriculture. Zingoni *et* al. (2005) also noted that as wetlands lose their environmental function, public interest in protecting them declines. In contrast, studies from developed countries (Mitsch & Gosselink, 2015; Everard *et* al.,2012) showed that strong institutional frameworks can enable restoration even after significant degradation, highlighting the importance of policy and resource support in reversing decline.

5.3: SOCIODEMOGRAPHIC FACTORS INFLUENCING AWARENESS ON WETLAND CONSERVATION

Findings from Chapter 4, **Table 4.2** indicate that males in Borrowdale (60%) demonstrated higher awareness of wetland conservation laws compared to Monavale (51.6%) and Budiriro (39.4%) due to socioeconomic and infrastructural limitations. This might be also linked to societal roles, access to education or involvement in community decision- making. In both suburbs few females were aware, this can be influenced by gender stereotypes whereby women are limited to education. Analysis of awareness across age groups showed variation by location. The highest level of awareness in Budiriro was found among respondents aged 35-44 years (48.5%) whereas in Borrowdale and Monavale, those aged 45+ had slightly higher awareness levels (50% and 35.5% respectively). The 35-44 age group in Budiriro may be more active in community development, parenting or housing cooperatives, making them more likely to engage with local governance and environmental information. In Borrowdale and Monavale, older individuals (45+) may have higher education levels, own property or be long-term residents concerned with preserving their environment. These findings suggest that age-based engagement strategies must modified in light of the local environment.

At Borrowdale, higher education appears to strongly influence awareness of wetland conservation laws, with 60% of tertiary-educated respondents demonstrating higher understanding. This is might be as a result of access to information. Residents with tertiary education may have better access to environmental policies through academic, digital or professional channels. In contrast, in Budiriro, those with only secondary education showed the highest awareness (48.5%), likely due to daily experiences with wetland encroachment and localized community initiatives. Monavale exhibited a balanced pattern, with both secondary and tertiary respondents equally aware (41.9%), suggesting that in certain contexts, environmental experiences and local activism may offset educational differences. Monavale may have strong

grassroots conservation networks for example Monavale Vlei Conservation Society (COSMO) Trust), that disseminate information widely regardless of education. Overall, **Table 4.2**, indicated that residential suburb (X^2 = 29.8; p < 0.001), age (X^2 = 13.98; p < 0.05), and educational level (X^2 = 0.527; p < 0.05) were significantly associated with awareness on wetland conservation. However, gender did not influence awareness on wetland conservation (p > 0.05).

5.4 TEMPORAL AND SPATIAL CHANGES IN WETLAND SIZE FROM 2013 AND 2023 IN HARARE

5.4.1 Overall Trend Analysis

All three wetlands experienced significant reduction in wetland cover between 2013 and 2023. Built-up area is the primary driver of wetland loss across all sites. A secondary pressure is the expansion of urban agriculture, especially in Budiriro and Monavale. Between 2013 and 2023, all three wetlands under study experienced a marked decline in wetland size due to encroachment from built-up areas and agricultural expansion. Budiriro recorded the most significant loss (70%), driven primarily by unregulated residential expansion and agriculture, particularly in the eastern part. Borrowdale experienced a 54.1% decline, with development shifting from the periphery to the wetland core, indicating structured urban expansion. Monavale had the least reduction in wetland size (21.5%), suggesting the effectiveness of local conservation efforts and its Ramsar designation. These trends underscore the need for localized wetland protection strategies, particularly in vulnerable high-density areas like Budiriro. The findings in the study align with Musasa et al. (2018) and Rebele et al. (2009), observed a spatial shift on urban land uses encroaching on wetland areas in Harare and other African cities. The severe loss in Budiriro mirrors trends in informal settlement zones across Sub-Saharan Africa. According to Davison (2014), global wetland loss estimated at 64-71% since 1900, similarly the study's conclusions show the range of wetland loss (21-70%) between 2013 and 2023 in Budiriro, Borrowdale and Monavale thereby aligning with global degradation rates. The study carried by Gumbricht *et* al. (2017) emphasized on using spatial data to analyze wetland dynamics across time which is similar to this study which validates GIS-based approach for monitoring Harare wetlands. In contrast, studies conducted by Mitsch & Gosselink (2015), illustrated how urban design and

policy can reverse or stabilize wetland degradation, highlighting key gaps in Zimbabwe's urban environmental management.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.0 INTRODUCTION

This chapter offers recommendations based on findings from Chapter 4, focusing on the implications for wetland management in Harare, particularly in Borrowdale, Budiriro and Monavale wetland. The recommendations aim to address the significant changes in wetland sizes, the danger that urbanization poses as well as the challenges identified on managing these vital ecosystems.

