# AN INVESTIGATION INTO THE CONTRIBUTION OF HOUSING DEVELOPMENTS TO WETLAND DEGRADATION WITHIN THE CITY OF HARARE, ZIMBABWE

by

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## Declaration

I, the undersigned Luke Mutisi student number 48427691 hereby declare that this dissertation is my own original work with the exception of quotations and references which are attributed to their sources.

Signature…….

Date……

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## Dedication

I dedicate this work to my mother, for her concern during my field work. Thank you mum for being there for me. This work is also dedicated to my wife and daughter who would stay awake with me during the compilation of the dissertation.

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## Acronyms and abbreviations

| | |
|---|---|
| **AAS** | Atomic Absorption Spectroscopy |
| **AN** | Ammonium Nitrate |
| **AP** | Aerial Photographs |
| **ASTER** | Advanced Space borne Thermal Emissions and Reflection Radiometer |
| **BOD** | Biological Oxygen Demand |
| **COD** | Chemical Oxygen Demand |
| **CSO** | Central Statistical Office |
| **DO** | Dissolved Oxygen |
| **DPI** | Dot per Inch |
| **DSHZT** | Dialogue on Shelter for the Homeless in Zimbabwe Trust |
| **EIA** | Environmental Impact Assessment |
| **ELB** | Epworth Local Board |
| **EMA** | Environmental Management Agency |
| **EPA** | Environmental Protection Agency |
| **GIS** | Geographic Information Systems |
| **HCL** | Hydrochloric Acid |
| **ID** | Identity |
| **LDP** | Local Development Plan |
| **MODIS** | Moderate Resolution Imaging Spectro-radiometer |
| **MoENRM** | Ministry of Environment and Natural Resources Management |
| **NGO** | Non Governmental Organisation |
| **ODMP** | Okavango Delta Management Plan |
| **SPSS** | Statistical Packaged for Social Scientist |
| **TDS** | Total Dissolved Oxygen |

| | |
|---|---|
| **TN** | Total Nitrogen |
| **TP** | Total Phosphate |
| **UN** | United Nations |
| **WWD** | World Wetlands Day |
| **ZimStat** | Zimbabwe National Statistics Agency |

## Abstract

*Wetlands are fragile ecosystems that deliver a wide range of environmental and ecosystem services that contribute to human well-being. This fragility has seen a number of wetlands succumb to degradations and loss arising from different causes. The positive contribution of wetlands to various ecosystems and the increasing rate of their degradation and loss has been a cause for concern to different stakeholders for a long time. One of the landmark indications of this concern is the constitution of the Ramsar Convention that was held in Iran in 1971 with the objective of addressing concerns regarding to wetland degradation and loss. Among the competing land uses resulting in wetlands loss and degradation could be listed urban agriculture, industrial development and housing.*

*The research sought to assess the extent of wetland degradation with respect to housing developments in Harare, Zimbabwe. The dilemma as to why and how wetlands were being degraded was an issue of concern. The research sought to determine whether abatement or mitigation measures were in place to address the challenges Associated with wetlands loss and degradation. The subsequent growth of developments, their associated activities and possible intervention measures had to be thoroughly assessed.*

*The administration of questionnaires and conducting of interviews was done to solicit data from the respondents. Collected data was analyzed through the Statistical Package for Social Scientists. Further to this, Google satellite imagery was used in the mapping of the Belvedere North and Epworth suburbs. Disturbed and undisturbed portions of the wetlands were analyzed by Geographical Information System software. Direct observation of the wetland area was used to examine existing natural features. To determine extent of pollution, water samples were collected in the wetlands and submitted to the laboratory for analysis. Analysis of selected chemical and physical parameters was carried out in the laboratory using selected methods.*

*The research made two important and broad findings. First, both the Belvedere North and Epworth wetlands have been severely degraded by anthropogenic activities with housing developments and urban agriculture as the major contributors of this degradation. The development of residential properties in the wetlands is a result of a high demand for residential space in Harare. Whereas housing developments in Belvedere are formal and planned, developments in Epworth were informal and haphazard. With no formal planning, the Epworth wetlands have been severely impacted by water and sand extraction as well as contamination of underground water by pit-latrines that are common in these informal settlements. Second, the research also found that wetland degradation was closely associated with the lack of clear wetland policies both at national and local levels. The laboratory results showed that the water in Epworth was more polluted than the water in Belvedere. The measure of pollutants in Epworth was higher due to the activities being carried out as compared to Belvedere. Measures*

*of Dissolved Oxygen, Total Dissolved Substances and conductivity increased from October to March in Epworth. Of note is the measure of Dissolved Oxygen that increased between October and March with a mean of 7.9 and 2.5 respectively. Total nitrogen and total phosphate also increased significantly in midstream and downstream sections. In essence, averages of 0.01 in October and 0.04 in March were recorded respectively for total nitrogen. The study concludes that an integrated land use approach has the potential of minimizing wetland loss and degradation. This is possible through the formulation and implementation of a comprehensive policy involving all relevant stakeholders. This will ensure a coherent decision making process.*

*In as much as integrated land use planning and policy formulation are potential approaches to wetland sustainability, the drive to implement policy by policy makers concerning wetlands has to be explored. As ignorance concerning the ecological importance of wetlands exists in some cases, it is critical to consider wetland benefits above other competing developments such as housing and urban agriculture. This can be achieved through merging interrelated disciplines with the idea of integrating wetland information. For instance, deriving engineering solutions could promote development yet preserving wetlands. It is also suggested that environmental impact assessments, as planning tools should be carried out simultaneously with the town planning aspect. If given to proper planning, wetlands have a huge chance of survival.*

**Key terms**

Wetland degradation, urban agriculture, water quality, informal settlement, land-use change, housing development, urbanisation, wetland mapping, encroachment, wetland protection, land use planning

# CHAPTER 1: INTRODUCTION

## 1.0 Background

This research seeks to unpack how housing developments in the City of Harare, Zimbabwe's capital are contributing to the loss and degradation of wetlands in selected areas. The research will also focus on determining possible intervention measures to minimise loss of these wetlands.

Wetland degradation has been an issue of concern for a long time and it is against this background that nations met for a Ramsar Convention in Iran in 1971 to address concerns regarding wetlands and their degradation (Ramsar Convention Secretariat, 2007).

According to Springate-Baginski, Allen and Darwall (2009: xiii), wetlands are defined 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 metres." Scott (1989) considers that wetlands can be classified into thirty groups of natural wetlands and nine man made wetlands. Overall, these wetlands can be categorised into five wetlands types, namely: estuaries, marine, riverine, palustrine and lacustrine. The wetlands have, however, been threatened by developments such as housing. The main reason for wetland destruction is primarily due to increasing populations in different nations leading to huge demands for housing developments.

The United Nations (2008) estimated that approximately 50% of the globe's population lives in urban areas, and that this figure was likely to increase in the future. The global urban population is projected to reach 60% by 2030 (United Nations, 2004). The United Nations (2008) noted that populations living in urban areas seek accommodation and cities are expanding both horizontally and vertically to meet this demand. Generally, the responsibilities of local governments are limited to land use, infrastructure provision and associated urban development strategies. The advantages of urban strategic planning include an increase in governance and cooperation that aids municipalities in coming up with sustainable development strategies. In Zimbabwe, the

capital city Harare has witnessed an increase in population due to a number of factors such as rural to urban migration and this has resulted in an increase on the demand for land for housing development.

The increase in population has resulted in families occupying almost all the available and open portions of land leading to denser living in the suburbs. This high demand for land has resulted in a progressive encroachment of wetland areas and the eventually loss of some wetlands. There is, however, a call for sustainable utilisation and conservation of wetlands if the ecological functions of the wetlands are to be realised (Barbier, Acreman and Knowler, 1997).

Harare has an estimated population of 1, 468,767 with 2,098,199 of the total population leaving in its metropolitan area (CSO, 2012). From an administrative point of view, Harare is an independent city almost equivalent to a province. Harare has become a trade centre for different agricultural products such as maize, tobacco, cotton and soya beans. Industries in Harare are mainly textiles, steel, chemicals and food amongst others. Mining activities are evident in Harare's surrounding parts with gold being the most mined. These commercial activities naturally pull workers to the city.

Harare has been expanding in size over the years as evidenced by the growth of residential properties. Houses are being built to provide accommodation to the residents of Harare and the families migrating from the rural areas. Certain portions of the land are utilised for housing purposes as well as construction of associated infrastructure.

It is imperative to note that humans have their own social activities that relate to use of resources. These associated activities can threaten the local environment especially when one considers the use of existing natural resources such as water and trees. Residential development has expanded in all directions of the City of Harare putting pressure on wetlands.

## 1.1 Statement of the problem

The study seeks to examine the degradation of selected wetlands in Harare. The degradation of wetlands has been driven by a high demand for residential space in both urban and peri-urban

areas. The demand for residential space has resulted in families occupying wetland areas which are known to be important for ecosystem services.

Several schemes targeting residential and commercial property developments on wetland have been and continue to be approved by the Harare City council. In addition to the formal and planned developments, several unplanned settlements have also mushroomed in the name of cooperatives also at the expense of wetlands. These formal and informal developments threaten the natural state of wetlands damaging the flora and fauna in wetland areas as well as the disturbing the hydrological system (Southern African Development Community, 2008). It is important to note that any housing development has supporting services that have the potential of further damaging wetlands. These include the construction of the road network, installation of sewer and water pipes which support the housing developments in their operational phases.

The progressive encroachment on to wetlands due to the demand for residential space has resulted in the subsequent pollution of water bodies. This is because wetlands are known to act as filters between land and water which play role in maintaining the quality of water. In spite of the undertaking of Environmental Impact Assessments (EIAs) in most projects, there seems to be on going destruction of wetlands. The destruction of wetlands has been evident despite the fact that the EIA reports present mitigation measures and environmental management plans that assist developers during their construction and operational stages (Environmental Management Agency, 2004). A Housing Policy was launched and yet wetlands still face horrendous degradation.

Despite the visible destruction of some notable wetlands, there is limited numbers of studies that has been carried out to investigate the degradation and drainage of wetlands in Harare. This study therefore investigates the degradation of selected wetlands and the factors leading to degradation.

## 1.2 Justification of the study

Land use development in Harare has intensified in the past decade due to the demand for accommodation and office space (Chatiza, 2010). This research seeks to understand the impact of how housing developments' encroachment into the City of Harare wetlands. The research will generate scientifically derived, policy relevant data that has the potential to assist enable policy

makers to make informed decisions when planning sustainable wetlands management in the City of Harare. The research also seeks to raise awareness on the impacts of wetlands degradation among the general public and civil society organisations so that they become aware of environmental challenges associated with anthropogenic wetlands degradation (Chenje, Sola and Paleczny, 1998).

## 1.3 Delimitation

The study was carried out in two distinct areas namely; Belvedere which is one of the low density suburbs of Harare and in the satellite town of Epworth which is approximately 15 km south east of Harare. Within these locations, the work was focused on parts of the wetlands that have been and are planned for development of both residential and commercial properties.

## 1.4 Aim and objectives

The aim of this research is to understand wetland degradation in relation to housing developments in the City of Harare since the year 2000. On the basis of this aim, the following twin objectives are spelt out:

1. To determine the link between housing development (including urban agriculture) and its effects on the wetlands in Epworth and Belvedere North suburbs in the City of Harare.
2. To evaluate responses put in place by the City of Harare in order to address housing development in the face of threatened wetlands, including clearing housing developments following environmental impact assessment (EIAs) studies or lack of such responses.

## 1.5 Key research questions

To meet the aforementioned objectives, the following twin research questions will be explored;

1. What is the link between housing development and wetland destruction in Epworth and Belvedere North Suburbs in the City of Harare?
2. What are the intervention measures that have been put in place so as to address housing development issues in relation to wetlands in the City of Harare, bearing in mind the role of EIAs?

## 1.6 Thesis outline

Chapter 2 specifically examines literature that relates land use to housing development and wetlands in and outside Zimbabwe. In brief, the chapter discusses the demand for residential space in relation to wetland degradation. Case studies of wetlands that have been encroached by housing and their associated drivers are outlined in the chapter. In addition, legislation relating to wetland conservation is also analysed in the chapter. The chapter concludes by presenting challenges on wetlands and the potential remedies to the same.

Chapter 3 outlines the methodology that was employed in data collection and analysis. The limitations, opportunities and changes that were encountered in the research are also discussed in this chapter. Chapter 4 provides the data gathered during the study in relation to methods used in Chapter three. Analysis of data was carried out and research findings were presented. Chapter 5 concludes the study by presenting research findings and suggestions of areas that require further research.

# CHAPTER 2: LITERATURE REVIEW

## 2.0 Introduction

This chapter reviews literature that relates to land use with environmental management in general. It specifically examines literature that relates land use to housing development and wetlands in Zimbabwe and outside Zimbabwe. The purpose is to understand how housing development has ripple effects on wetlands.

## 2.1 Cities and housing needs

Urban housing demand has been rising in several developing nations over the years. What is evident in this is that the housing demand is also linked to affordability (Chirisa, 2010). For instance, the bulk of urban settlers residing informally in settlements are low income earners and as such they demand for housing they can afford. The low income earners who are mostly informal traders, often occupy space that is cheap thus resulting in informal settlement (Chirisa, 2010). Housing demand in cities has been closely associated with movement of families from one location to the other. As employment is created in different cities, it is realised that in-migration becomes one of the challenges to space required for housing (Ahmad et.al, 2010). Thus, two given scenarios of African countries are given in the following sections that cover growth of population (Byamukama, Carey, Cole, Dyszynski and Warnest, 2011).

Urbanisation is evident in nations that are experiencing economic development and industrialisation (Feresu, 2010). In most developing nations, families travel to seek opportunities in urban areas hence the increase in the population and pressure on the available land. A population study in Rwanda for example, reveals that, "Urbanisation in Rwanda currently stands at 18% and increasing at a rate at a rate of 4% per annum. By 2020 is expected that over 50% of the population will be living in urban centres" (Byamukama et al, 2011:49). This expected population increase results in a high demand for housing. In Rwanda's capital, Kigali, unplanned

settlements mushroomed due to refugees returning into the city after the genocide in 1994. These refugees have exerted pressure on the land thus resulting in waste disposal and water pollution being on the increase in the Nyarugenge District in the country.

China has also seen an increase in housing demand due to urbanization. China's case shows an in-migration level of approximately 17 million people in its low elevation coastal land between the year 1995 and 2000 (McGranahan, Balk and Anderson, 2007). The concentration of the population in coastal region is being driven by economic opportunities in these regions. The population increase has in turn led to increased demand for housing. Another example is an area known as Gujarat in India that is succumbing to high population increase due to urbanization. The coast land in the Gujarat area is vulnerable to housing demand due to the movement of people in the area (Revi, 2008).

The India and China scenarios show the potential pressure on wetlands in cities due to population increase. Wetlands have been under pressure from urban agriculture, sand abstraction, recreation, forest products, water supply and even construction of both infrastructure and superstructure.

A research carried out by Boyer and Polasky (2004); shows that there has been a higher demand for urban housing development than for agriculture. The research shows that the demand for residential premises has been highly driven by urbanisation. The demand for residential and commercial space and its associated infrastructure has been evident in cities and as such contribute to environmental destruction (McInnes, 2009). An example in Zimbabwe's Chitungwiza Town, presents houses that were constructed on wetland areas as a response to housing demand. The local authority (Chitungwiza Municipality), allocated houses on wetland areas this resulting in environmental disturbance. Waste disposal as well as erosion of the wetland areas was evident due to demand for commercial and residential space (Masara, 2012).

## 2.2 Demand for land and urbanisation in Africa

Urbanisation is normally associated with population increase, which no doubt exerts pressure on public and private goods demand (Boadi, Kuitunen, Raheem and Hanninen, 2005). Population increase is in some instances associated with activities such as urban agriculture that contributes towards land use change. According to Feresu (2010), urban agriculture involves different agricultural practices, part of which may necessitate land clearance through felling of trees, and hence lead to massive deforestation, whilst at the same time irrigation development may also be employed to supplement erratic rainfall patterns.

The biggest challenge with urbanisation is the pressure it exerts on land. This is because land is always utilised during the development of superstructure and infrastructure in any city. Biophysical characteristics such as land and water are usually placed under pressure due to development activities that are critical in any housing project. According to Azous (1997), urbanisation potentially affects biotic characteristics of the land which include vegetation, fauna and hydrology (surface and underground). These characteristics are common in sensitive ecosystems such as wetlands which are present in some urban areas like those under investigation in Zimbabwe.

Research carried out in Nigeria shows that urbanisation is one of the major causes of wetland depletion. This wetland depletion is highly contributed by the agricultural activities that are carried out in Lagos' metropolitan area. Agricultural activities in turn result in alien invasive species being introduced to the wetland areas (Ajibola, Adewale and Ijasan, 2012). On the other hand, overharvesting of forest resources and introduction of chemicals on wetland areas also contribute to wetland depletion.

Zimbabwe has also succumbed to in-migration due to prevailing economic challenges. According to a Zimbabwe Statistics Office, it is noted that the population of Harare in the year 1982 stood at 700 000 whilst the census of the year 2012 presented a population of 2,098,199 (Zimstat, 2012). This urban population growth shows a great stride in urbanisation thus placing a

demand on land for accommodation. Harare, being at the centre of socio-economic activities, has seen an influx of people hence increasing the demand for space. Some families have occupied space informally in the Epworth and Hopely areas. Epworth is a suburb located south east of Harare whilst Hopely is an unplanned suburb located south of Harare.

### 2.2.1 Harare's housing needs and the threat to wetlands

Zimbabwe's housing needs have been indicated by the backlog in housing. The poor are the most vulnerable in Zimbabwe as they do not have access to the expensive portions of land. This overally creates slums and informal settlements such as Hopely farm and other portions of Epworth (Marongwe et al, 2011). Politicians have however taken advantage of the poverty stricken environment. These politicians have allocated land politically to the benefits votes. Part of this land is wet in nature.

Population growth in Zimbabwe over the past decades has inevitably increased demand for land for housing space. According to the Ministry of National Housing and Social Amenities (2010), the urban population of Zimbabwe was estimated at 4.456 million people with a growth rate of 5% to 7% per year. Records from the Ministry of Local Government, Public Works and Urban Development (2006:2), shows that there was a 15 000 and 20 000 units decline in provision of housing during the period 1985 and 1995. This further declined to 5 000 units per year by the year 2000.

As a result, there is a huge housing backlog in almost all the urban areas of Zimbabwe. A housing backlog in urban areas of over one million stands was realized in the year 2000 with a household occupancy rate of high to medium density areas being 12 people per 200m$^2$ stand against a standard of six people on the same area (National Housing Fund, 2003). This clearly indicates over-crowding in some areas and the need for additional housing space which is creating pressure to utilise all available land in urban areas within Harare. Some of the available open areas include wetlands and recreational areas.

The City of Harare has a number of wetlands that are within Harare's urban area. Wetlands are in areas such as Avondale, Budiriro 4, Ashdown Park, Monavale, Borrowdale, Newlands, Ballantyne Park and Mandara amongst others (EMA, 2012). Most of these wetlands have been directly affected by infrastructural development (Goredema and Sithole, 2013).

Wetlands in Harare have been under pressure due to infrastructural development. An example of such developments is a school that was built in the Ashdown Park wetland, North West of Harare. The construction of the school led to the clearing of the wetland vegetation on the school site and the subsequent was cleared thus distorting the ecosystem functions. Besides, the flow of water in the wetland area was disturbed as school buildings were erected during construction. Further to this, environmental and social impacts that emanate from the infrastructural developments result in the loss of beneficial habitats, loss of biodiversity and increase of run off on open surface areas. On the other hand, the increase of run on open surface areas has the potential of flooding the suburbs in Harare.

Wetlands have succumbed to human activities over the years. The disturbance of wetlands in Zimbabwe's urban areas covers a considerable area in Harare alone, with other wetland areas being already developed. Infrastructural development results in pollution water resources and reservoirs over time. Pollution of underground water has the potential of affecting the health of the residents over time (Mandava, 2012). This is because the quality of water would have been altered due to introduction of foreign chemical components. For instance, an excavator operating on a given site has the potential of spilling lubricants on the ground if it has technical problems. This can contribute in the deterioration of water quality in the wetland.