6.1 CONCLUSIONS

The study revealed that wetland ecosystems in urban Harare face multifaceted and interlinked threats that are deeply rooted in human activity, institutional, weaknesses and socio-economic pressures. A nuanced understanding of how land-use practices differ across residential suburbs provides critical insight into the nature and pace of wetland degradation.

First, land-use intensity and residential classification strongly influence the scale and type of pressure on wetlands. High-density areas such as Budiriro experience more rapid and unregulated transformation of wetland areas due to population pressure, informal settlements, and subsistence urban agriculture. In contrast, low-density areas like Borrowdale face threats from elite land acquisition and infrastructural developments, often under formal planning frameworks yet still resulting in significant ecological loss.

Second, socio-demographic characteristics including age, gender and education emerge as significant determinants of awareness and attitudes toward wetland conservation. Higher levels of education and older age groups generally correlate with increased knowledge of environmental policies and a stronger sense of stewardship. This has implications for designing awareness campaigns that are tailored to specific community profiles.

Third, the analysis of spatial and temporal wetland changes between 2013 and 2023 underscores the urgent need for more effective land-use planning and enforcement. The continued reduction in wetland cover, even in areas designated for protection, highlights policy implementation gaps, institutional overlaps, and the challenges posed by urban expansion.

6.2 RECOMMENDATIONS

There is need for Government and environmental regulatory authorities to introduce wetland restoration projects especially in Budiriro to reverse degradation using vetiver grass, native species and controlled rewatering. China has succeeded in wetland restoration in the Yangtze Basin included community-driven projects that restored over 300 000 ha of wetland. Therefore Zimbabwe, should follow suit the methods that were used by China to restore the degraded wetlands. The study recommends that local authorities should collaborate closely with the identified key institutions, environmental advocacy organizations and community members to promote effective wetland management. According to Emerton *et* al., (1999), in Uganda, the National Environment Management Authority (NEMA) successfully mapped and gazette wetlands, significantly reducing illegal encroachment. This can also be implemented in wetlands in Zimbabwe though EMA gazette wetlands in 2022, there is in need for enforcement to protect wetlands. It is crucial to develop and enforce stricter regulations that protect wetlands from encroachment and agricultural expansion. Policymakers should prioritize wetland conservation in urban planning frameworks. Urban planners should incorporate wetland conservation strategies into development plans. This includes creating buffer zones and promoting sustainable land use practices that minimize impacts on wetlands.

The Environmental Management Agency (EMA) and the City of Harare should enhance public awareness across all suburbs. This awareness campaign could be implemented through using electronic platforms, television, newspapers and informational fliers aimed at educating citizens about the importance and protection of wetlands. Target demographics with lower awareness, such as younger individuals and those with lower education attainment is very essential. Additionally, accurate land use planning should be supported by the mapping of wetland areas using Geographical information Systems (GIS) and remote sensing technologies.

6.3 FURTHER RESEARCH

Recommending to conduct longitudinal studies to monitor wetland changes over time, allowing for deeper understanding of the dynamics between developments and wetland health. To conduct comparative research on wetlands in Harare or other regions, focusing on identifying successful management strategies that could be adapted to the Budiriro context, several key suggestions and case studies can be considered. According to UN Development Program Report (2020), it

identified 30 wetlands in Harare under threat from illegal settlements, emphasizing the need for coordinated efforts to protect these areas. It provided a framework for understanding the socio-economic pressures that lead to wetland degradation and suggested strategies for sustainable management. Monavale Vlei, an urban wetland has seen successful community-led conservation efforts, including educational programs and restoration projects. The collaboration between local communities and municipal authorities serves as a model for similar initiatives in Budiriro.

6.4 CONCLUSIONS

In conclusion, the GIS results show that over a ten-year period (2013 to 2023), there has been a 70% loss in the size of wetlands in Budiriro, 54,1 % loss in Borrowdale, 21.5% loss in Monavale. Furthermore, wetlands in Harare, especially those in Budiriro, Monavale and Borrowdale, are experiencing degradation and wetland size loss. As the study shows, this is caused by both overt activities like urban agriculture and settlement growth as well as more covert forces like poor institutional coordination and insufficient policy enforcement.