Wetland areas remain threatened in different parts of Harare. The Borrowdale area alone, North of Harare, has seen a retail shopping complex being planned for, for future development. Further to this, a hotel and shopping centre have been constructed and are waiting commissioning. The facility was established on a vlei by a Chinese company in the year 2013. It is important to note that locals benefit from wetlands in the times of drought when water is scarce.

Mapping of natural resources has been an issue of concern in the past 10 years (Decade). The reason for the mapping of natural resources has been to identify the wetlands present and eventually quantify them (Agardy and Alder, 2005). The Environmental Management Agency (EMA) has a fully fledged planning office that has been mapping wetlands throughout Harare and Zimbabwe at large (Environmental Management Agency, 2005). The mapping of wetlands permits sustainable management strategies to be implemented in the mapped areas. Mapping of wetlands permits effective monitoring to be put in place so as to minimize destruction over time. Monitoring of wetlands helps in restoration of the very wetlands as well as performance evaluation of the same (Banman, 2004).

In Namibia, wetland mapping involved the observation of bio physical parameters such as soil, water and vegetation. These parameters were used to assess the level degradation of wetlands over time. According to Banman (2004) the depletion in quality and quantity of the bio physical parameters meant that wetlands were under threat.

According to Rogan and Chen (2003), the tools that have been used for wetland mapping are mainly the Geographical Information System (GIS) and Remote Sensing (RS). Remote Sensing presents data during wetland mapping whilst Geographical Information Systems (GIS) analyses data so as to detect any variations or changes (Spruce, Karsmizki and Giardino, 2004)

A research by Fitoka and Karemitsoglou (2008) shows that mapping of wetlands in the Mediterranean area were carried out by use of Landst TM Satellite imagery between the year 2005 and 2007. The mapping showed changes in forest cover thus permitting monitoring of the Mediterranean area. Furthermore, Jansen and Madzwamuse (2003) were involved in the mapping of the Okavango delta by use of Moderate Resolution Imaging Spectro-radiometer (MODIS) satellite imagery. The mapping process then resulted in the establishment of the Okavango Delta Management Plan (ODMP) which was then presented to the Botswana Government (Jansen, 2002). On the other hand, Advanced Space borne Thermal Emissions and Reflection Radiometer (ASTER) and MODIS satellite images were used to map the *Eleocharis birds* in the Blue Lagoon National Park in Zambia (Munyati, 2007). It is important to note that

the mapping of wetlands entails the viewing of images using varying band combinations in their multispectral state (Jensen, 2005).

It is more ideal to map wetlands in the dry season in Southern Africa as the wetland vegetation stands out more than on the dry land (Mukwada, 2003). It has been observed that wetland areas have green dense vegetation during the dry season as they have water logged within them. In essence, confusion is minimized when mapping in the winter season as compared to the summer season as vegetation images properly interpreted (Danz et al, 2005).

Wetland mapping requires Participatory Rural Appraisals for identification of wetland areas as well as monitoring. Wetlands in Zimbabwe are mostly observed by way of level of saturation and vegetation presence (Whitlow, 2003). These parameters are mainly observed in accessible areas whilst inaccessible areas become a problem over time as some of the land is in private properties. GIS is being employed by the EMA as well as a few consultants in Zimbabwe due to the high costs involving acquiring GIS equipment.

## 2.3 Valuation and benefits of wetlands

According to Nasi, Wunder and Campos (2002), valuation is related to the environmental functions or processes that occur in a given ecosystems. These environmental functions include preservation of wildlife habitat as well as water purification to the benefit of the human life around the wetland (Chomitz and Kumari, 1998). In other words, relationships can be created between species present and the human life that benefit from them. In this context, wetland species have an important role to play in water quality and water supply. In turn goods and services are generated because of the relationships in the ecosystem (Daily, 1997). The generation of goods and services in the wetland can be realized by the production food such as fish and the supply of clean water to the surrounding communities. In turn, the community will have to preserve the wetland by minimizing pollution as well as avoiding the building of any wetland area. This then means that there are two categories related to ecosystem services and goods in any wetland. The categories can be termed as the demand and the supply side in the ecosystem.

The Supply side (Input) entails services an ecosystems supply/offer in the wetland supply chain. The supply side includes water-flow maintenance and supplies. This means water can be stored, replenished and regulated by the wetland. Wetlands regulate water quality by way of waste purification and sedimentation control in their given area. Further to this, wetlands minimize hazards such as flooding by way of flood attenuation. Wetlands also retain water during drought seasons or dry periods.

The Demand side (Output) involves the products that wetlands can provide for reason of use by consumers. These good or products include plants, fishery and agricultural land. In other words, the goods that the wetland yields result in the creation of a demand side which eventually permits a linkage in an ecosystem to be established.

There are agricultural benefits that are associated with wetlands. A case study carried out in Palisa District, Uganda; shows that a population of more than half a million benefits from agricultural activities such as the growing of rice, subsistence farming and grazing. Besides, the wetlands have been used for transport, acquiring of medicine, hand art and fishing. From an economic valuation point of view, it is considered that the wetlands generate up to $34 million per year due to different food resources that emanate from the wetlands in Palisa District. These wetlands benefit locals in the District at household level since an average of $500 per hectare is realized (Karanja, Emerton, Mafumbo and Kakuru, 2001). The wetlands have been sources of economic development to the subsistence farmers and as such families have been supported thereby.

Wetlands also improve water quality as they act as natural water filters. It is known that wetlands occur between land and open water; and as such they reduce pollution to the closest water sources. In other words, all the toxicants and metals that emanate from industries and mining activities can be managed through the use of wetlands (Kotze, 2000).

Wetlands have been considered to provide direct benefits such as flood management (attenuation, groundwater management (recharge and discharge), and preservation wildlife habitat (Wright et al, 2006). This is because of vegetation species such as *Typha latifolia* which have the ability to biologically and physically remove pollutants. The benefit of a given wetland is however more pronounced over a wider area as more species are identified (Daily, Johnson, White and Perrot-Maître, 2007). However, wetlands are sensitive ecosystems yet they are of great value in the way they synergistically connect between habitats and the aquatic fauna and flora species. In other words, wetlands serve several purposes to the benefit of the surrounding flora and fauna in any given ecosystem (De Groot, Stuip, Finlayson and Davidson, 2006). Wetlands permit a good breeding ground for fish and avifaunal species thus promoting aquatic productivity. In particular, wetlands act as a critical niche in the food chain. Wetlands are a source of nutrients thus permitting continuity in the flow of life in a given ecosystem.

## 2.4 Wetlands: Are they threatened?

Wetlands have been threatened by human activities in urban areas. According to a research carried out in Turkey, it was noted that urban development and dam construction are a threat to wetlands (Karadeniz, Tiril and Baylan, 2009). The research shows that Turkey had a total of 94 wetlands by 2007. These 94 wetlands had many factors threatening them over time. These wetlands have been threatened by unsustainable fishing and chemical contamination amongst other factors thus contributing to wetland depletion.

As urbanisation has been seen to be on the rise, it is evident that sensitive and fragile ecosystems are threatened by land use activities and in particular housing and its associated infrastructure. Wetlands, being habitats for aquatic fauna as well as being the main support of vegetation species, have been threatened by the housing developments (City of Harare, 1997).

Urbanisation has resulted in a demand for land for housing. Informal settlements such as squatters and slums have been the highest threats of wetlands. The fact that slums and squatters are a form of informal housing in a given location cannot be denied. In most cases, slums and squatters are ‘unplanned’ and as such much of the ecological fabric is challenged. For instance,

the rising of informal settlement such as Hopley Farm are a challenge to the local authority and interested institutions. Hopley Farm is situated south of Harare and has become an informal settlement (Marongwe et al, 2011).

Unplanned settlements have mushroomed due to poverty. The residents residing in Hopley came from high density suburbs that had their illegal structures demolished as part of the operation. The families are depended upon livelihoods such as vending and part time informal employment. The conditions that prevail in the Hopley area are generally poor. As such, the residents have constructed in any available open space and this includes wetland areas that should be preserved according to the Regional, Town and Country Planning Act.

## 2.5 Impacts of housing developments on wetlands

Housing development usually negatively impacts wetlands from both the surface and underground perspectives. In Lagos, Nigeria, it was identified that wetlands are being affected by the construction activities occurring in the City. It emerged that construction activities result in the alteration of water quality, indirect modification of the hydrological system and loss of habitat (Ajibola et al, 2012).

Human health is also negatively impacted due to housing developments in wetlands. Goredema and Sithole (2013) show that diseases emanate from the construction of houses due to the presence of water. They indicate the fact that waste is dumped in wetland areas as these are deemed open and disused areas. This waste attracts scavengers and flies and as such, disease emanate from the dumping of waste. Diseases common in waterlogged areas are dysentery, cholera and diarrhoea amongst others.

Malfunctioning sewer reticulation systems are a further source of pollution that may end up in wetlands in urban areas. The existing sewer reticulation system in the City of Harare has been in this situation. The city has been experiencing sewer bursts due to the fact that the sewer system is old, overloaded and has not been maintained over the years (Moyo, 2005). The wetland areas

therefore become sinks to the sewage that would have been directed into wetland areas. Sewage components have eutrophication effects to wetlands that eventually accumulate nutrients which increase chemical oxygen demand (COD) in the water quality.

Lastly, urban agriculture is also known to contribute to wetland degradation. In instances were land is allocated in areas that overlook streams, cultivation of maize, yams, sugarcane and vegetables is likely to take place. The application of fertilizers onto the wetlands eventually result in eutrophication and high acid content due to reactions that occur between chemicals and water present in wetlands. This culture is apparently inbuilt in most families as they take from their forefathers and other city fathers (Shine and Klemm, 1999).

### 2.5.1 Wetland water quality

Any land changes its water quality at any given time. Stagnant or flowing water has the potential of receiving external chemical and physical components (Perry and Vanderklein, 1996). Agriculture, industrial and domestic practises have the potential of introducing different toxicants, nutrients and sediments to wetland areas. These anthropogenic practises have the potential of increasing phosphorous and nitrogen components in the wetlands (Hunt, 2004). These chemical elements are commonly known as pollutants as they alter the quality of water (Adamus, Clarain, Smith, and Young, 1987). The quality of water then either affects the downstream users or contributes to the growth pattern of certain plant species in the water body. For instance, increase of nitrogen contributes to algal bloom and exponential growth of water hyacinth. It is important to note that Nitrogen and phosphorous reduce the amount of oxygen as these react to nitrates and phosphates respectively thus altering the water quality.

Pollutants such as nitrates from fertilizer contribute to Chemical Oxygen Demand (COD) (Howard-Williams, 1983). These pollutants move through a wetland as through flow; and these are stored within it at different rates and periods. According to Hemond and Benoit (1988), Biological Oxygen Demand (BOD) is defined as “the measure of oxygen required for the degradation of organic matter.” COD refers to the measure of organic material in water and this

is used in relation to BOD. Wetlands are meant to reduce levels of BOD by way of decomposing organic matter during anaerobic respiration. This means that high levels of BOD are meant to reduce the amount of oxygen required by the plants. This therefore reduces the amount of oxygen required by the aquatic organisms that is required for their survival. High levels of BOD are effectively managed by wetlands hence the degradation of wetlands means that aquatic plants are threatened (Wieder and Lang, 1986).

Toxicants are mainly considered to be metals, viruses and bacteria in a wetland (Lazrus, Larange and Lodge, 1970). Metals in particular emanate from human activities such as mining and industrial activities. Metals such as zinc, iron, and cadmium are amongst other metals that can be discharged into a wetland. These metals undergo oxidation and reduction depending on the aerobic and anaerobic conditions in the water (Gambell and Patrick, 1988). These oxidation-reduction processes result in irreversible reactions with organic components in the water. This means that the water will be deprived of oxygen thus affecting the normal existence of aquatic flora and fauna in the wetland. Wetlands are known as metal retention bodies as they reduce the amount of metals and at times adsorb them through plants.

Physical parameters such as Temperature and pH contribute to the above reactions. The toxicants and organic material in water work under certain temperature, conductivity, salinity and pH. Most aquatic organisms (bacteria) thrive under narrow pH ranges for reactions to occur. For instance, a temperature range of between $22^{o}C$ – $27^{o}C$ and a pH range of between 6 -7.5 is common in most water bodies were aquatic microorganisms thrive. The temperature and pH range permits aquatic plants and organisms to function productively. These physical parameters permit irreversible reactions with metals thus resulting in poor water quality (Albert and Minc, 2004).

Total dissolved solids (TDS) and salinity indicate the measure of salts in the water. TDS mainly indicates inorganic salts and dissolved materials present in water (Strecker, 1992). The inorganic salts contribute highly to a balance that is required in water as the presence of chlorides, carbonates, sulphates, magnesium and potassium permits an exchange of these dissolved components between microorganism bodies (Van der Valk, Davis, Baker and Beer, 1979). An

imbalance would mean that detrimental effects are expected in water. Salinity however shows the salts that maintain the osmotic potential in plants. A balance is required in the amount of salt within aquatic organisms.

Conductivity however denotes the presence of ions in water. In other words, conductivity in a given stream or river indicate discharge from a particular point along the channel. A higher conductivity therefore means that there is a higher presence of ions due to activities occurring around the water body. It is important to note that dry periods may show reduced conductivity as ion transportation may be minimal. Sections upstream or at the influent may show higher conductivity due to recharge in the dry season (Begg, 1990). However, in wet seasons, high conductivity is expected as there is movement of ions due to washing.

On the other hand, suspended solids contribute highly to turbidity of water. The measure of suspended solid depends on the flow rate of a stream, river or wetland area. The flow rate in any wetland contributes to the chemical storage over time (Day, Sklar, Hopkinsin, Kemp and Conner, 1982). A fast flow rate usually occurs when there is a steep gradient thus minimal storage is expected in the wetland. A faster flow rate means that there will be a higher level of suspended solids as compared to a slow flow rate (Gaudet, 1978). These suspended solids will then reduce photosynthesis as light will be hindered by the particles. This eventually reduces the productivity of the wetland.

### 2.5.2 Water quality standards

Water quality has standards that have been set internationally. The quality of water differs in wetlands of the world due to the different components that are involved. Surface water and underground water succumb to different components (EPA, 2002). Chemical, biological and physical parameters vary with governments and organisations depending on the need and the intended purpose. For instance, the United State of America has a department responsible for the management of water quality standards known as the Environmental Protection Agency (EPA). This department is responsible for the setting standards and their overall monitoring. However, at

an international level, the World Health Organisation has set standards that have been adopted by other nations of the world. Continual monitoring is critical to ensure that the water quality is improving or deteriorating (Niemi and McDonald, 2004)

Physical parameters have been identified by governments for surface water. Water quality for surface water entails physical parameters such as pH, temperature, salinity, Total Dissolved Solids, Dissolved Oxygen amongst others. These parameters simply prove the quality of water at any given time and in a given area (Chow Fraser, 2006). Limits have been set by different organisations for different parameters. For instance, there is an upper and a lower limit for the amount of pH in a fresh water lake or wetland. In other words, a pH range of 1 – 14 shows how acidic or alkaline the water is in a given water body. It is important to note that there are acceptable values of between 6, 5 – 7, 5 that show the neutrality of the water in pH. Such values show minimal contamination of the water and if values go beyond this either way of the acceptable values it is proof of the introduction of a foreign component.

All parameters in question have acceptable and unacceptable values. Specific values have set for different parameters so as to ensure that governments are guided by the same standard. Values outside the acceptable limits usually prove the presence of pollutants and as such, strict measures are put in place to manage pollution. From a qualitative perspective, concentrations of different chemical parameters have been set to ensure measures are known. Surface and ground water chemistry differs with the activities that will be occurring. The presence of trace elements in either surface or ground water means that responsible departments will have to monitor the source of the elements (Mitsch and Gosselink, 2007).

### 2.5.3 Wetland hydrology

Hydrology denotes the flow, level and frequency of water in a given water body. The hydrology of particular wetland has an important part it plays. For instance the flow of water contributes highly to salinity, conductivity and total dissolved solids in a wetland. These parameters also vary with the frequency of water since some of the wetlands are temporarily water logged (Mitsch and Gosselink, 2000).

Surface water is the main contributor of water in any wetland. Surface water usually has several sources of water no wonder they are major contributors of water. According to Van der Valk (2006), surface water flows at a faster rate in the rainy season. Besides, surface water also flows in wetlands due to the impermeable nature of the soil. On the other hand, the surface water flows easily when the water table is below the wetland. This in turn means that underground water will not have the ability of supplying water to the wetland. In some instances, surface water is highly contributed by flooding that could have occurred in the area.

Underground water has a significant part it also plays in wetlands. Underground water plays an important role in the regulation of water in a given wetland (Mitsch and Gosselink, 2000). Interactions if groundwater may occur in two ways, namely, recharge and discharge. Recharge normally occurs when wetland water is fed into groundwater reserves whilst discharge occurs when water from the groundwater is release into the wetland. With underground water, most of the water is released when the wetland depression is very close to the water table. This water is release as a spring or seeps in most instances. On the other hand, wetlands located on slopes may enjoy a discharge effect due to the level of groundwater as one goes down the slopes.

Hydrology is critical in wetland operations and management over time. This is because wetlands have different levels of water at any given time due to the presence of absence of rain. The pattern of a wetland at any given season is known as a hydroperiod. In other words, there are moments when the wetland is water logged whilst in other seasons it is dry. This therefore means that wetlands have the capacity of presenting different physiochemical characteristics in the wetland. Components such as oxygen presence, nutrients, sedimentation and toxicity are altered depending on the hydro-period. This means that each season undergoes alterations depending on the absence or presence of water thus presenting different ecosystem productivity levels (Mitsch and Gosselink, 2007).

Wetland hydrology can be classified according to hydroperiods. These hydroperiods show the amount of water in a wetland at any given time namely: Intermittently flooded (water standing periodically without a seasonal pattern), Temporarily flooded (water standing for a short period in the growing season), Saturated (when soil is water logged with water to the surface during the

growing season but standing water is rare), Seasonally flooded (when standing water is present for extended periods of time), Semi-permanently flooded (standing water present throughout the growing season in most years), Intermittently exposed (standing water present throughout the year except in years of severe drought), Permanently flooded (standing surface water present through put the year) (Cowardin, 1979). These hydro-periods however prove that at times the wetlands plants are submerged under water depending on the precipitation.

When the plants are submerged, anaerobic reactions are highly likely. The submerged plants are likely to undergo anaerobic respiration as the pollutants increase due to high flow rates. On the other hand, the oxygen levels are low when the plants are submerged as plants and microorganisms utilise the available oxygen over time. The submerged environment then creates anaerobic processes due to the organic component in the water. In other words, the ions, nutrients and toxicants react underwater at a faster rate due to the environment that is anaerobic (Van der Valk, 2006). On the contrary, an environment that is mostly shallow has varying reactions. The plants have the ability to undergo retention of metals as shallow waters have slow flow rate. The shallow waters also have a link with the season as less water flows in the wetland. This gives the opportunity for most of the solids to be stored in the wetland over time.

## 2.6 Wetland protection and related legislation

From an International perspective, wetlands are conserved in consideration of the Ramsar Convention on Wetlands. The Ramsar Convention was signed on 2 February 1971, in Ramsar, Iran. The Ramsar Convention of 1971 brought up the World Wetlands Day (WWD) that commemorates the establishment of the convention in the conservation and sustainable utilization of wetlands (McInnes, 2010). Government departments, non governmental organizations (NGOs) and Environmental Groups are always raising public awareness on the sustainable use and value of wetlands. The Ramsar Convention promotes and seeks for commitment from member countries to ensure wetlands are sustainably utilized and that these wetlands are planned for. Although the Ramsar Convention is not directly affiliated to the United Nations system of Multilateral Environmental Agreements (MEA) but is well respected in

treaties related to biodiversity management (McInnes, 2010). The whole idea of the Convention is the promotion of sustainable utilization of wetlands for the benefit of future generations.

The Government of Zimbabwe has addressed environmental issues over the years. There has been an enactment of the Environmental Management Act which addresses environmental issues holistically. The Environmental Management Act prescribes projects which require EIAs to be carried out before any development is implemented. The Environmental Management Act prescribes projects which require EIAs to be carried out before any development is implemented. Housing Developments are amongst some of the prescribed activities that require an EIA to be carried out. An EIA is a planning tool that provides a detailed description of the project in line with the proponent's requirements. The EIA further specifies any anticipated impacts that the project might have on the environment and in turn mitigation measures are proposed. Further to the mitigation measures, ways of monitoring and managing environmental impacts (Environmental Management Agency, 2005).

The Zimbabwean Environmental Legislation does not currently have a specific piece of legislation that stops development on wetlands. The present pieces of legislation permit development after an EIA has been carried out. In essence, the Environmental Management Act of 2003, Chapter 20:27, Section 4, provides for several environmental rights from a citizen's perspective. The Act shows that every citizen of Zimbabwe has the right to a clean environment, access to information, protection of the environment to the benefit of future generations amongst others.

A statutory instrument on protection of ecosystems was prepared to manage the environment at large. The Environmental Management (Environmental Impact Assessment and Ecosystems Protection) Regulations, Statutory Instrument No. 7 of 2007, addresses the Environmental Impact Assessment process and ecosystems protection. This piece of legislation does not specifically address on wetlands in particular but rather, it states that no project should be implemented without an EIA being carried out.

However, it further requires thorough public consultation to be carried out but if the Agency is not satisfied with the consultation amongst stakeholders, it then does not offer a license for developing that very area over time. This then shows that there is a gap in the legislation since it is not clear on what response the stakeholders will give.

The current legislation simply requires a permit to be acquired to develop on a wetland. The Environmental Management Act of 2003, Section 113 shows that it is illegal to cultivate or build on a wetland without a permit. The Act in Section 113 states that "the minister may declare any wetland to be an ecologically sensitive area and may impose limitations on development in or around such area. Any activity conducted on/in a wetland, without a licence from the agency is considered illegal, and is punishable with a level 10 fine and or a prison sentence of no more than six months." This then means that any developer should apply for wetland utilization from an EMA office.

The Local Government Offices also carry the responsibility of protecting wetlands. According to Mushamba (2010), the local governments push for environmental management by conservation of natural resources, protection of recreational facilities and creation of open spaces at the planning stages. The Local governments are governed by various Acts such as the Urban Councils Act (Chapter 29:15), the Rural District Councils Act (Chapter 29:13), and the Regional Town and Country Planning Act (Chapter 29:12). These Acts have been put in place to promote environmental sustainability in all areas.

On the other hand, the Ministry of Environment established a National Environmental Policy which presents an integrated land-use planning approach to ensure sustainable use of land. As part of the Policy, the Ministry of Environment advocates on issues relating to wetland research as well as strategies of rehabilitating degraded land (Government of Zimbabwe, 2009).

Proper planning reduces human activities associated with wetland related issues. Planning in municipalities is however changed in nations that are still developing or underdeveloped (GOZ, 2001a).It is evident that as housing needs increase; municipalities have to develop policies that are applicable and relevant to housing. As cities grow and operate they have an increased

demand for infrastructure. Besides, national governments can help create a sound institutional fabric and a sound knowledge base to support local decision makers engage with stakeholders to identify and carry out cost-effective actions (Mtisi et al, 2012).

Looking at a Zimbabwean approach, Guiding principle number (Twenty) 20 of the environmental strategy calls for "an integrated, multi-sectoral and spatial approach to planning for population growth and … to ensure sustainable development and environmental protection" (MoENRM, 2009: 13). Spatial approach to planning considers the associated impacts of the built environment on the biophysical environment. Hence issues of environmental preservation, environmental integrity and carrying capacity are taken in to consideration. This helps the local authority to have a clear perspective on how to handle the current planning aspects in relation to the future of the nation.

When planning has been carried out, enforcement then follows. The City of Harare by laws, in line with the Regional Town and Country Planning Act, do not permit stream bank cultivation and sensitive ecosystems such as wetlands. Although it is generally known that housing by laws deny stream bank cultivation, enforcement has not been exercised. The local authority specialises in being reactive more than in being proactive hence pausing a challenge. An example is the situation when the City of Harare personnel destroyed some of the crops in Kuwadzana and along the Mukuvisi River due to stream bank cultivation issues. The damage to the environment had already been done which is enough proof that there was lack of enforcement (Feresu, 2010). From an environmental point of view, it is evident that the land that is undergoing informal agricultural development will need special consideration since planning will not be executed effectively. It is unfortunate that urban agriculture encroaches into sensitive ecosystems such as wetlands (MoENRM, 2009).

Wetland loss is contributed by failure of enforcing policy on the ground. For instance, urban agriculture is prevalent in Harare in opposition to the existing laws that prevail such as the Town and Country Planning Act of 1996. It is evident that unsustainable practices have prevailed because there is lack of technology, funds and economic expertise that lead the road of sustainable development. On the other hand, awareness and education of the citizens of the city

will help in the management of wetlands through environmentally friendly practises (Shine and Klemm, 1999).

## 2.7 Conclusion

Wetlands are important ecosystems that have to be protected if humans are going to benefit from them. These wetlands are however threatened by different human activities that result in either their fragmentation or degradation. Urbanization has however contributed to the influx of people in different cities that placing pressure on available urban space. To manage the demand for space, land has been allocated to individuals for infrastructural developments and of this land, wetlands are included.

These wetlands have been encroached for different purposes and these include urban agriculture, residential and commercial developments amongst others. Wetland encroachment has resulted in the quality and the state of wetlands being destroyed. The destruction of wetlands has occurred with pieces of legislation being in place. Of note is the Environmental Management Act of 2002 that requests developers to carry out an EIA before project implementation. The Act does not stop developers from developing in wetlands but rather it requires mitigation measures to be put in place to manage the impacts.

On the other hand, there is a gap between the presence of legislation and its enforcement. This is because unlawful practices are carried out in sensitive areas yet the authorities are not enforcing. Wetlands then succumb to degradation thus affecting both the abiotic and biotic components of the environment. If wetlands are to be conserved effectively, policy will have to be enforced by the relevant authorities. Besides, surrounding communities will need to be educated on issues relating to the importance of wetlands in their area.

# CHAPTER 3: METHODOLOGICAL ORIENTATION

## 3.1 Introduction

This chapter gives a detailed description of the study area as well as its biophysical environment. It goes further to discuss the methods and materials that were used during the research. There were different methods that were used to gather data and to collate it. The limitations and changes that were encountered are also discussed in this chapter.

## 3.2 Study areas and selection criteria

The study areas are Epworth (Overspill) and Belvedere North which are both situated in the Harare Province. Epworth is an old high density suburb which mainly comprises informal settlements. Belvedere is a suburb in Harare Urban and is formally planned. Figure 3.1 shows the location of the two sites within Harare Province:

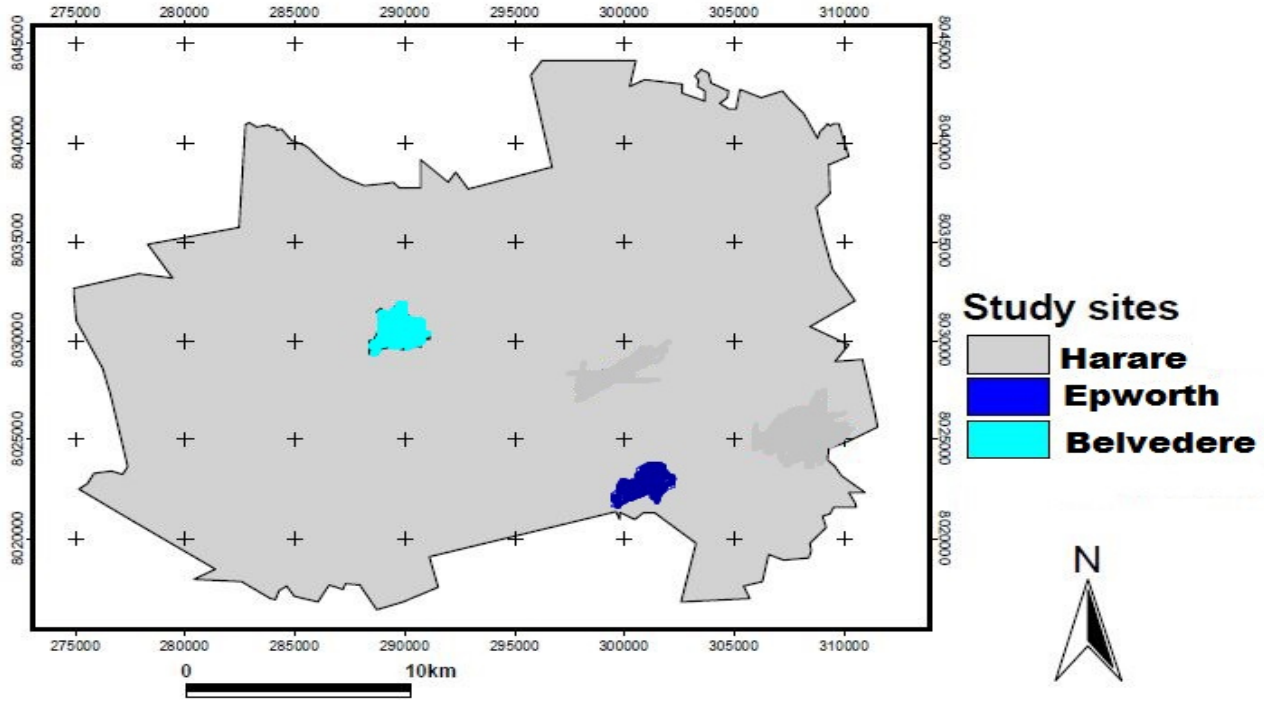
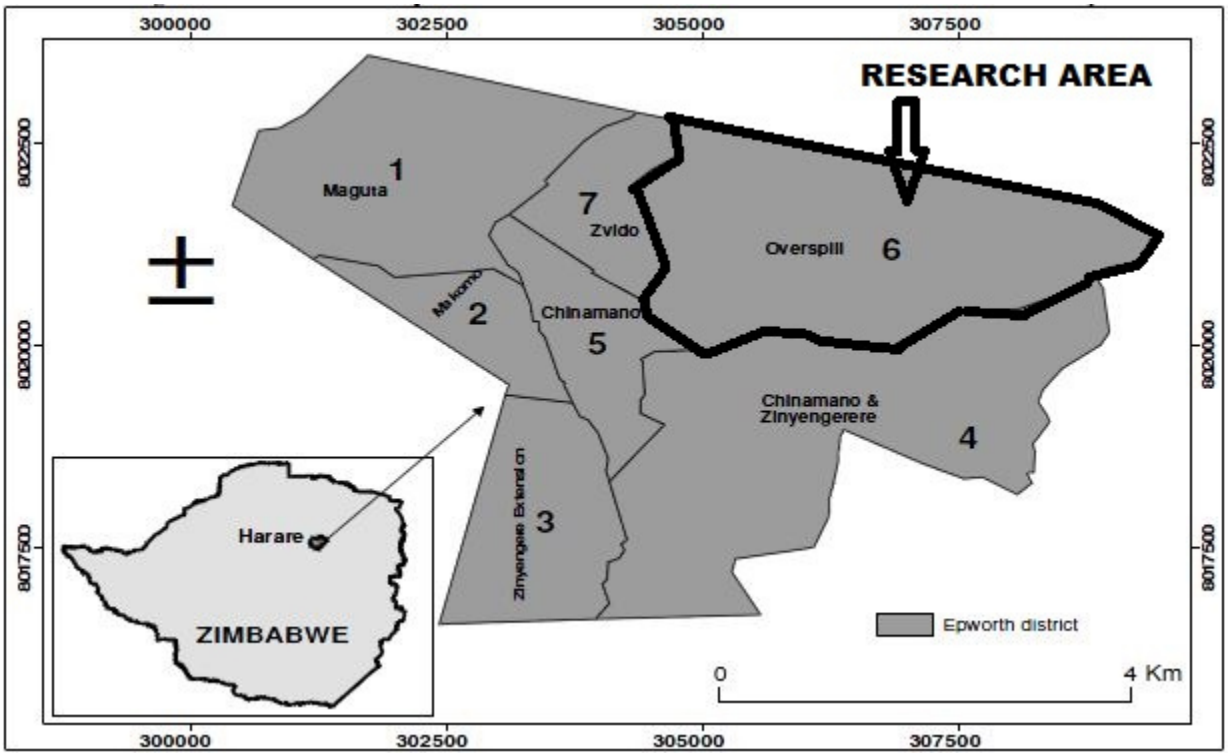



**Figure 3.1: Harare boundary map with study sites**

The two sites were chosen for comparison. The site selection criterion was determined by three factors. The first criterion was concentration of wetlands and extent of housing development on the wetlands. The second criterion was the ease of access (proximity) of the targeted area and the third was the land use characteristics based on this criteria the study was confined to Belvedere North and Epworth Ward 6 (Figure 3.1 and 3.2).

**Figure 3.2: The 7 Wards in Epworth**




Source: Chanza and Chirisa (forthcoming)

## 3.3 Description of the study areas

Epworth is located south east of Harare. The settlement was established in 1892 by the Methodist Wesleyan Mission as Epworth Farm. The Mission attracted recruited converts and by the year 1950, it had recruited about 500 families (DSHZT, 2009). The recruited families were all allocated land for cropping and residential purposes (Butcher, 1993). The liberation war (1966-1979) saw an influx of several families into the Epworth area. These families settled in Epworth

where there was no local authority in charge and thus relied on the Mission to allocate them the land in the area.

The post-independence era saw the establishment of the Epworth Local Board (ELB) in 1986. At that time there were approximately 5,000 residential stands that were formally allocated. The post-independence era saw an influx of people in the area with during which the incoming families created illegal structures as they sought for a place to stay (Nyamvura and Brown, 1999). This influx continued to such an extent that by the year 1997, there was an estimated population of 150 000 people (ELB, 2007). The illegal structures were demolished in 2005 and some families were resettled elsewhere (ELB, 2007). However, despite the demolition of illegal structures, more people continued to settle in Epworth and by the year 2007, the Epworth population had risen to 300 000 people (Chirisa, 2010b). The spatial distribution of settlements the seven wards of Epworth shows the new settlers have occupied portions of schools, hospitals, wet lands and electricity buffer land zones. According to Chirisa (2010b), these informal occupants are poor and their occupancy of the land is referred to as the "law of adverse possession." This concept refers to instances were individuals occupy space without authorization from the local authority. After some time of informal occupation, the families then settle as though they were formally settled.

In comparison, Belvedere is a formally planned suburb that is strictly controlled by the local authority, the council. Belvedere is located west of Harare and suburb is served by a relatively well functional system in terms of infrastructure compared to Epworth. Most of the portions in Belvedere North are fully built up, with few open areas that were reserved due to their sensitivity. However, the year 2013 saw constructions creeping into the reserved area most notable the construction of a shopping mall (Long Cheng Plaza) and residential properties all built on a wetland. The City of Harare approved some of the plans on a financial income basis. Of note is the fact that the Ministry of Local Government and Public Works engaged in a land deal exchange for the Belvedere Wetland area with a portion of state land elsewhere. The Belvedere North area has a perennial river running through it known as Marimba River.

## 3.4 Research methods

A combination of qualitative and quantitative methods was employed in the study. A qualitative analysis was characterised by the emphasis on understanding, observations and measurements in natural settings, closeness to data, process oriented, generalizations by comparison and context of individual organism (Gauri, 2005). In qualitative research, the researcher purposefully selected respondents that can provide information relating to the phenomena under investigation. The most preferable respondents may be learned or exposed to the subject under examination (Creswell, 1994). Landman (1988:77) says, "Qualitative research is not based upon a fixed set of rigid procedures, but nevertheless the researcher does need to develop a set of strategies and tactics in order to organize, manage and evaluate information."

The quantitative method was employed in the study so as to quantify respondent's answers in defined variables to draw statistical conclusion and comparisons. According to Gummesson (2000) the quantitative method gives objectivity to the results since the respondents were located differently and gave different answers. A combination of research methods were employed in the study to ensure that appropriate data is collected as shown in Table 3.1.

**Table 3.1: Research methods summary**

| Issues | Interviews & Questionnaires | Observation | Literature Review | Images | Laboratory Analysis |
|---|---|---|---|---|---|
| Background | | ** | *** | | |
| Wetlands in general | ** | ** | *** | * | * |
| Housing and wetlands | *** | ** | *** | ** | ** |
| Policy Issues | *** | * | ** | * | * |

**Legend:**

| | |
|---|---|
| Least useful method | * |
| Useful method | ** |
| Very useful method | *** |

### 3.4.1 Selection of respondents

To select respondents in Epworth, a random sample was used. A random sample was used in Epworth due to the informal haphazard nature of settlement in the suburb. The study area had a total of 307 units and the study targeted 20% of these units. This resulted in a total sample of 60 respondents being selected randomly. Epworth is a suburb that consists of both formal and informal settlements. The informal settlements have arisen due to an influx of people who were rendered homeless by an informal settlement destruction operation codenamed *Murambatsvina* (operation restore order) in 2005 as well as the political situation that was experienced in Zimbabwe in the first decade of the 2000s (Ncube and Phillip, 2006 and UN Habitat, 2009).

To select respondents in Belvedere North, systematic sampling method was employed. The systematic sampling was used because the Belvedere North population is logically homogenous and uniformly distributed. Systematic sampling is the most ideal method of sampling since the houses were in a linear form and this assisted the researcher to use stand numbers to select respondents (Burgess, 2000). Systematic sampling assisted the researcher to select the respondents in a manner that is uniform with respect to the household under study (Gummesson, 1991). There were 101 houses that were considered in the study area. Of these 101 houses, a total of 25 respondents were selected on the basis of selecting 1 out of every 4 houses in the area. The materials used in the collection of data were mainly pretested questionnaires that were prepared by the researcher. A total of 25 questionnaires were used in the field during data collection. Belvedere North is formally a residential area. However, the area has seen other developments. For instance a multipurpose hotel has been constructed in the area. The Belvedere area has an approved layout and displays a formal settlement in comparison to Epworth.

To select the professional interviewees, non probability purposive sampling was employed. Non probability purposive sampling permitted the selection of interviewees (professionals) whose qualities or experiences permit an understanding of the phenomena in question and are therefore valuable (Denzin and Lincoln, 2000). A total of 15 interviewees were purposively chosen due to their knowledge of issues under investigation. The researcher selected residents from the study areas for the purposes of gathering data.

The following departments and respondents were considered in Table 3.2:

**Table 3.2: Professional respondents**

| **Institution** | **Number of respondents** |
|---|---|
| Planning department of the City of Harare | 2 |
| Department of Physical Planning | 2 |
| Planning, Architectural and Survey Consultants | 3 |
| Housing Cooperatives | 2 |
| Environmental Management Agency | 2 |
| Ministry of Environment, Water and Climate Change | 1 |
| Ministry of Health and Child Care | 1 |
| University of Zimbabwe specialists | 2 |

### 3.4.2 Data Collection

#### a. Questionnaires in Epworth and Belvedere North households

A total of 25 respondents were interviewed in Belvedere North suburb and 60 respondents in Epworth. The materials used during data collection entailed structured and semi structured

questions in a questionnaire. The questionnaires that were used were divided into household and professional questionnaires. The household questionnaires had three sections namely personal information, key wetland issues and policy issues. The household questionnaires had 10 questions that were coded. The professional questions had 18 questions that were coded. According to Cresswell (1994) a questionnaire is defined as a set of questions on a form, which is completed by the respondent in respect of a research project. It is a list of presented questions to which respondents are asked to supply answers. Respondents were persons of whom the questions were asked. In this research, respondents for the questionnaire were from household heads in the selected suburbs, namely Epworth and Belvedere North.

**b. Interviews to professionals**

An interview guide was employed so as to obtain information by way of interviews. Interviews were employed because they permitted the researcher to gather attitudes, judgments and spontaneous capturing of information in a natural manner. Interview guides were used to serve time and as such the researcher prepared an interview guide in advance so as to determine how much time each question will take. A total of 15 key informants were selected from institutions and companies that have an understanding of wetlands. According to Gauri (2005), an interview is highly suitable for exploratory types of study and it enable the researcher to gain a more accurate and clear picture of a respondent's position or behaviour. This method of data collection was mainly qualitative in nature and enabled the researcher to collect views and opinions from the respondents. This also enabled the researcher to collect opinions and views concerning the area of study. In these interviews open questions were used to allow respondents an opportunity to share their views and express their feelings. Close ended questions were of paramount importance as they allowed data to be analyzed by way of SPSS. The close ended questions were coded for purposes of importing in analyzing software.