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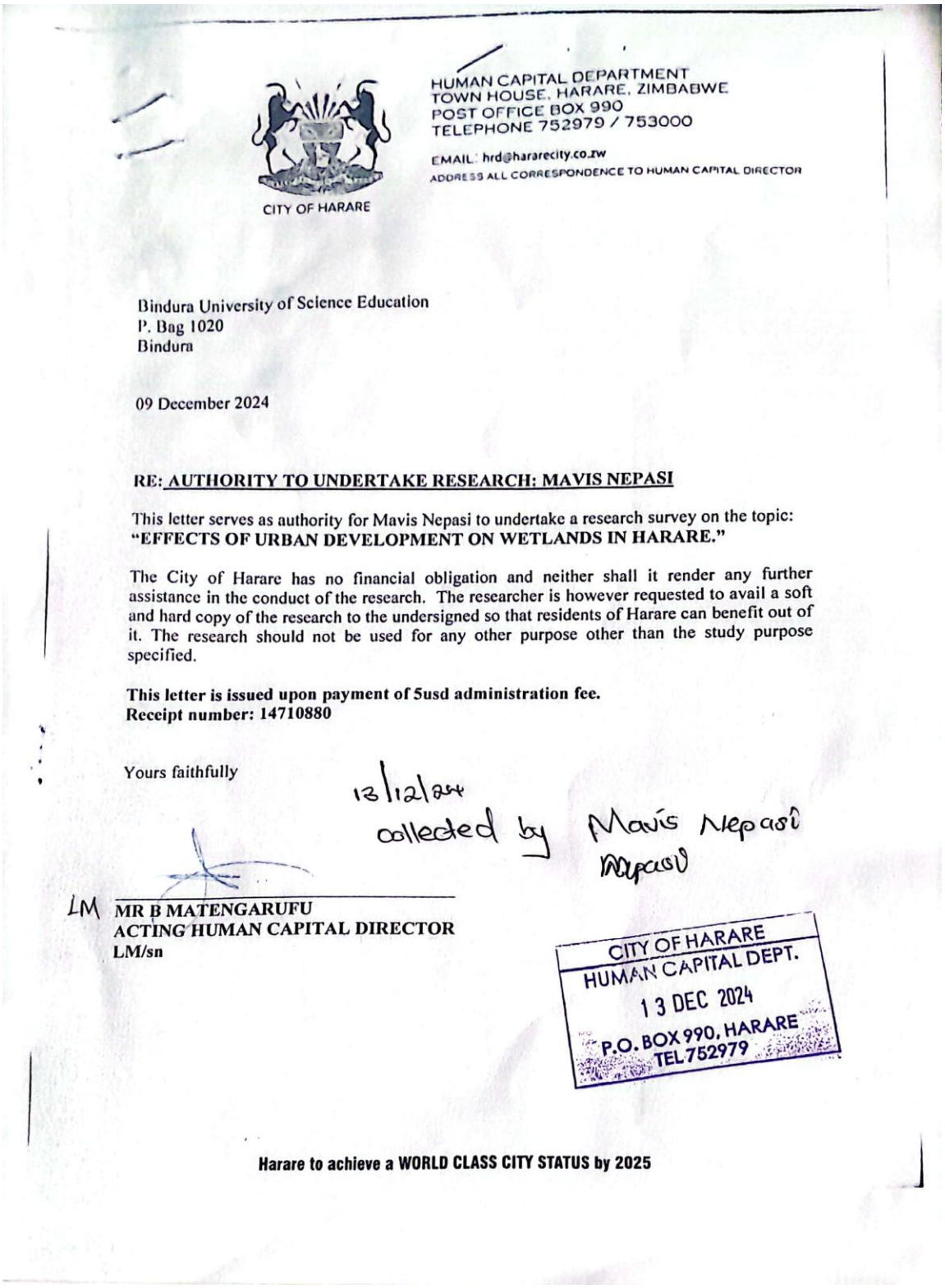
LIST OF APPENDICES

APPENDIX A: Clearance letter by the City of Harare to conduct research



CITY OF HARARE

HUMAN CAPITAL DEPARTMENT
TOWN HOUSE, HARARE, ZIMBABWE
POST OFFICE BOX 990
TELEPHONE 752979 / 753000

EMAIL: hrd@hararecity.co.zw
ADDRESS ALL CORRESPONDENCE TO HUMAN CAPITAL DIRECTOR

Bindura University of Science Education
P. Bag 1020
Bindura

09 December 2024

RE: AUTHORITY TO UNDERTAKE RESEARCH: MAVIS NEPASI

This letter serves as authority for Mavis Nepasi to undertake a research survey on the topic: **"EFFECTS OF URBAN DEVELOPMENT ON WETLANDS IN HARARE."**

The City of Harare has no financial obligation and neither shall it render any further assistance in the conduct of the research. The researcher is however requested to avail a soft and hard copy of the research to the undersigned so that residents of Harare can benefit out of it. The research should not be used for any other purpose other than the study purpose specified.

This letter is issued upon payment of 5usd administration fee.
Receipt number: 14710880

Yours faithfully

13/12/24
collected by Mavis Nepasi
Nepasi

LM **MR B MATENGARUFU**
ACTING HUMAN CAPITAL DIRECTOR
LM/sn

CITY OF HARARE
HUMAN CAPITAL DEPT.
13 DEC 2024
P.O. BOX 990, HARARE
TEL 752979

Harare to achieve a WORLD CLASS CITY STATUS by 2025

APPENDIX B: Clearance letter by Bindura University of Science and Education to conduct research

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE
DEPARTMENT OF NATURAL RESOURCES

P Bag 1020
BINDURA, Zimbabwe
Tel 263 - 71 - 6505
Cell 0772236104
Email
wmhlanga@buse.ac.zw

BINDURA UNIVERSITY OF SCIENCE EDUCATION

27 November 2024

Dear Sir/Madam

REQUEST FOR PERMISSION TO COLLECT DATA FOR ACADEMIC RESEARCH PROJECT

PROJECT TITLE: ***EFFECTS OF URBAN DEVELOPMENTS ON URBAN WETLANDS IN HARARE***

ACADEMIC SUPERVISORS: MS C. MASONA

This letter serves to inform you that **Nepasi Mavis , Registration Number (B213649B)** is a fourth year student at Bindura University of Science Education, in the Department of Natural Resources. During her fourth year of study she is supposed to do a research project in her area of specialisation.

Please assist in any possible way. Data collected will be used for academic purposes only and will not be published without your prior consent.

Thank you for your assistance.

Yours faithfully

Mr W. Mhlanga
DEPARTMENT OF NATURAL RESOURCES

APPENDIX C: Questionnaire for residents

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

Survey questionnaire Title: **The effects of urban developments on wetlands, in Harare**

Good day. My name is Mavis Nepasi , I am doing my final year at Bindura University of Science Education. I am undertaking a research entitled "The effects of urban developments on wetlands, in Harare". You are therefore, requested to assist in the research by completing the questionnaire fully and as truthfully as you can. All the information you provide will be used sorely for the purpose of this study and will be treated with utmost confidentiality.

Date ..... **Questionnaire ID**.....

INSTRUCTIONS

- *Please click on the appropriate answer and fill in were ever possible.*

Questionnaire

The completion of the questionnaire is anonymous and your willingness to assist is highly appreciated.

SECTION A: BIOGRAPHICAL INFORMATION

1. **Indicate your gender.**

1.	Male	
2.	Female	

2. **Indicate your age category**

1.	18-24 years	
2.	25 - 34 years	
3.	35 - 44 years	
4.	45+ years	

Indicate your education level

1	Primary	
2	Secondary	
3	Tertiary	

SECTION B: CLOSED ENDED QUESTIONS

A number of statements are provided. Indicate your level of agreement by circling the appropriate block.

Write your answer in the box in front of the question using the scale below
Scale (1 = strongly disagree, 2 = disagree, 3 = Neutral, 4 = agree, 5 = strongly agree)

		Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
1	Wetlands play a fundamental role in regulating climate change						
2	The challenges to water scarcity is exacerbated by poor management of wetlands						

3. What is your awareness level regarding wetland conservation laws and policies?
   - ☐ **Highly aware**
   - ☐ **Somewhat aware**
   - ☐ **Not aware**

4. What are the development activities that are taking place on urban wetlands? Tick where applicable.

Roads establishment	
Industrial activities	
Urban Agriculture	
Commercial buildings	
Residential Buildings	

5. What are the challenges have you encountered by staying in wetlands?

Flash floods	
Mosquito bites	
Water scarcity	
Loss of biodiversity (wildlife migration & flora and fauna extinction	

What are the benefits are you getting from the wetlands?