**c. Direct and Systematic Observation**

The method of observation was critical as it allowed the researcher to gather data on study sites. Direct Observation refers to the visits that were made in the study areas (wetlands). This means that the houses in the study areas are visited so as to have a physical check and to have more

direct manner of acquiring information (Gillham, 2000). On the other hand, systematic observation was employed so as to continuously check the wetland characteristics and to spend time with the locals. Further to the gathering of information, detailed observation of the features and the associated activities in the wetland areas was realized.

### 3.4.3 Data analysis

The analysis of data was carried out by way of the SPSS method of analysis. Three excel spreadsheets were generated for the Epworth, Belvedere North and professional questionnaires. All responses were assigned a code for the purposes of input into the SPSS, version 16. Codes were given a numerical value as shown in Table 3.3. In this case the codes ranged from 1 – 5 depending on the variable being analyzed. Questions being analyzed were fed into the x-axis of an Excel spreadsheet. The questions were fed into the excel spreadsheet as Q1, Q2 to Qn. In other words Q1 represented Question 1. The questionnaires were also assigned ID (identity) numbers which were fed into the y-axis of the excel spreadsheet. The Belvedere North spreadsheet had 25 IDs, Epworth spreadsheet had 60 IDs and the professional spreadsheet had 15 IDs. The data collected was imported into the SPSS system for analysis. After importing the data into the SPSS system, the data was then queried to generate descriptive and graphical statistics. The data collected was presented in form of bar graphs. The data was presented in a descriptive nature and narrative manner for most of the respondents.

**Table 3.3: Questionnaire codes**

| Survey Answer | Assigned Code (Household) | Assigned Code (Professional) |
|---|---|---|
| Male Gender | 1 | 1 |
| Female Gender | 2 | 2 |
| Secondary Education | 1 | 1 |
| Tertiary Education | 2 | 2 |
| Formal employment | 1 | 1 |
| Informal employment | 2 | 2 |
| Allocated households | 1 | - |
| Non allocated households | 2 | - |
| Municipal water source | 1 | - |
| Borehole water source | 2 | - |
| Well water source | 3 | - |
| Yes | 1 | 1 |
| No | 2 | 2 |
| Strongly disagree | - | 1 |
| Disagree | - | 2 |
| Not sure | - | 3 |
| Agree | - | 4 |
| Strongly agree | - | 5 |

The ages of the respondents ranged were also coded as below:

18 – 24 years = 1, 25 – 30 years = 2, 31 -40 years =3, above 40 years = 4

### 3.5 Water sampling

Sampling was carried out at 4 points in either river (Jacha River in Epworth or Marimba River in Belvedere). The samples were collected upstream, midstream and downstream of the wetland area within a distance of 1 kilometer. The four sampling points were upstream of the wetland, two points midstream of the wetland and downstream of the wetland. Location of every sampling point was selected by the aid of a handheld GPS gadget within a distance of 1km. The following coordinates were selected for the sample points as shown in Tables 3.4 and 3.5:

**Table 3.4: Belvedere North sampling sites**

| Coordinates (UTM) | X | Y |
|---|---|---|
| Upstream | 288289 | 8028923 |
| Midstream 1 | 288198 | 8028572 |
| Midstream 2 | 288153 | 8028198 |
| Downstream | 288306 | 8029247 |

**Table 3.5: Epworth sampling sites**

| Coordinates (UTM) | X | Y |
|---|---|---|
| Upstream | 303302 | 8021091 |
| Midstream 1 | 303255 | 8021495 |
| Midstream 2 | 303408 | 8022100 |
| Downstream | 303186 | 8021786 |

The sampling process was carried out in October 2013 (Dry Season) and in March 2014 (Wet Season). The month of October is considered to be the dry season because the rains would not have fallen. In other words, the month of October is just before the rains fall i.e. just before the beginning of summer. During this period, the river flows at a slow rate and the wetlands area is less wet. The month of March comes after the rains have fallen. This results in a fast flow rate than in the river and the wetland area is wet more than in the month of October.

The analysis of water samples focused on both the physical and chemical parameters of the samples. The physical parameters include temperature, pH, total dissolved solids (TDS), dissolved oxygen (DO) and conductivity. An onsite multi-meter was used instantly to analyze physical parameters such as temperature, pH, TDS (Total Dissolved Solids), DO (Dissolved Oxygen) and conductivity. These parameters were measured using a WTW 330i conductivity meter and a HACH pH meter (APHA, 1996).

The chemical parameters under study were salinity, total nitrogen and total phosphate. Analysis of parameters was carried out in the laboratory using the titrimetric and electrode methods of analysis. Analysis was carried out twice at each point of collection both before and after the rainy season. One way ANOVA (Analysis of Variance) was used to analyse the movement of pollutants through the wetlands from the upstream to the downstream sections of the study site. Raw data was fed into the SPSS statistical package to derive the variance in the sampling points of the study sites.

Besides, non-treatment methods were also employed namely, spectrophotometric and turbidimetric methods. The turbidimetric method was used for the analysis of total phosphates whilst spectrophotometric method was used for the analysis of total nitrates. However, salinity was analyzed using the conductivity meter mentioned above.

The parameters were selected based on their cumulative effects on the quality of water in wetlands. All the parameters are commonly known as pollutants due to the impacts they cause on wetlands. According to Perry and Vanderklein (1996), there are ten water quality impacts that emanate from different land uses namely: salinisation, pH (acidification), change in flow of water, temperature, heavy metals, toxins such as herbicides, nutrient load, bacteria and viruses, organic matter and biological (and chemical) oxygen demand and changes in suspended sediment load.

An example is the use of fertiliser by residents whilst undergoing urban agricultural activities. Fertiliser contributes highly to the phosphate, sulphate and nitrogen component of the water. This is because some of the fertilizer is washed away or dissolved in the process thus contributing to pH, Total Dissolved Solids and Chemical Oxygen Demand amongst others. In other words, these parameters depend on the land use, of which with domestic related activities, salinity is likely to be expected due to the salts used by residents in their day to day activities. Conductivity and pH were selected due to the presence of ions in water over time.

Water samples were collected at each different sample points by way of water sampler. The water sampler had a sucking tube that drew (collected) water from the river. The water sampler was squeezed by the researcher until the water sampler was full with water. The water was then

poured into a sterilized 500ml plastic bottle. The plastic bottles were chosen above glass bottles because there were available, easily accessible and cheap. This process is commonly known as the 'grab' method of sampling. The samples were kept in 500ml sterilized plastic bottles that were preserved under low pH. Water was collected at least 5cm below the water surface at all sampling points. The water is collected at 5cm below water surface so as to collect all possible pollutants flowing in the water. Chances are that some of the pollutants would have gone below the surface due to density whilst some would have dissolved in the water. All the sterilized plastic bottles were labelled so as to ensure identification of all the bottles. Samples were collected twice in October 2013 (before the rains) and March 2014 (after the rains).

### 3.5.2 Selection criteria of water points

To ensure that the selection was in relation with the research, the two factors were considered. (1) The type of land use and activity in a given wetland. Collection of water samples was mainly from streams that are or have been affected by housing development and infrastructural developments. Housing developments have contributed to loss or degradation of wetlands over the years (Goredema and Sithole, 2013). (2) Discharge from developments under study. With most developments in Harare, sewage has been discharged into wetlands due to the malfunctioning of the pipes. In essence the sewage pipes are old and as such sewer burst are prevalent.

### 3.5.3 Description of sample points

Water sampling points' characteristics are shown in Table 3.6 as follows:

**Table 3.6: Characteristics for the study sites**

| Wetland location | Characteristics |
|---|---|
| Bevedere North | -The wetland area seasonally wet<br><br>-A Chinese Mall was built on the wetland<br><br>-The prevailing soils are expansive clayey soils<br><br>-Riparian vegetation is more pronounced in the wetland area with typha latifolia in most sections.<br><br>-A stream flows perennially from Monavale towards Kambuzuma<br><br>- Urban Agriculture also occurs in the wetland in the summer season |
| Epworth | -The wetland is seasonally wet<br><br>-Informal dwellings already exist in the wetland<br><br>-The prevailing soils are largely silt to clay in nature<br><br>-Riparian vegetation more pronounce in the wetland with reeds dominating within the wetland<br><br>-The stream flows seasonally and fully submerges wetland in summer |

## 3.6 Wetland mapping

Considering the two sites under study, mapping of the areas using GIS was considered over time.

### 3.6.1 Aerial photographs and image digitization

The Department of the Surveyor General of Zimbabwe gave the researcher black and white Aerial Photographs (APs) of the study sites that were taken in 2002. These APs were scanned at 400 Dots Per Inch (DPI). Photographs are normally taken once a year in Zimbabwe. Geographical Information System (GIS) 10.1 was used to ensure that the APs were imported.

These APs were immediately saved into the tagged image file (tif) format. The Digital Elevation Model (DEM) was used to orthorectify the images. The orthorectification is a process of geo-referencing the APs.

The resampling of APs of the wetlands produced boundaries which were digitized through textural analysis and tone. Any other infrastructural activities that were observed were also digitized. The detection of land use change for the year 2008 to 2014 was digitized during the dry season from Google earth images. The Google earth images that would have undergone digitization were then polygonised so as to determine the area of the different land uses in the wetland under study.

The Google earth images of the wetland areas before they were disturbed were presented for both study areas. Google earth images of both study areas after settlements were established were also digitized and presented. This helped in showing the difference between the undisturbed and disturbed wetland areas.

### 3.6.2 Analysis of Land use changes

The analysis of data involved the display of the spatial extent of wetlands in ArcGIS 10.1. ArcView 10.1 measure shapes (polygon) in hectares and presents. Wetland areas and their related images were then calculated for the wetland sites so as to observe changes. The detections of land-use change are expressed as a percentage after calculations. The formula used to determine spatial changes in wetlands is presented as follows:

$$[(Y - Z) / Y] * 100$$

Where Y represents the previous wetland area and Z represents the recent wetland area. The different land-uses and activities in the study sites were observed and presented in the images.

### 3.6.3 Measure of Accuracy

The knowledge available, ground truthing and scientific reasoning were used to group the different categories into different land use classes. For instance, classes such as subsistence agriculture and settlement may be more pronounced in a given wetland (Pan et al, 2004). Making reference to type of crops and dwellings (structures) present will aid in the process of ground truthing for the wetland areas (Lausch and Herzog, 2002). Overally, the accuracy of the software on presenting land use activities depends on the special resolution and satellite images (Hansen et al, 2001). If the satellite imagery is accurate, the amount and distribution of a given activity is easily identified.

## 3.7 Conclusion

This chapter justifies the choice of the study areas and water sampling points. The appropriate research design, methods and tools employed in the study were discussed. Further discussions on data collection methods used were linked with mapping and laboratory analysis of the study areas. Measures of accuracy relating to data collection were analysed. This led to the next chapter that presents the research findings of both study areas.

# CHAPTER 4: RESULTS AND DISCUSSION

## 4.0 Introduction

This chapter presents data, analyses it and discusses the emerging research findings as is guided by the research objectives and research questions. The findings focus on wetland uses, wetland protection, legislation and policy in the two study locations of Belvedere North and Epworth in Harare, Zimbabwe.

## 4.1 Wetland Mapping

Both the Belvedere North and Epworth wetlands images were mapped using the Geographical Information Systems (GIS). The mapping showed the disturbed and the non-disturbed areas in the two regions.

### 4.1.1 Belvedere North and Epworth wetland maps

Both wetland areas can be classified as dambos (commonly known as vleis). This could be because the wetland area has water in some of the seasons and not others. The dambos are mostly treeless with grass being the dominant vegetation. The wetland vegetation comprised *typha latipholia* in most of its sections. The soils are grey – black in color with moisture permanently. The vlei showed the presence of silt in some portions, thus proving the presence of water.

The GIS calculations show that the total area of the Belvedere North study site (Figure 4.1) is 59.2 hectares. Of the 59.2 hectares, a total of 24.89 hectares are under human occupation and the remaining 34.31 hectares (57.9%) is still uninhabited wetland.

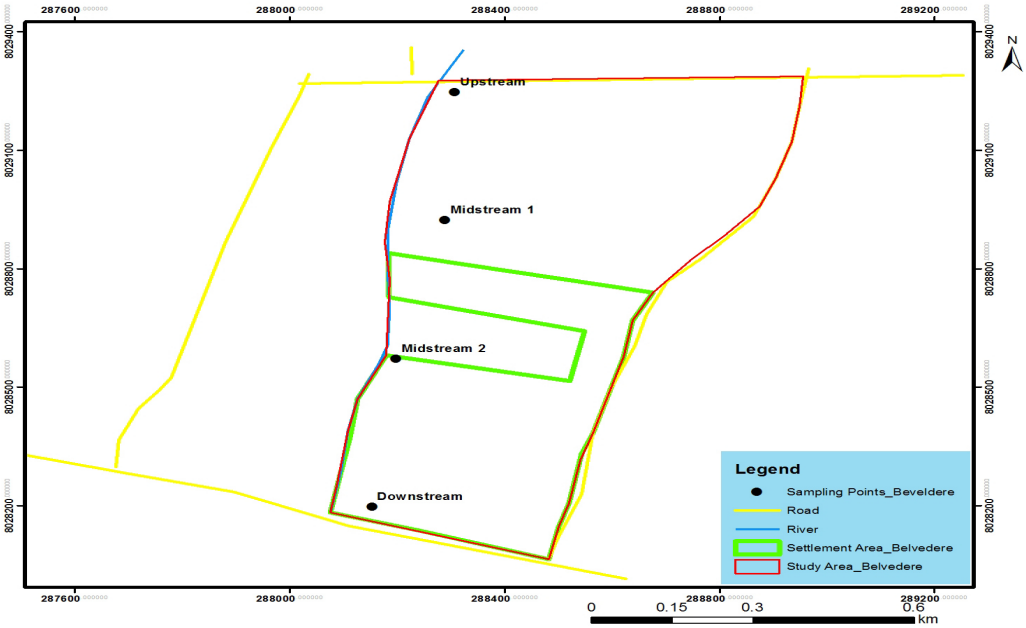



**Figure 4.1: Belvedere North wetland showing settled area**

Calculations show that a total area of the Epworth study site is 62.26 hectares (Figure 4.2). Out of the land areas, 39.25 hectares (63%) was under human occupation and use leaving just 40% as uninhabited.

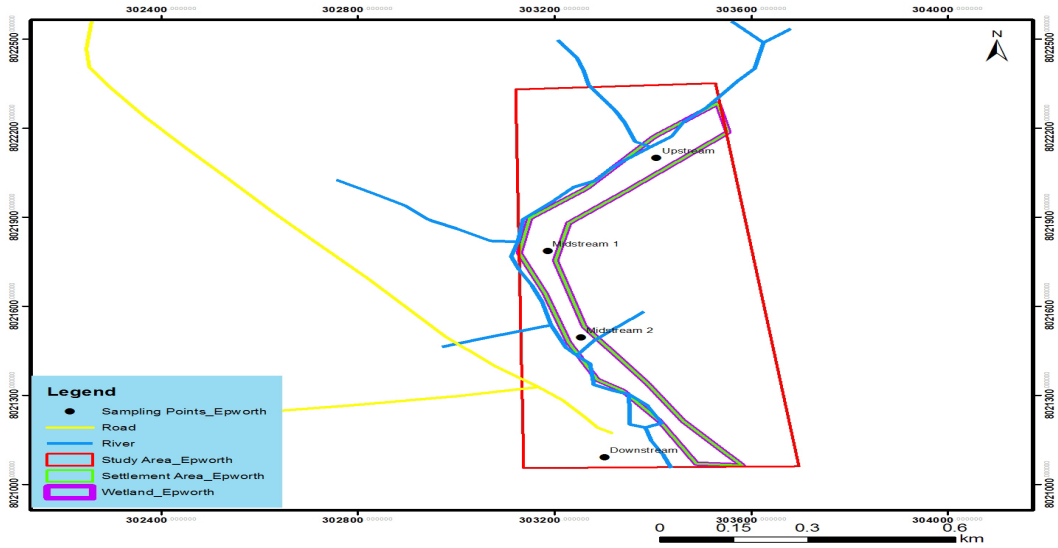



**Figure 4.2: Epworth Wetland showing settled area**

### 4.1.2 Land-use changes in the Belvedere North and Epworth wetlands

A comparison of historical and current aerial photographs shows that there have been changes in the wetland uses in both Belvedere North and Epworth. Figure 4.3 is a 2011 photograph of the Belvedere North wetland before it was occupied. It shows that most of the tall trees have been cleared. The trees were cleared to facilitate the cultivation of foods crops. Figure 4.4 shows the same wetland in 2014. The construction in the 2014 photograph is a shopping mall constructed by a Chinese company in the year 2013.

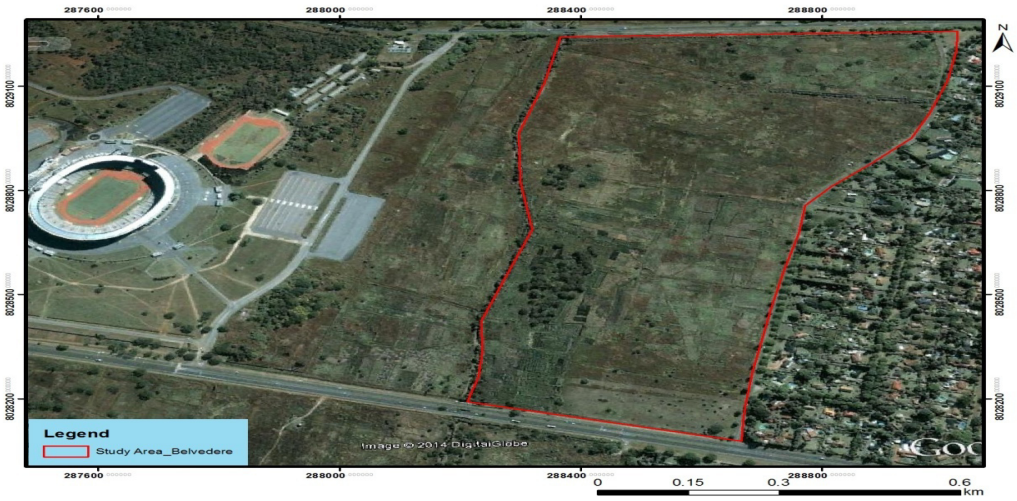



**Figure 4.3: Belvedere North wetland before settlement (Google Earth April 2011)**

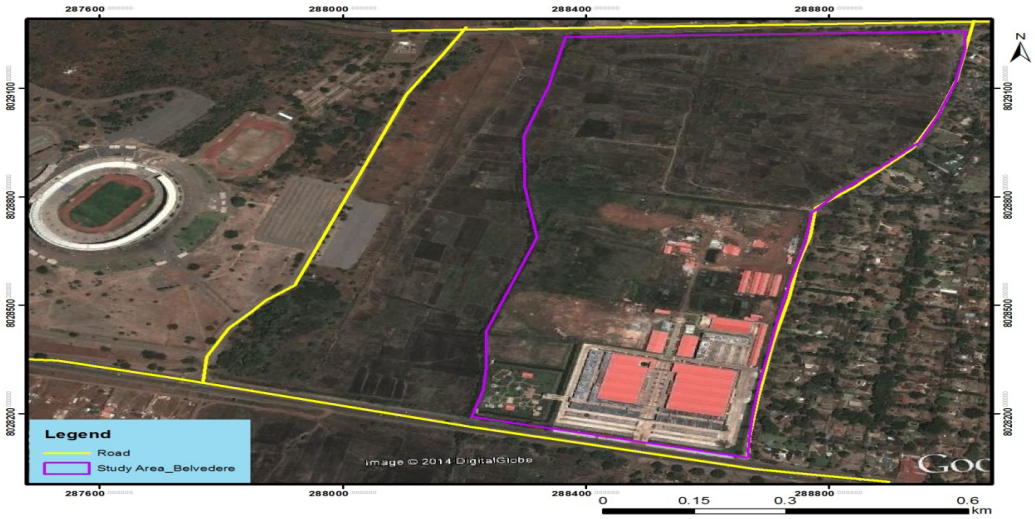



**Figure 4.4: Belvedere North wetland after settlement (Google Earth, April 2014)**

The wetland in Epworth also shows an increase in occupancy. Figure 4.5 shows the Epworth wetland before it was occupied (2011). Figure 4.6 shows the same wetland in 2014. The 2014 figure shows a dense informal settlement that grew in just three years. An interesting observation is that the settlement was linear following the nearby river, the Jacha River

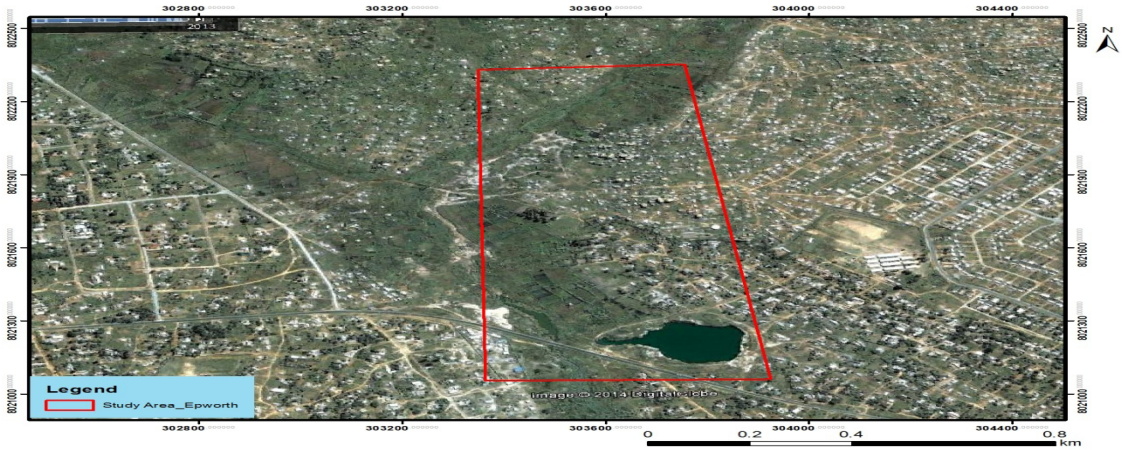



**Figure 4.5: Epworth wetland before settlement (Google Earth, April 2011)**

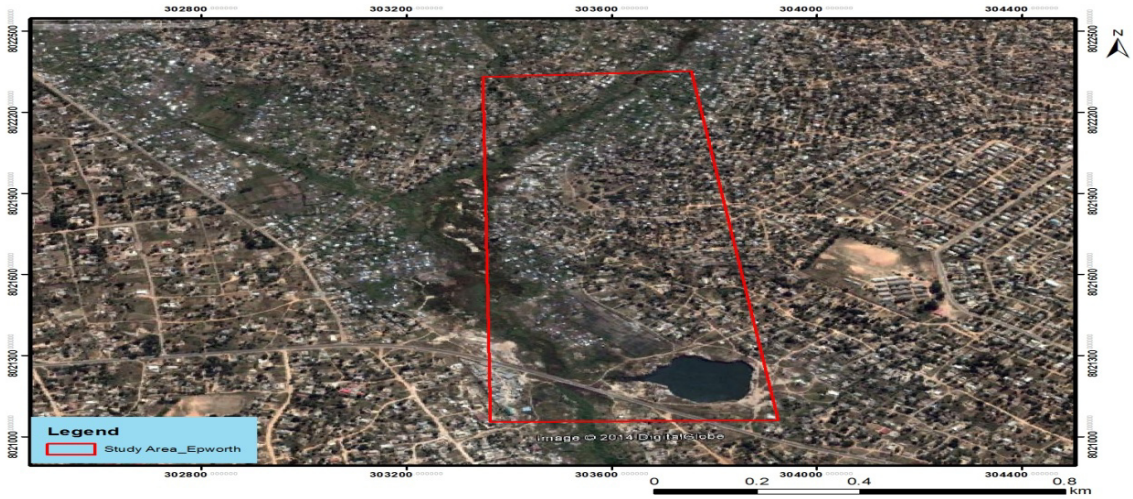



**Figure 4.6: Epworth wetland area after settlement (Google Earth, April 2014)**

### 4.1.3 Comparison of mapped areas

The Belvedere North wetland has a commercial property that covers most part (Figure 4.7) of the wetland. The Epworth wetland (Figure 4.8) was mainly dominated by residential dwellings as

compared to Belvedere North wetland. The area disturbed in the Epworth wetland (63%) was more pronounced as compared to the Belvedere North wetland (42%). The vegetation in both wetlands was almost similar although much of it had been destroyed in Epworth as compared to Belvedere North.

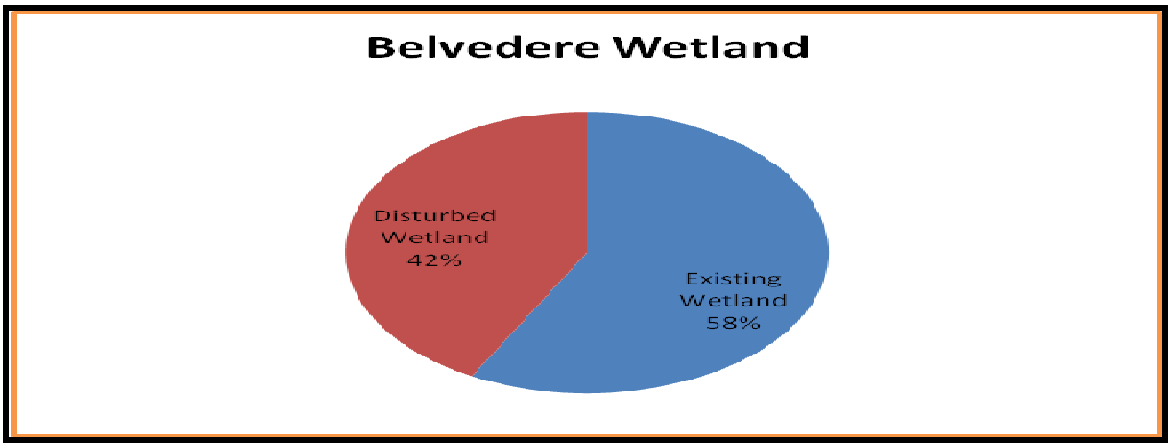



**Figure 4.7: Disturbed and undisturbed wetland areas in Belvedere North**

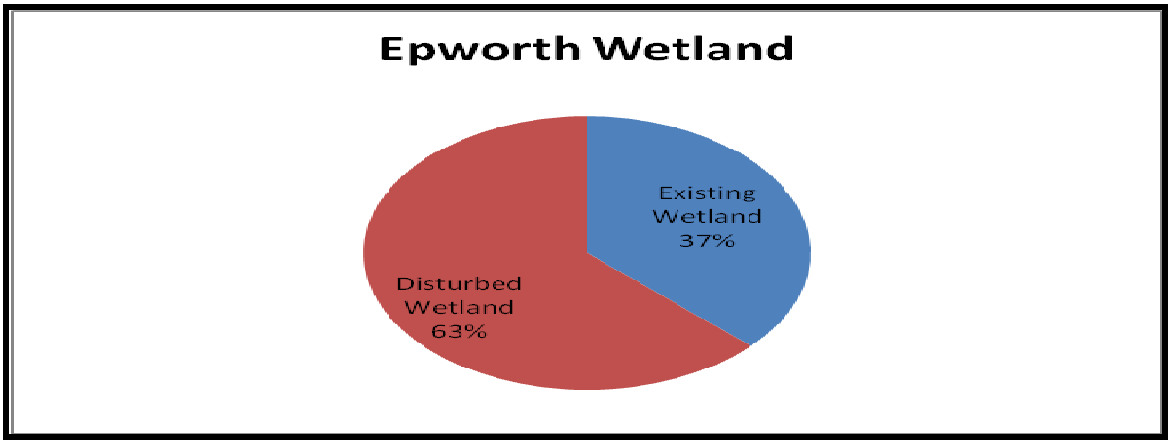



**Figure 4.8: Disturbed and undisturbed wetland areas in Epworth**

The overall mapping of the Belvedere North and Epworth study areas led to the discussion of activities being undertaken in the wetlands. Activities in the study areas are with respect to the disturbed and undisturbed portions of the wetlands.

## 4.2 Activities in wetland areas

### 4.2.1 The Belvedere North Scenario

There were 25 respondents in the Belvedere North study area. Of these, 68% were females whilst 32% were males. There were 15 respondents who were formally employed. As shown in Figure 11, 52% of the respondents were aged between 31 – 40 years whilst 20% of them were aged between 25 – 30 years (Figure 4.9). The respondents were aware of wetlands but had not been informed by the Environmental Management Agency (EMA) that the Belvedere North wetland had been zoned as a wetland area (EMA, 2012). This is because 72% of the respondents had good knowledge of wetlands.

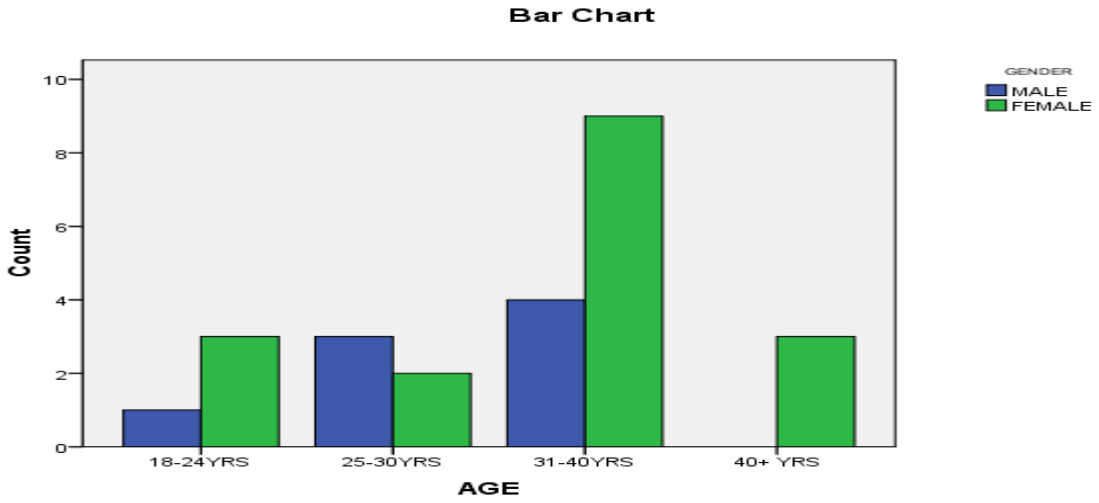



**Figure 4.9: Employment and gender in Belvedere North**

The major activities in the wetland were housing, urban agriculture and dumping of waste (Chiesura, 2009). The Belvedere North area has been inhabited for more than 15 years. The suburb was formally planned by the City of Harare and is thus fully serviced with water and roads. Initially, the houses in Belvedere North were more than 300m away from the wetland. However a high demand for residential land has led to the allocation of land within wetlands. The mall shown in Figure 4.4 is the latest of buildings constructed on the Belvedere North wetland as at 30 May 2014.

Part of the wetland is yet to be designated legally. The undesignated portion of the wetland is being used for agriculture and illegal dumping of waste. Residents dispose waste in wetland areas and this refuse goes uncollected for days (Goredema, 2013). The residents usually dump wood components, leaves falling from tress, plastic, paper and metallic components. The refuse piles over time and disturbs the aesthetic value of the wetland area. The residents said they use the wetlands for waste dumping because of the infrequency of municipal waste collection services. A research carried out by Masara (2012) confirms the disposal of waste on wetlands in Chitungwiza Town.

Urban agriculture is carried out all year round depending on the availability of water in the wetland. The residents grow crops such as maize, sweet potatoes and yams on a subsistence basis. The cultivation process involves the creation of ridges so as to create channels for water to both drain the land and irrigate the crops. The respondents said that they add fertilizers such as Ammonium Nitrate (AN) to enhance growth of the crops in the wetland. The residents stated that they had not been prohibited from cultivating or dumping in wetlands. Cultivation on wetlands is confirmed by Goredema and Sithole (2013) in their research in Harare. He explains that wetlands are being used for agriculture by residents on a subsistence basis.

The residents added that if the local authority formally notified them that wetland encroachment is prohibited then probably they would accept. The majority of the respondents (84%) stated that there were not aware of any as well as campaigns in the Belvedere North area with regards to wetland (Figure 4.10). In contrast, 16% of the residents stated that they had heard about concerns about wetlands in television programmes. This shows the inadequacy of the current wetlands awareness and protection programmes in the area.

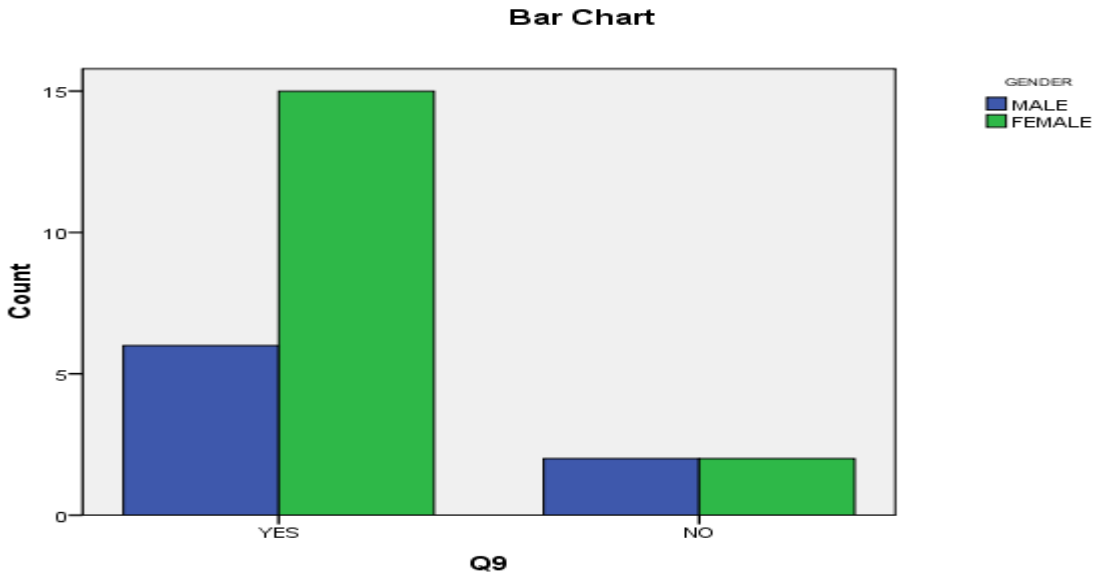



**Figure 4.10: Responses regarding wetland awareness**

### 4.2.2 The Epworth scenario

There were 60 respondents in the Epworth area. The respondents residing in the Epworth wetland comprised mainly of women. The women comprised 82% of the respondents and all had gone through secondary education. According to the 2012 Census Report (ZimStat, 2012), Epworth's Ward 6 had a total of 12,838 females and 12,759 males. This makes a total of 25,597 people in one ward out of seven wards. Most of the respondents were able to communicate and understand issues regarding wet areas. However, the respondents were informally employed with 23% being formally employed. The women said that the Epworth area does not have a sewer and water reticulation system and as such they use other means for their livelihood.

As observed in literature, the Epworth area largely comprises informal settlers who have illegally occupied land (DSHZT, 2009). These informal settlements extend to wetlands in the area. This is because the wetlands were some of the previously unoccupied pieces of land.

The residents abstracted sand from the wetland for construction of their own houses. Some of the extracted sand was sold to locals who were building in Epworth. A study carried by Chirisa (2010) shows that different communities thrive from their surrounding environment but to an

extent of exploiting the existing resources to their exhaustion. This is a common scenario in Epworth especially considering the demand for space.

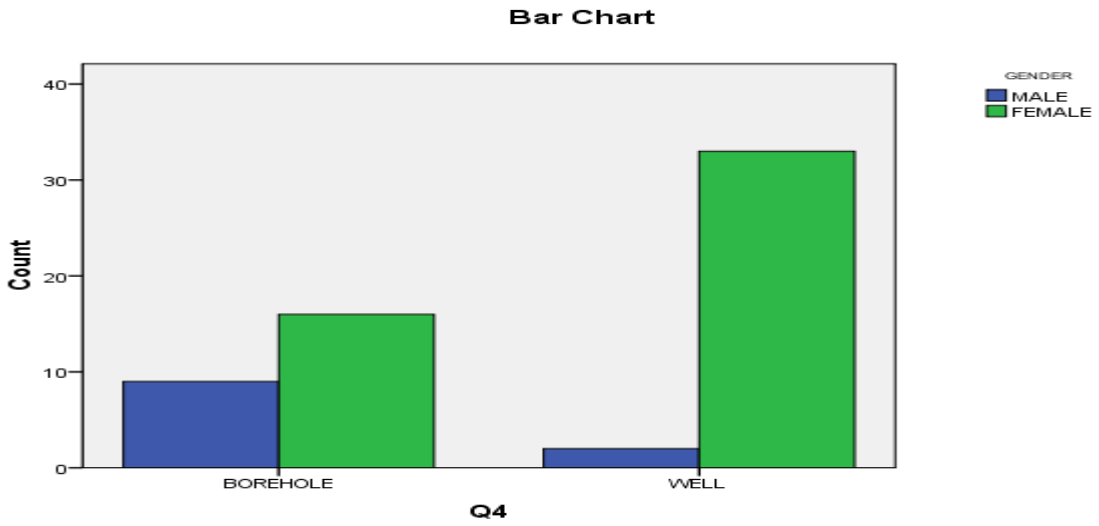



**Figure 4.11: Responses to water source in Epworth**

The absence of a proper sewer system has resulted in residents constructing open pit latrines for their toilets. The open pit latrines have been erected in the wetland and during the rainy season, sewage leaches from latrines. The latrines are open holes that are not lined. Besides, open wells are dug close to dwellings and toilets in the Epworth wetland (Figure 4.11). The open wells have a depth of between 0.80metres and 1.9 meters depending on the location of the well (Figure 4.12). Some of the boreholes are protected from contamination by lids but such protected wells are few in number. The open wells are deepened in the dry season so as to access water. The water from the open wells is used for cooking, drinking, washing and watering vegetables. The water from the open wells was visible dirty and respondents acknowledged this. They claimed that they boil this water prior to drinking.

**Figure 4.12: Open wells in Epworth (Photograph by Luke Mutisi on 26/10/2013)**

Observations in the Epworth wetland included washing of clothes, abstraction of water for domestic use, artisanal quarry mining, sand abstraction, defecation, subsistence agriculture and construction of houses. These activities were not controlled by either the local authority or the EMA. The residents said that they were traditionally used to utilizing wetlands to their benefit. In Epworth as a whole, there are currently no formal and informal organizations responsible for the management of wetlands. In addition there has been no enforcement of standing by-laws by the local authority despite a growth in informal settlements. According to Boadi et al (2005), it was confirmed that urban growth was faster than the provision of land and water resources.

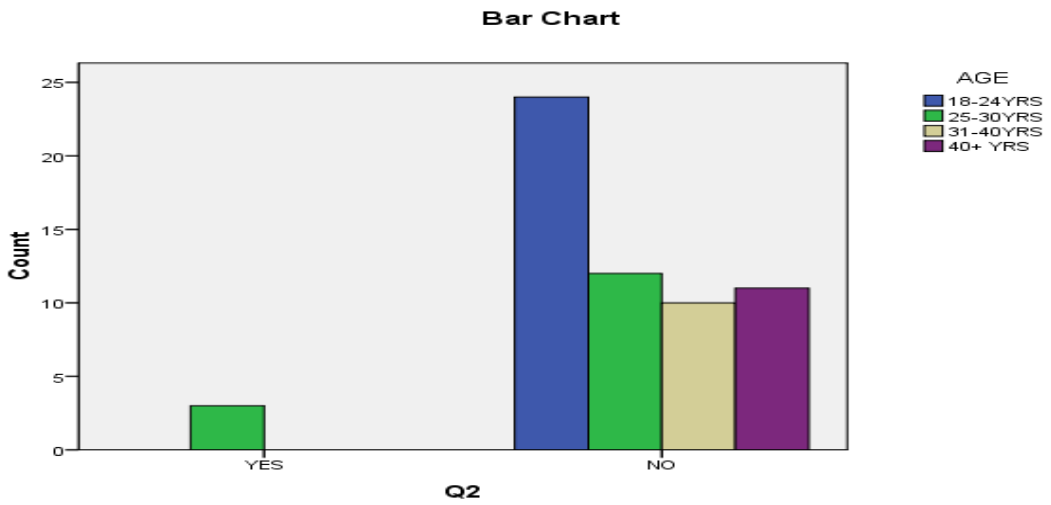



**Figure 4.13: Responses to whether residents had been informed about wetland**

According to Figure 4.13 above, 92% of the locals claimed that they had not been informed about wetland destruction. The age groups in Figure 4.13 were interviewed and indicated that they were not informed. However, they acknowledged that wetlands are beneficial in a significant way. The residents said that wetlands have been beneficial through supporting the cultivations of food crops such as maize, vegetables and sweet potatoes (Figure 4.14). The cultivation of crops was carried out all year round in the wetland area because water is readily available.