Climate regulation	
Food security	
Access to clean and safe water	
Animal habitat	
Socio-economic benefit (tourism and education)	
Aesthetic value (natural beauty)	
Biodiversity	

SECTION C: OPEN ENDED QUESTIONS

7. What are the changes in wetland have you noticed over the 10 years, please describe?

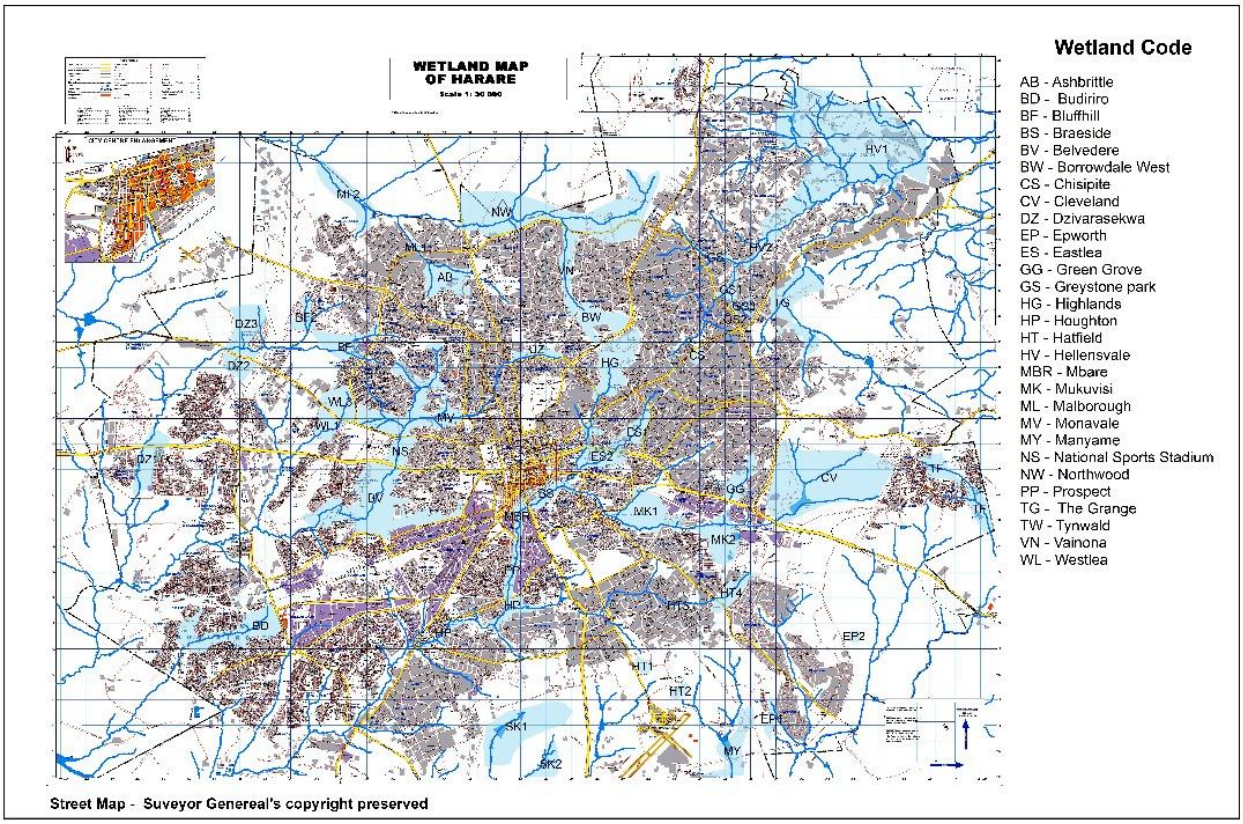
8. What are the regulations, you know that governs wetlands in Zimbabwe?

9 **What do you think can be implemented to overcome challenges to wetland management?**

10. Do you have any personal experiences or stories related to wetlands you would like to share?

THANK YOU!!!!!

APPENDIX D: WETLAND MAP OF HARARE



2025 DISSERTATION MAVIS NEPASI B213649B.docx

ORIGINALITY REPORT

14%	12%	7%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	uir.unisa.ac.za Internet Source	3%
2	hdl.handle.net Internet Source	3%
3	ir.uz.ac.zw Internet Source	1%