**Figure 4.14: Cultivation, settlement and toilet in the Epworth wetland (Photograph by Luke Mutisi on 26/10/2013)**

The wetlands in Epworth were under threat because the area was highly populated. From the 2012 census report (Central Statistical Office, 2012), Epworth had a total of 161,840 people with 25,597 people being in the study area (Ward 6). This population had a potential of placing pressure on the wetlands as there is no sewer system.

To complement responses from residents, further information was sought from selected professionals. Information from professionals was meant to augment with that of residents from the two study areas.

### 4.2.3 Responses from Professionals

The research interviewed 15 professionals in this field. Interestingly all respondents were males aged above 30 years. All the respondents in this group were formally employed with 73% of them having gone through tertiary education.

The respondents showed that wetland survival was threatened by a number of factors. These factors were either anthropogenic or naturally induced as follows:

**i. Demand for space**

All the professionals agreed that housing developments were mushrooming due to the land pressure facing the council. In particular, one of the Housing Cooperative Heads stated that there was pressure on the land due to the increasing population as a result of in-migration.

To address increasing population, the cooperatives were targeting all the available open spaces such as wetlands. He one of the respondents argued that, "Land in Harare is scarce and as such we are opting for wetland areas as residential land since it is available and not being utilized. Suburbs such as Avondale, Budiriro, Strathaven, Monavale, Ashdown Park, Westlea and Tynwald are already built up in wetlands. As cooperatives, we will encourage all land beneficiaries to include special foundations during construction."

Another Housing Cooperative Head concurred to the same as he said, "wetlands are open spaces that could be utilized by locals to ease the accommodation challenge. However, constructions

should be carried out in an appropriate manner to minimize falling of housing structures. If wetlands are the available land, why not use them?"

### ii. Wetland degradation

All 15 respondents agreed that wetlands were being affected by activities such as housing, urban agriculture, dumping of waste, water pollution, water and sand extraction. However, housing stood out (70%) as the major activity in wetlands. Urban agriculture, dumping of waste and sand extraction (25%) contributed to wetland degradation. As indicated in Figure 4.15, urban agriculture is practiced in most wetlands in Harare. One of the senior environmental planners from the City of Harare had this to say about urban agriculture, "Urban agriculture is rampant in Harare wetlands regardless of the prohibition by the local authority. Residents grow maize and sweet potatoes in wetlands on a subsistence basis. This destroys the aquatic related flora and fauna in wetlands."


**Figure 4.15: Cultivation in Epworth wetland (Photograph by Luke Mutisi, 25/10/2013)**

An EMA official further slammed urban agricultural and waste dumping activities in wetlands. He said that, "Wetlands are fragile ecosystems that need to be preserved. However, these wetlands have been used for urban agriculture and dumping as well. Pollutants from these activities have affected water quality due to fertilizers introduced during cultivation. Besides, housing plays a major role in the drying up of wetlands"

Another official from the same organization said that, "wetlands are "breathing spaces" for the suburbs. In other words, they reduce chances of flooding in the suburbs in times of continuous rains. Wetlands would help in the maintenance of the water table. Water abstraction and degradation should be minimized if wetlands are to benefit the generations to come."

A Ministry of Health and Child Care official indicated that the destruction was due to infrastructural developments. He said pollution of wetland had deleterious health impacts on water users downstream. The official stated that housing developments carried a higher chance of introducing pollutants to the wetland which eventually affect the quality of water. He said that, "pollution from housing activities affects downstream water users. This creates serious health hazards to the communities as residents drink dirty water thereby affecting their health."

This however shows that urban agriculture most likely has a role to play in the degradation of wetlands. Degradation of wetlands affects the water loving vegetation and the water retaining soils.

### iii. Planning issues

A total of six (6) planning officers were part of the respondents. Of these, two (2) were from the City of Harare, two (2) from the Ministry of Local Government and Public works and two (2) from private planning consultancy firms. All these planning officers agreed that wetlands were threatened by housing developments and proper planning was the solution. An official from the City of Harare suggested that, "The way forward to addressing land pressure is to plan vertically. In this I mean that high rise buildings should be built in the available space so as to ease the pressure on wetlands."

In addition to the council official, the researcher also engaged private sector professionals in this area. One senior official from Deam Planning Consultancy (Pvt) Ltd (a firm that offers planning and environmental services in Zimbabwe) said that wetlands have to be zoned for recreational purposes. The senior official proposed that, "wetlands are to be zoned as recreational areas. This will mitigate impacts on wetlands. For instance, a wetland can be use for bird viewing. This will ensure that the wetland is not disturbed by any other activities."

An Official from the Ministry of Local Government wherein the Department of Physical Planning is housed indicated that available land should be allocated to citizens. He said that "Plans are underway to allocate land in developable areas outside Harare. Besides, the Government of Zimbabwe is planning on expanding the City of Harare boundaries so as to create residential space."

An academic from the University of Zimbabwe said that wetlands were to be zoned as protected and restricted areas. He cited that, "The Regional, Town and Country Planning Act (1996) requires that sensitive ecosystems be preserved by restricting construction and cultivation within a 30 meter distance from a river or stream. This is not being respected as residents cultivate in the wetlands."

**iv. Wetland awareness and enforcement of related by-laws**

All the respondents agreed that awareness was being carried out regarding wetlands. However, they all disagreed to any enforcement being carried out in the area. The respondents said that the lack of enforcement contributed to wetland degradation. An ecologist from the Ministry of Agriculture and Mechanization blamed the local authority for failing to enforce by-laws. He said that, "the local authority is not enforcing its existing by laws. Instead, it has not addressed the issue of degrading wetlands. Those destroying wetlands should be arrested and fined for destroying wetlands."

One City of Harare official argued that it was not their sole responsibility to carry out enforcement. He said that EMA was also responsible for enforcing wetland related issues. He argued and said that, "the City of Harare has been trying its best to enforce laws. The

introduction of EMA meant all the responsibility regarding wetlands would be on them. As the City of Harare, we know that EMA gives fines to wetland offenders."

On the contrary, the EMA official who respondent said that enforcement was difficult as some of the land was politically negotiated. Besides, some of the wetland areas were allocated to individuals 7 years prior to the introduction of EMA. He further argued that some developers would develop on wetlands and then regularize the land later. He said, "As EMA, we are trying our best to ensure that wetlands are preserved. The major challenge is that some of the land had already been approved by the local authorities. Besides, some of the developers politically find their way to ownership of land."

### v. Stakeholder Engagement

All the professionals suggested that stakeholder engagement may address issues of wetland degradation. The Ministry of Environment, Climate Change and Water agrees that stakeholder engagement may assist in addressing wetland degradation. Unfortunately forums have been carried out lately and as such, they have to be planned for. EMA, pressure groups, local authority and the general public should meet to address wetland issues.

Stakeholder engagement in informal communities would create a platform for concertizing the locals about the functions of wetlands. He further said that it was not easy to stop urban agricultural activities as some locals survive from the crops they grow in wetlands. He also said that proper policing would ensure that wetlands were preserved although the process would take time before being embraced.

### vi. Policy and legislation

Issues emanating from the stakeholder forums should then be incorporated into policy. To establish a sound policy, previous by-laws and policy instruments have to be revised. Wetland preservation may be assisted by a people driven policy. In other words, contribution from different individuals would create sustainable strategies for wetland utilization.

It is interesting to note that 44% of the respondents did not know of any future plans regarding wetlands. About 12% of the respondents were not sure on how these respondents were going to

be managed. It is with this regard that policy on wetlands is not clear. The environmental policies may need to be reviewed if wetlands are to be protected.

## 4.3 Water Quality in Research Sites

As already highlighted in the methodology chapter, the grab method of collecting samples was employed in the study. This method was used due to the accessibility of water in the study areas. The results obtained from the 4 (four) sampling sites in October 2013 and March 2014 are discussed further in the following sub-sections. The World Health Organizations' water guidelines were used for benchmarking and analyzing the results.

### 4.3.1 Water Quality in Belvedere North

The parameters analyzed in this study were selected with respect to the activities in wetlands. In essence, the parameters were selected on the probable pollutants that are associated with particular activities. In this case, housing developments are associated with anthropogenic activities that have the potential of polluting the environment. As a result total nitrogen (NP), total phosphate (TP), salinity, conductivity, temperature, dissolved oxygen (DO) and pH were selected as pollution indicators. According to Hemond and Benoit (1988) pollutants such as phosphates, nitrogen, conductivity and dissolved oxygen emanate from anthropogenic activities. These indicators were analysed in water samples collected in Marimba River were carried out at two different times i.e. October 2013 (dry season) and March 2014 (wet season). The analysis results are presented in Table 4.1.

The total dissolved solids (TDS) recorded a mean of 407.5ppm in October in comparison to a recording of 403.75ppm in March. On the other hand, pH recorded a mean of 8.38 in October in comparison to a mean of 8.265 in March. This shows that the results were almost similar for both months. Results for both months are shown in Tables 4.1 and 4.2:

**Table 4.1: Belvedere North water sampling data for October**

| Condition & Units | Phosphates µg/l | Nitrogen µg/l | Conductivity µS/cm | TDS ppm | Salinity mg/l | pH | DO mg/l |
|---|---|---|---|---|---|---|---|
| Upstream | 0.032 | 0.014 | 560 | 398 | 352 | 8.5 | 3.7 |
| Midstream 1 | 0.033 | 0.014 | 579 | 410 | 362 | 8.3 | 5 |
| Midstream 2 | 0.046 | 0.013 | 580 | 411 | 360 | 8.39 | 5.6 |
| Downstream | 0.039 | 0.014 | 580 | 411 | 364 | 8.34 | 5.8 |
| | | | | | | | |
| Mean | 0.0375 | 0.01375 | 574.75 | 407.5 | 359.5 | 8.38 | 5.025 |

**Table 4.2: Belvedere North water sampling data for March**

| Condition & Units | Phosphates µg/l | Nitrogen µg/l | Conductivity µS/cm | TDS ppm | Salinity mg/l | pH | DO mg/l |
|---|---|---|---|---|---|---|---|
| Upstream | 0.0125 | 0.045 | 573 | 407 | 303 | 8.5 | 7.1 |
| Midstream 1 | 0.0125 | 0.044 | 573 | 400 | 307 | 8.3 | 6.3 |
| Midstream 2 | 0.013 | 0.045 | 603 | 385 | 304 | 8.0 | 6.2 |
| Downstream | 0.0125 | 0.045 | 596 | 423 | 320 | 8.1 | 5.1 |
| Mean | 0.01262 | 0.04475 | 586.25 | 403.75 | 308.5 | 8.225 | 6.175 |

The results in Tables 4.1 and 4.2 show that the conductivity levels were constant in both months. This could have been contributed by the Monavale wetland located upstream of the study site. This confirms that wetlands act as filter to dissolved and suspended solids as depicted by Gambrell and Patrick (1988). Of note is the March sample result in midstream 2 where it is highest (Figure 4.16). The result correlates with the high midstream 2 phosphate levels of 0.013mg/l shown in the Table 4.2 above. Absolutely, pure water is a poor conductor of electricity. Water shows significant conductivity when dissolved salts are present (EMEA, 2006). According to Schilperoort et al (2006), over most ranges, the amount of conductivity is directly proportional to the amount of salts dissolved in the water.

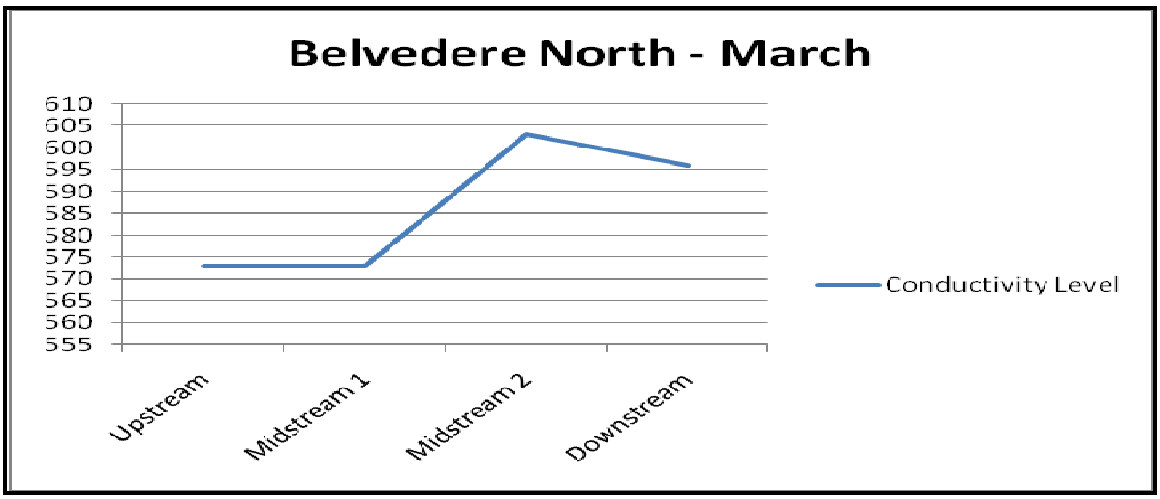



**Figure 4.16: March conductivity levels in Belvedere North**

The total dissolved solids (TDS) levels were more or less constant in both months. However, a figure of 423ppm (highest) was recorded downstream in the month of March. The results show that the downstream section was more contaminated more than the upstream and downstream sections (Figure 4.17). This may indicate that there were more impurities (salts and minerals) in the water downstream. Strecker et al (1992) confirm that high levels of TDS indicate the presence of salts and minerals. As water moves downstream it is bound to dissolve more solids.

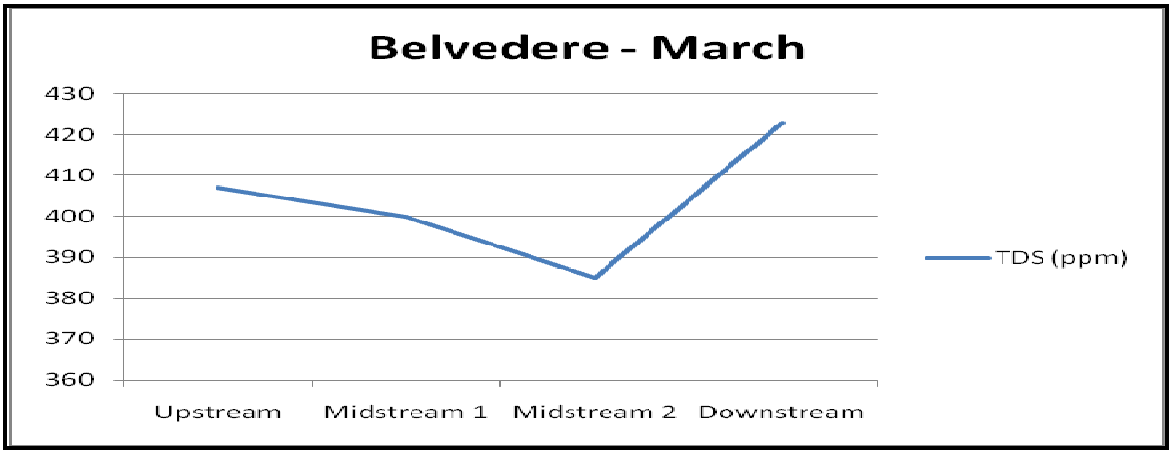



**Figure 4.17: March TDS levels in Belvedere North**

However, there was a slight difference in nitrogen levels between water samples taken in October and those taken in March (Tables 4.1 and 4.2). The results collected in October were

lower whilst those collected in March were higher. An increase from 0.013mg/l to 0.045mg/l was realized on the midstream section in October and March respectively. The increase in nitrogen levels can be attributed to different agricultural activities in the wetland during these periods. The residents who were carrying out agricultural activities could have used fertilizer during the cultivation process. The application of fertilizer could have increased the nitrogen level in the water. According to Hemond and Benoit (1988), cropland contributes the nitrogen component due to fertilizer application and other anthropogenic activities. The lower nitrogen levels in October can be attributed to less or no urban agricultural activities occurring during this period.

The upstream section of the Belvedere North wetland showed an undisturbed portion. As such, water samples collected upstream were less polluted as compared to downstream water samples. If the portion of the wetland remained undisturbed, this then meant that filtration of most pollutants would occur. This would improve the water quality downstream of the wetland. Adamus et al (1987) however reject this finding as pollutants are expected to increase downstream due to anthropogenic activities on the wetland.

The existing settlement (shopping mall and residential houses) could have contributed to the increase of conductivity levels. The water conductivity measure was lower in October as compared to that in March. This could have been contributed by the domestic activities and commercial operations at the Mall. Domestic activities have the potential of releasing ions in the water. The ions will in turn contribute to conductivity levels. However, Begg (1990) rejects the results obtained in October since a high measure of conductivity is expected in the dry season due to recharge.

The dissolved oxygen (DO) and salinity levels did not change significantly. This could have been contributed by the absence of agricultural activities as well as a slow flow rate in October. In the month of March, the flow of the river was faster than in October thus resulting in the dilution factor coming to play (Gruber et al, 2004). The results still remained constant in the month of March.

The pH and temperature levels of both months were within acceptable/normal range with most sections of the river showing a pH range of between 7 and 8.6. A mean pH 8.265 was recorded in March and 8.38 in October showing that the pH was within an acceptable range that permits aquatic microorganisms to thrive. It is most likely that the aquatic life might not yet have been affected by the pH levels. The aquatic life might not be under threat from the activities in the area. Mitsch and Gosselink (1986) have noted that aquatic organisms thrive within a narrow range of pH.

**Table 4.3: Analysis for Nitrogen and Phosphate at 95% confidence interval (Belvedere)**

| Upstream to Downstream | Degrees of freedom | Standard Deviation | Standard Error Mean | Significance (2 Tailed) | Upper and Lower Limits |
|---|---|---|---|---|---|
| Total Nitrogen | 1 | 0.219 | 0.0155 | 0.479 | -0.2134462 and 0.1804462 |
| Total Phosphate | 1 | 0.049497 | 0.035 | 0.5 | -0.0479719 and 0.0409717 |

An analysis of the Belvedere North's upstream and downstream sections showed a standard deviation of 0.219 and a standard error of 0.0155 for total nitrogen at 95% confidence level (Table 4.3). Total phosphates showed a standard deviation of 0.0049 and a standard error of 0.035 at 95% confidence interval. The pH levels of all sampling sites ranged from 8.05 to 8.5, with a mean of 8.32 thus showing a small variation. Overally, the variance between the upstream and downstream sections is insignificant. This shows that the wetland might have been acting as a reservoir/filter of the pollutants. This is evidenced by the levels of total nitrogen and phosphates that were low. The low levels in Belvedere could also have been contributed by dilution or deposition in sediment from the upstream to the downstream sections. Kgomotso and Swatuk (2006) have noted that seasonal disturbances occur in wetlands due to activities such as agriculture that introduce pollutants through fertiliser.

### 4.3.2 Water Quality in Epworth

The Epworth wetland is coded as EP 1 on the Harare wetlands map (attached in the appendix section). The Epworth wetland shows high levels of conductivity, TDS, salinity and DO in the midstream and downstream sections of the wetland. The levels of conductivity alone had averaged 828.5µs/cm showing that there were ions and solids in the water. The conductivity was higher than in Belvedere North for both months (October and March) were high most likely due to the density and formality of settlements. A research by Van der Valk (2006) confirms the finding that pollutants from settlements reduce the quality of water. There were several activities within the wetland during the period of study. These activities included subsistence agriculture, settlement, washing of clothes, artisanal quarrying, water abstraction and erection of pit latrines.

Water abstraction was considered as one of the main causes of wetland degradation. According to Breen et al (1997) it is confirmed that water abstraction eventually reduces water quality. This is because during the process of water extraction, organic matter from the base of the river mixes with water. This in turn increases the ions in the water. Water extracted from wetlands can be used in the irrigation process of other gardens a distance away from the wetland.

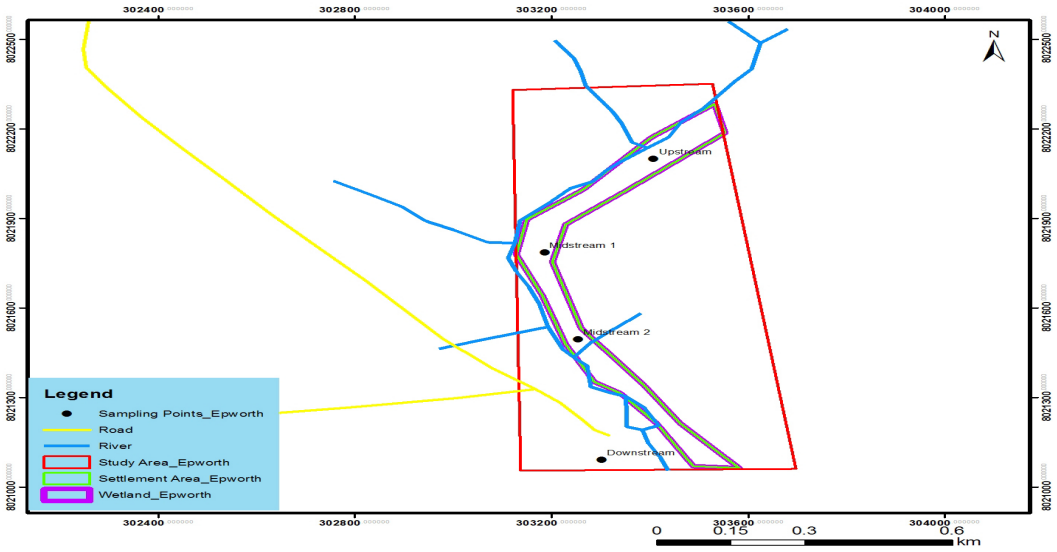



**Figure 4.18: Epworth wetland showing area settled**

The water samples of the upstream sections of the Epworth wetland show low conductivity, TDS and salinity levels. This could be because there are few settlements upstream and as such, the

wetland section is heavily affected by anthropogenic activities. However, these measure increase significantly midstream and downstream as shown in Table 4.4.

**Table 4.4: Epworth water sampling data for October**

| **Condition & Units** | **Phosphates mg/l** | **Nitrogen mg/l** | **Conductivity µs/cm** | **TDS ppm** | **Salinity** | **pH** | **DO mg/l** |
|---|---|---|---|---|---|---|---|
| Upstream | 0.016 | 0.016 | 130 | 92 | 86 | 7.5 | 3.1 |
| Midstream 1 | 0.041 | 0.013 | 1242 | 876 | 757 | 6.7 | 10.8 |
| Midstream 2 | 0.037 | 0.014 | 1241 | 891 | 751 | 8.3 | 9.1 |
| Downstream | 0.017 | 0.014 | 701 | 482 | 418 | 8.8 | 8.7 |
| | | | | | | | |
| **Mean** | 0.027 | 0.01425 | 829 | 585 | 503 | 7.8 | 7.9 |

**Table 4.5: Epworth water sampling data for March**

| **Condition & Units** | **Phosphates mg/l** | **Nitrogen mg/l** | **Conductivity µs/cm** | **TDS ppm** | **Salinity** | **pH** | **DO mg/l** |
|---|---|---|---|---|---|---|---|
| Upstream | 0.013 | 0.045 | 156 | 110 | 88 | 7.4 | 3.2 |
| Midstream 1 | 0.013 | 0.046 | 732 | 518 | 393 | 7.3 | 1.9 |
| Midstream 2 | 0.0125 | 0.046 | 740 | 516 | 397 | 7.5 | 1.8 |
| Downstream | 0.0125 | 0.046 | 753 | 532 | 403 | 8.2 | 5 |
| | | | | | | | |
| **Mean** | 0.0125 | 0.04575 | 595.25 | 419 | 320.25 | 7.6 | 2.525 |

It is important to note that the water quality results for TDS, Salinity and DO at the midstream section were higher in October as compared to the month of March (Tables 4.4 and 4.5). This could be due to the increase in activities such as agriculture in the wetland as water will be flowing slowly or stagnant. There was little flow of water due to the dry season in October i.e. before the rains. The residents extract water, defecate and wash their clothes in portions of the wetland that have stagnant or little flow of water. According to Figure 4.19, the ions from these

domestic activities could have contributed to TDS and salinity in the river. Hunt (2004); Perry and Vanderklein (1996); Hemond and Benoit (1988); and Mitsch and Gosselink (2000) noted that anthropogenic activities contribute to the increase of TDS and conductivity in rivers close to settlements.

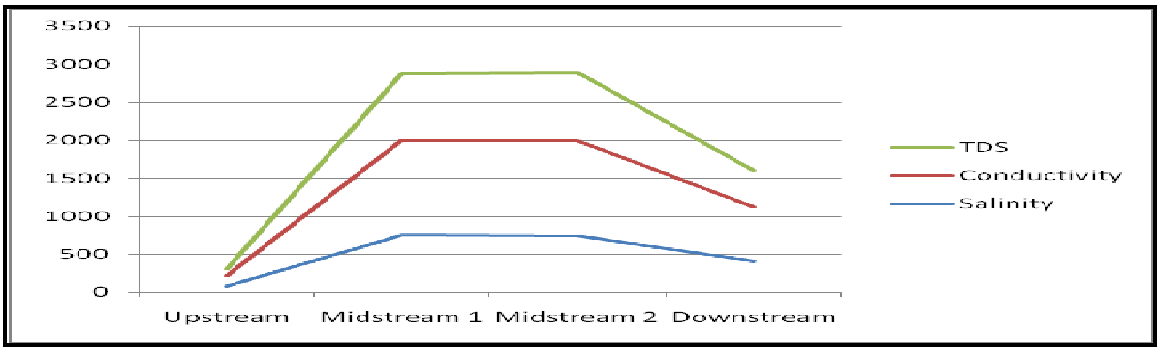



**Figure 4.19: Conductivity, salinity and TDS levels in Epworth (October)**

There was an increase in DO levels in midstream section (Figure 4.20). The DO could have increased due to the increase of organic components in the water at this section of the wetland. DO increased from 10.8 to 9.1 and 1.9 to 1.8 respectively in both months. A DO measure of less than 2mg/l indicates poor water quality that could have been attributed by the presence of organic components in water (Day et al, 1982; Hemond and Benoit, 1988; and Hunt, 2004). It is important to note that the midstream section in the Epworth wetland could be considered as the point of discharge as such, more pollutants are expected in this section of the wetland.

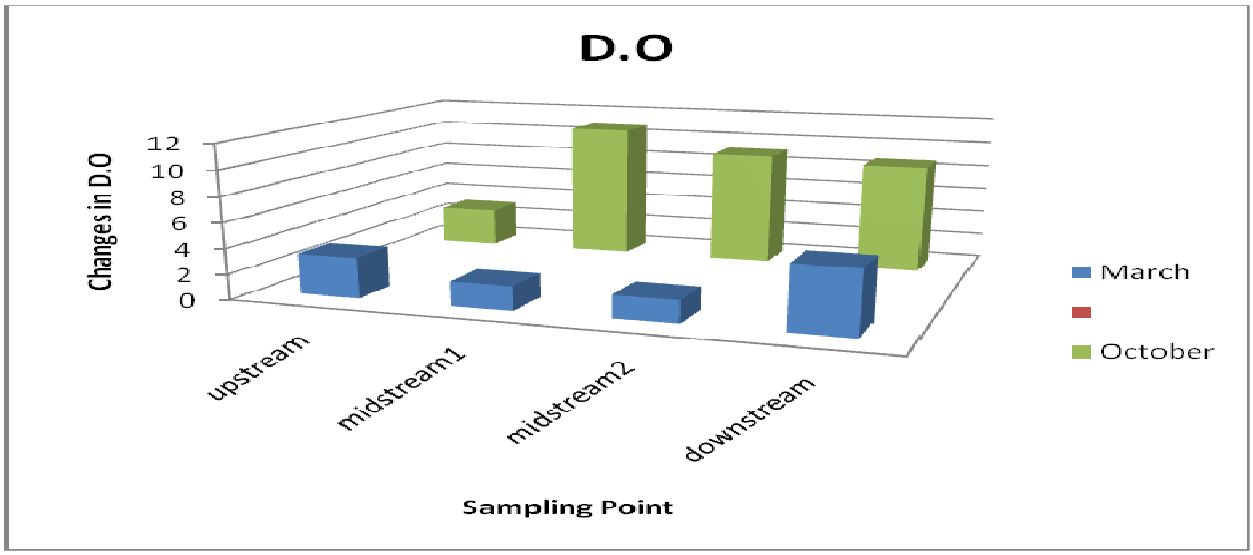


**Figure 4.20: Dissolved Oxygen levels in March and October**

The water quality in the downstream sections improved marginally in comparison to the midstream section. This could have been attributed by the fact that most of the pollutants could have been filtered in undisturbed portions of the wetland. As confirmed in a research by Kotze (2000) wetlands are important filters to pollutants.

The total phosphates and total nitrogen present in water may be emanating from post agricultural activities as well as pit latrines present in the wetland area. These were significant in the midstream and downstream sections of the study area in October (Table 4.4). The nitrogen components may have been Nitrate based fertilizers used in agricultural activities. The sewage from the pit latrines could also contribute to the nitrogen that could have been released by sewage. Besides, the significant levels of phosphates in October could have been contributed by the accumulation of fertilizer in the stream (Table 4.4). The accumulation of phosphates could have also contributed to the TDS in the stream in the Month of March. As confirmed by Moyo (1997), TDS levels usually increase when phosphates are introduced in water.

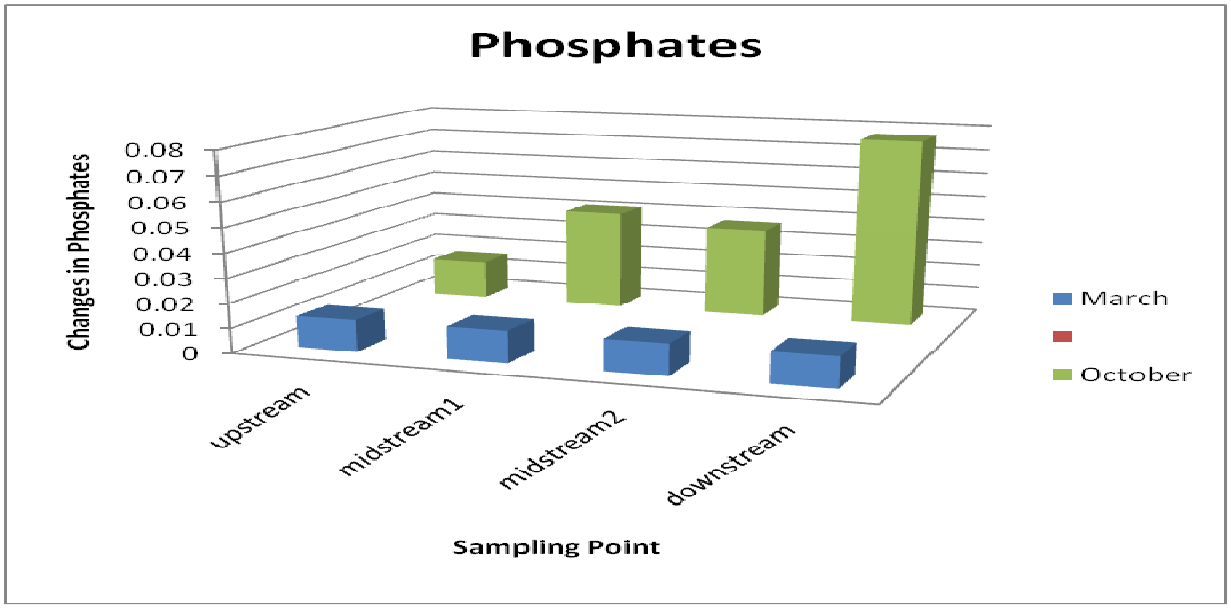



**Fig 4.21: Phosphate levels in March and October**

The conductivity and salinity of the midstream section was significantly high in October (Table 4.4). This can be attributed to ions emanating from the sewage in the pit latrines. A study carried

out by Phiri (1998) show that sewage has the potential of increasing conductivity. The pit latrines are all build in the wetland or at the peripheries of the wetland section.

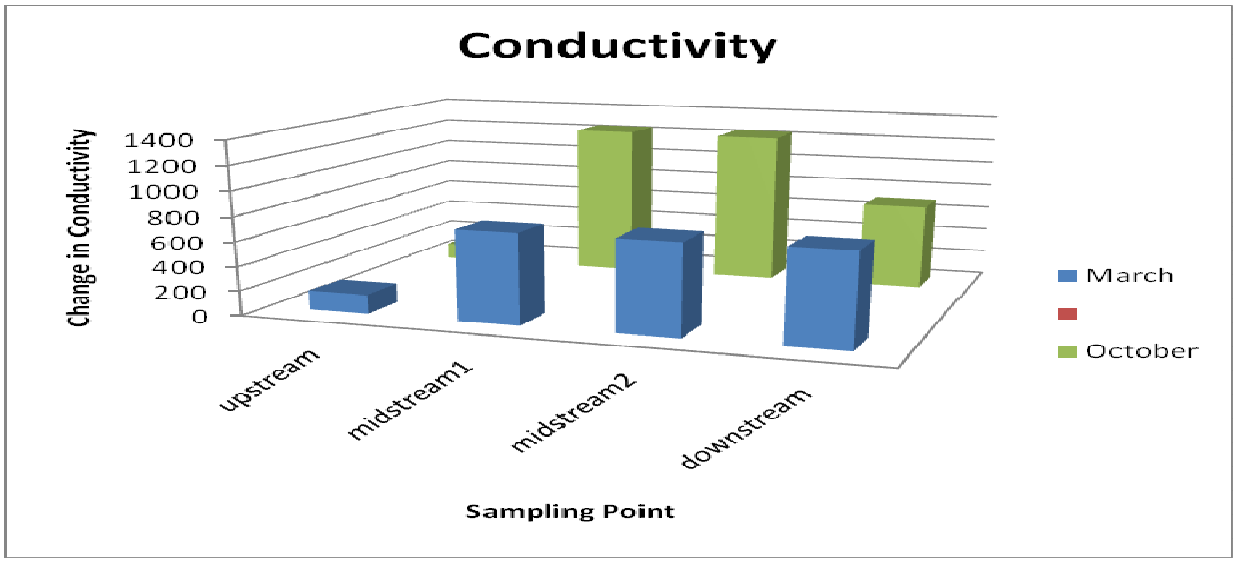



**Fig 4.22: Conductivity levels between March and October**

In addition, sand extraction and artisanal quarrying could have increased ions in the midstream sections of the study area. Quarrying activities contribute to ions as dust and rock particles mix with water during the process. A combination of pollutants from vehicles and mobile equipment could have contributed to the conductivity levels in the dry period. As noted by Hemond and Benoit (1988), some of these activities could have largely contributed to the ions present in the water.

The temperature and pH of the Epworth wetland were in the normal/acceptable range. The pH range was between 6 and 8 whilst the temperature had an average of $22^0$C. These values do permit the thriving of aquatic life.

An analysis of the Belvedere North's upstream and downstream sections showed a standard deviation of 0.212 and a standard error of 0.015 for total nitrogen at 95% confidence level (Table 4.6). Total phosphates showed a standard deviation of 0.0219 and a standard error of 0.0155 at 95% confidence interval. The pH levels of all sampling sites ranged from 6.7 to 8.8, with a mean of 7.7, thus showing a small variation. Overally, the variance between the upstream and downstream sections was insignificant. This shows that the wetland might have been

experiencing disturbance from different activities. This could have been contributed by the levels of pH which varied from one sampling point to the other due to potential activities. According to Nhapi et al (2002) the introduction of pollutants results in the change of water quality. Conductivity, TDS and Dissolved Oxygen levels could have increased due to the introduction of pollutants from activities such as urban agriculture and quarrying in the study site.

**Table 4.6: Analysis for Nitrogen and Phosphate at 95% confidence interval (Epworth)**

| Upstream to Downstream | Degrees of freedom | Standard Deviation | Standard Error Mean | Significance (2 Tailed) | Upper and Lower Limits |
|---|---|---|---|---|---|
| Total Nitrogen | 1 | 0.021213 | 0.015 | 0.795 | -0.0185593 and 0.0195593 |
| Total Phosphate | 1 | 0.0219203 | 0.015 | 0.48 | -0.2134462 and 0.1804462 |

## 4.4 Discussion of findings

The discussion of the mapped areas portrays the common land-use activities in wetlands. Mapping assists in showing wetland change over time. A research by Fitoka and Karemitsoglou (2008) shows that mapping of wetlands in the Mediterranean area were carried out by use of Landst TM Satellite imagery between the year 2005 and 2007. The mapping showed changes in forest cover thus permitting monitoring of the Mediterranean area. Furthermore, Jansen and Madzwamuse (2003) were involved in the mapping of wetland in the Okavango wetland with the aid of local institutions and indigenous knowledge for the purposes of wetland management. This culminated in the establishment of the Okavango Delta Management Plan as the area was declared a Ramsar site. Spatial distribution of the riparian vegetation in the Okavango delta was mapped for management and conservation purposes. On the other hand, ASTER and MODIS satellite images were used to map the Eleocharis birds in the Blue Lagoon National Park in Zambia (Munyati, 2007).

Wetlands are being threatened by demand for residential space. Masara (2012) studied wetlands and demand for residential space in Chitungwiza. In his study he considered the demand for space in relation to wetland areas. He focused on both infrastructure and superstructure that was established in wetlands. In his study he highlighted that houses, schools and commercial buildings were being constructed on wetlands. His results showed that other activities such as dumping of waste were affecting the environment. He also showed that the infrastructural developments were distorting the ecosystem. He said that the distortion of the ecosystem occurred by way of erosion and loss of habitat due to construction (Masara, 2012).

Population pressure places demand on housing. A study carried out by McGranahan, Balk and Anderson (2007) in China showed an increase in housing demand due to urbanization between the years 1995 - 2000. China's case showed an in-migration level of approximately 17 million people in its low elevation coastal land. The population increase resulted in pressure being place on the coastal land which led to demand for housing. The population concentration was perpetrated by trade activities that attract families to the coasts. Their results show that as families moved to the coasts, space was required for housing so as to accommodate the families (McGranhan, Balk and Anderson, 2007).

Informal settlements are a threat to wetlands. Marongwe et al (2011) studied the mushrooming of informal settlements in Harare. He focused his study on Hopley Farm, which is a well-known informal settlement in Harare. They showed that informal settlements were rising to the expense of the wetlands. They said that the slums were constructed in an unplanned manner. The qualitative results show that informal settlements affect wetlands. They indicated that the squatters are the highest threat to wetlands as they manipulate natural resources.

There are agricultural benefits that are associated with wetlands. A case study carried out in Palisa District, Uganda; shows that a population of more than half a million benefits from agricultural activities such as the growing of rice, subsistence farming and grazing. Besides, the wetlands have been used for transport, acquiring of medicine, hand art and fishing. From an economic valuation point of view, it is considered that the wetlands generate up to $34 million per year due to different food resources that emanate from the wetlands in Palisa District. These wetlands benefit locals in the District at household level since an average of $500 per hectare is

realized (Karanja et al, 2001). The wetlands have been sources of economic development to the subsistence farmers and as such families have been supported thereby.

Pollution varies with location and land-use. In a study carried out by Perry and Van der klein (1996) it is shown that stagnant or flowing water has the potential of receiving external chemical and physical components. Agriculture, industrial and domestic practices have the potential of introducing different toxicants, nutrients and sediments to wetland areas. These anthropogenic practices have the potential of increasing phosphorous and nitrogen components in the wetlands (Hunt, 2004). These chemical elements are commonly known as pollutants as they alter the quality of water (Adamus et al, 1987). The quality of water then either affects the downstream users or contributes to the growth pattern of certain plant species in the water body. For instance, increase of nitrogen contributes to algal bloom and exponential growth of water hyacinth. It is important to note that Nitrogen and phosphorous reduce the amount of oxygen as these react to nitrates and phosphates respectively thus altering the water quality.

## 4.5 Conclusion

Wetlands have been degraded by anthropogenic activities. Results show that the Epworth and Belvedere North wetlands have been encroached over time. Epworth shows a dense informal set up as compared to Belvedere North. The activities in Epworth are more pronounced in their effects as compared to Belvedere North. This is because of the activities being carried out on the Epworth wetland.

# CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

## 5.1 Introductions

The aim of this study was to unpack how housing developments in the City of Harare, Zimbabwe's capital are contributing to the loss and degradation of wetlands in selected areas. The study focused on determining the impacts of such housing developments on wetlands and propose possible intervention measures to minimize the loss and degradation of these wetlands. Two case study areas were chosen, namely: (1) Belvedere North and (2) Epworth suburb. This chapter therefore presents a summary of the study findings in relation to the research objectives, questions and the theory that relates to the study. The chapter then presents conclusions and suggestions based on the findings of the research.

## 5.2 Research objectives: A recap

The research was guided by two research objectives. The first objective looked at determining the link between housing development (including urban agriculture) and its effects on the wetlands in Epworth and Belvedere North suburbs in the City of Harare. The second and last objective was to evaluate responses put in place by the City of Harare in order to address housing development in the face of threatened wetlands, including clearing housing developments following environmental impact assessment (EIAs) studies or lack of such thereof.

To meet these objectives, the research sought to answer twin questions drawn out of the spelt out objectives, namely: (1) What is the link between housing development and wetland destruction in Epworth and Belvedere North Suburbs in the City of Harare? (2) What are the intervention measures that have been put in place so as to address housing development issues in relation to wetlands in the City of Harare, bearing in mind the role of EIAs? As for the main justification of the study areas, both Belvedere North and Epworth were chosen due to the visible occupation of their wetland areas, an aspect that leads to their degradation.

## 5.3 Summary of main findings

The study revealed that the Belvedere North and Epworth wetlands were being severely degraded. The major drivers of the degradation were human settlements and urban agriculture. Of the total wetland area in Epworth, 63.1% (62.26 hectares) of the wetland had been degraded. In contrast, 42.1% (24.89 hectares) of the Belvedere North wetland had been degraded. The research established that human settlements in wetlands were driven by a high demand for residential space in both study areas. The Belvedere North wetland was characterised by formally built structures whilst the Epworth wetland was characterized by an illegal unplanned settlement. Emerging from the research as potential solutions to avoid wetlands loss and degradation are the following key points that: to create residential space, the Ministry of Local Government and Public Works should consider expanding the City's boundaries; construction of multiple storey buildings could address the demand for accommodation; and lastly, the Environmental Management Agency and City of Harare was advised to continuously monitor housing and agricultural developments to ensure that project proponents carry out EIAs before the implementation of any project.

Urban agriculture was prevalent in both wetland areas. Residents grew crops such as maize and sweet potatoes on a subsistence basis throughout the year. Residents engaging in agricultural activities benefited from the use of wetlands in both study areas. To avoid this, awareness by the Environmental Management Agency and the City of Harare should be intensified in all the suburbs in Harare. This can be done through electronic media (television and radio), newspapers and fliers that inform citizens on wetlands. This should be coupled with mapping of wetland areas with the use of both Geographical Information Systems and remote sensing tools so as to demarcate land-use areas accurately.

The Epworth wetland presented more activities than the Belvedere North wetland. The study revealed that activities as sinking of wells, creation of open pit latrines and water extraction were more pronounced in Epworth than in Belvedere North. These contributed to the degradation of the Epworth wetland. To avoid this, the Epworth Local Board was advised to establish enforceable by-laws on wetlands. Epworth Local Board was further advised to source funds to

install a proper water and sewer reticulation system. This will ensure that sanitation is improved in Epworth's Ward 6.

The housing developments and agricultural activities contributed negatively to the quality of water in both case studies. The study revealed that water quality in Epworth was poor in comparison than in Belvedere North. The poor water quality was as a result of anthropogenic activities. Measures of Dissolved Oxygen, Total Dissolved Substances and conductivity increased from October to March in Epworth. Of note is the measure of Dissolved Oxygen that increased between October and March with a mean of 7.9 and 2.5 respectively. The study found out that ions increased significantly downstream of the wetland. The ions were contributed by more activities such as (i) sand extraction (ii) the sinking of wells and (iii) sinking of wetlands. Total nitrogen and total phosphate also increased significantly in midstream and downstream sections. In essence, averages of 0.01 in October and 0.04 in March were recorded respectively for total nitrogen. These pollutants were contributed mainly by fertilizer application by farmers during in their agriculture practices. To reduce pollution, an idea was proposed leading to the establishment of environmental committees at community level. These environmental committees will inform locals on the effects of urban agriculture and ways to mitigate associated impacts.

Wetland degradation was also associated with the lack of clear wetland policies both at national and local levels. The study revealed that there were no clear policy instruments to guide both residents and institutions in the management of wetlands. This was coupled with the lack of stipulated legislation that addresses wetland related activities. There is currently no enforcement and less awareness by the local authorities concerning wetlands in Harare. Minimal awareness and lack of enforcement is due to weak linkages between Government departments, City of Harare, EMA and the Department of Physical Planning that have not shared responsibility regarding wetland management. To avoid this, the study suggests that the local authorities should work synergistically with the key institutions identified herein, environmental advocacy groups and residents to ensure that wetlands are managed effectively. This can be done through holding meetings on a quarterly basis and through the proposed environmental committees.

The study further revealed that wetlands were not being properly planned for. Housing developments were evident in both wetland areas. The developments were established on wetlands after the year 2012, with Epworth being the most populated of the study sites. To address this, planning for wetlands through the creation of local development plans is required. The local development plan should include zoning of wetlands for recreational purposes. Further to this, the establishment of local development plans should involve the locals through public consultations. This will ensure that planning authorities, developers and residents are involved in the planning process from the onset. Lastly, reserving wetlands as protected zones will minimize encroachment of wetlands.

## 5.4 Conclusions

There has been a high demand for residential space in Harare. This has resulted in housing developments being established in wetlands. The developments have in-turn contributed to wetland fragmentation and their subsequent loss and degradation. The study has revealed that an integrated land use planning approach has the potential of addressing wetland degradation and fragmentation. In addition, reviewing current environmental policy may assist in the preservation of wetlands. However, an overall joint management and monitoring of wetlands will ensure less degradation of these wetlands.

## 5.5 Suggestions

The study has revealed that an integrated land use approach has the potential of minimizing wetland loss and degradation. It has further revealed that policy review will aid in addressing wetland degradation. However, the identified land use activities were limited to the areas of study and not other wetland areas. Besides, the study focused on surface water and land related activities only. As such, further research is required to:

- Identify the effects of housing developments and urban agricultural practices on wetlands in relation to underground water.

- Investigate potential human health problems emanating from wetland loss and degradation.
- Confirm the willingness of policy makers on issues relating to wetlands in Harare.
- Explore other wetland activities and their related impacts besides the ones identified in this research.
- Establish whether the quality of water has effects on the aquatic microorganism such as phytoplankton.
- Come up with engineering solutions that minimize impacts emanating from housing developments.

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**LIST OF APPENDICES**

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

ALL CORRESPONDENCE MUST
BE ADDRESSED TO THE
DIRECTOR OF URBAN PLANNING
SERVICES
Telephones: 775086, 749802-7
Facsimile: 772507
E-mail: dow@hararecity.co.zw

When calling or telephoning,
Please ask for Mr Choga

Your Reference:
Our Reference: 6/3/3

City of Harare

**DEPARTMENT OF URBAN PLANNING SERVICES**
**Cleveland House**
**92 Leopold Takawira Street**
**P.O. Box 1583**
**Harare, Zimbabwe**

11 September 2012

Mr Luke Mutisi
No. 5 Aberdeen Road
Avondale
**HARARE**

Dear Sir

**APPLICATION FOR RESEARCH AUTHORISATION IN HARARE**

I kindly make reference to your letter of 20 August 2012 regarding the above mentioned subject matter.

In your letter, you did indicate that you endeavour to carry out a research on wetlands in relation to infrastructure development within the Municipality boundaries of Harare. There are two areas that you want to confine your research and these are Belvedere North and Epworth. Please note that you have to seek authority from the Epworth Local Board in order to carry out your research in Epworth Township as this area is not under Harare Municipality.

This letter authorizes you to carry out your research in Belvedere North which is under the Harare Municipality jurisdiction.

The continuous growth of the City of Harare has resulted in intense competition among different land use activities leading to various contraventions, one of which is encroachment on wetlands. Your research is indeed ideal as it will identify these encroachments and their impacts on biodiversity. May I please have a copy of your final report.

I wish you all the best in your studies and be blessed.

Yours faithfully

**P.C. CHIWANGA**
**DIRECTOR OF URBAN PLANNING SERVICES**

DIRECTOR OF URBAN PLANNING SERVICES-*Psychology Chivaku Chiwanga* (BA Gen (Economics and Geography), Msc (RUP) (UZ), MZIRUP
Principal Officers–*R.M.Rusike* (Adminstration & Finance) - *CKT Kurauone* (City Architecture) *B. Masasi* (City Land Survey)
-*M. Gandiwa* (City Planning) - *C. Mupunga* (City Traffic & Transportation) - *MP Moyo* (City Technical Service)

## APPENDIX B: Clearance letter by Epworth Local Board to conduct research

EPWORTH LOCAL BOARD

P.O. Box EP100
EPWORTH
1038 Chirombo Road
Harare

Telephone: (04) 577445/9
Fax: (04) 577883
E-mail: elb@zeinet.co.zw

DEVELOPING WITH THE PEOPLE

*ALL CORRESPONDENCE SHOULD BE ADDRESSED TO THE SECRETARY*

*Our Reference ELB/ /* *Your Reference:*

5 November 2012

Mr. Luke Mutisi
Mawenje Consulting
5 Aberdeen Road
Avondale
Harare

THE ADMINISTRATION OFFICER
EPWORTH LOCAL BOARD
P.O. BOX EP 100
EPWORTH, HARARE
Date 5/11/12

**APPLICATION FOR RESEARCH AUTHORISATION IN EPWORTH**

The above subject refers.

Authority is hereby granted to Mr. Luke Mutisi to carry out a research on wetlands in relation to infrastructure development and in particular housing in Epworth.

Mr. Mutisi is a student at the University o f South Africa (UNISA) and is pursuing a Masters in Environmental Management.

Offer him the necessary assistance.

D.Kaseke
**ADMIN OFFICER**
**EPWORTH LOCAL BOARD**

# APPENDIX C: Research ethics clearance letter

UNISA university of south africa

Letterhead2

2013-11-29

Ref. Nr.: 2013/CAES/130

To:
Student: L Mutisi
Superivosr: Prof G Nhamo
Department of Environmental Science
College of Agriculture and Environmental Sciences

Student nr: 48427691

Dear Prof Nhamo and Mr Mutisi

**Request for Ethical approval for the following research project:**

***An investigation into the contribution of housing developments to wetland degradation within the city of Harare, Zimbabwe***

The application for ethical clearance in respect of the above mentioned research has been reviewed by the Research Ethics Review Committee of the College of Agriculture and Environmental Sciences, Unisa. Ethics clearance for the above mentioned project (Ref. Nr.: 2013/CAES/130) is approved after careful consideration of all documentation submitted to the CAES Ethics committee. Approval is only given for the duration of the research project.

Please be advised that the committee needs to be informed should any part of the research methodology as outlined in the Ethics application (Ref. Nr.: 2013/CAES/130), change in any way. In this instance a memo should be submitted to the Ethics Committee in which the changes are identified and fully explained.

The Ethics Committee wishes you all the best with this research undertaking.

Kind regards,

**Prof E Kempen,**
**CAES Ethics Review Committee Chair**

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 429 12 429 4150
www.unisa.ac.za

## APPENDIX D: Questionnaire for residents

**QUESTIONNAIRE – HOUSEHOLD LEVEL (AFFECTED)**

**(PLEASE TICK WERE NECESSARY)**

**A. Personal**

1. Age:
2. Sex:
3. Level of Education:
4. Main source of income:

**B. Key issues**

5. How long have you been staying here?

   …….....

6. From your own perspective, what can you say about wetlands, in general?

   ……

7. Do you know or have you been informed that this area is a wetland?

   ……

8. If YES/NO state the reasons?

   ……

9. From your own observation how did people end up building / occupying these wetlands?

   ……

10. Please identify and list major development activities being carried out in the wetlands?

    …….

11. What is the main source of water in the area?

    ……

12. Is the source of water protected / contaminated?

……

13. What are the challenges / opportunities derived from wetlands?

……

14. What are your long term plans as you stay in the area?

……

15. May you state the plans?

……

16. Are you paying anything (levies) to council?

……

17. If paying, what are you paying for?

……

**C. Policy Issues**

1. In your own opinion, list intervention measures that can be put in place to protect wetlands?

   ……

2. Are there any strategies that will ensure that wetlands are protected from human activity?

   ……

3. What actions have the local authority taken to manage the encroachment of housing, agriculture and other developments into wetlands?

   ……

4. What awareness activities (if any) have been carried out to ensure that wetlands have been protected?

   ……

5. In your view, has the local authority been strong in intervening against wetland encroachment?

   ……
   …….

6. What channels (if any) are in place to have key stakeholders consulted regarding the use of wetlands in the area?

   ……

7. Are there any persons / departments that have been set aside to manage wetland issues?

   ……

8. Has there been any enforcement to ensure that wetlands are protected in the area?

……

## APPENDIX E: Questionnaire for professional respondents

**QUESTIONNAIRE – KEY INFORMANTS (PROFESSIONAL)**

**A. Personal**

1. Age: ……..
2. Sex: ……
3. Level of Education: …….
4. Occupation / Profession: …….
5. Organisation: …….

**B. Key issues**

6. Are you aware that the area has been designated as a wetland?

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

7. Are you aware that people are building in a wetland?

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

……

8. What are you doing as Professionals / Local Authority to address the situation?

……

9. What are the challenges you are facing as a Professionals / Local Authority?

……

10. I am aware that there is a future plan regarding wetland encroachment?

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

……

11. There is action being taken in order to ensure that there is no wetland encroachment in the future?

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

……

12. There are council by laws governing wetland encroachment?

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

13. Are there any stipulated measures that the Local Authority has put in place?

……

14. Houses have encroached into wetlands against existing plans aimed at preventing such

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

……

15. Urban agriculture has encroached into wetlands against existing plans aimed at preventing such.

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

16. Who has been allocating land for residential purposes in the wetland area?

……

17. Housing developments have negatively affected the wetland areas.

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

……

18. Urban agriculture has negatively affected the wetland areas.

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

19. There are other activities outside housing development and urban agriculture that are carried out in wetlands.

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

……...

20. How have people benefited from the wetlands / What have you used the area for?

……

21. How have water and sanitation issues been handled in wetlands since the soils are clayey?

……

22. What are the challenges that have been faced in this area since the houses began to be built?

……

23. How can the open wetland areas be managed in the future?

……

24. There possibility of restoring the state of the wetland environment after the degradation in the future.

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

……

## C. Policy Issues

25. What best can be done to manage or protect wetlands?

……

26. There are strategies that will ensure that wetlands are protected from human activity

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

.....

27. The local authority has sound plans to manage the encroachment of wetlands?

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

……

28. Awareness has been carried out by the local authority and other interested and affected parties to ensure that wetlands have been protected.

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

…….....

……

29. How can local authorities realise sustainable use of wetlands?

……

30. Key stakeholders are regularly consulted regarding the use of wetlands in the area.

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

……

31. There is staff and departments that have been set aside to manage wetland issues by the municipality.

| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

……

32. Has there been any enforcement to ensure that wetlands are protected in the area?

……

33. The Government is in support of wetland conservation in the area.

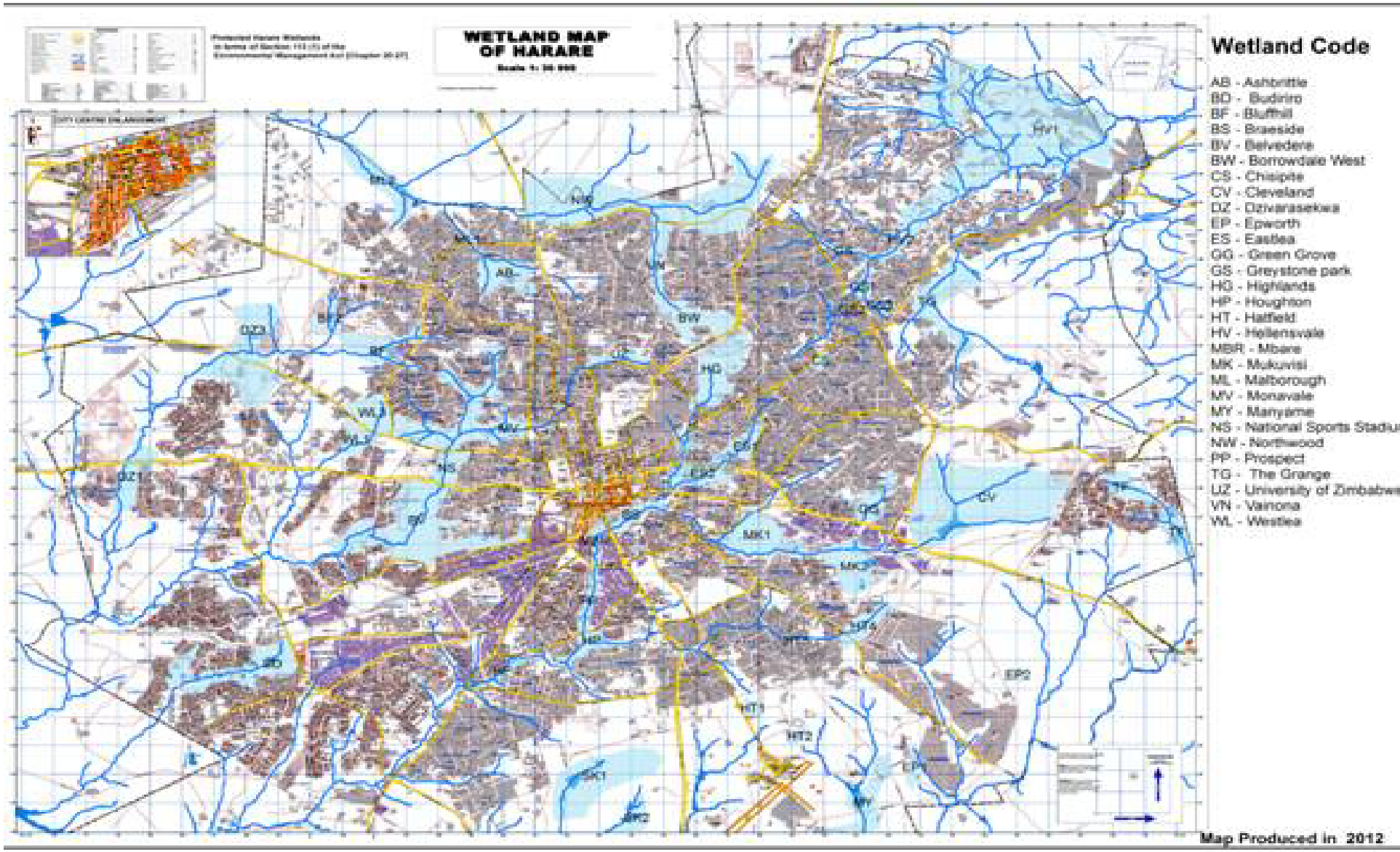
| Strongly disagree | Disagree | Not sure | Agree | Strongly agree |
|---|---|---|---|---|
| | | | | |

If your answer above is either 'agree' or strongly', please elaborate further.

……

……

## APPENDIX F: WETLAND MAP OF HARARE




Street Map - Surveyor General's copyright preserved