MIDLANDS STATE UNIVERSITY

OCTOBER 2017

AN ASSESSMENT OF THE ENVIRONMENTAL IMPACTS ASSOCIATED WITH URBAN AGRICULTURE. A CASE OF GWERU, ZIMBABWE

BY

R141574J

A DISSERTATION PRESENTED TO THE DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF BACHELOR OF SCIENCE HONOURS DEGREE IN GEOGRAPHY AND ENVIRONMENTAL STUDIES

Midlands State University

Approval Form

The undersigned certify that they have read and recommend to the Midlands State University the acceptance of a dissertation entitled **"An assessment of the environmental impacts associated with urban agriculture. A Case of Gweru, Zimbabwe"**

By

Tafadzwa Muswati

(R141574J)

Submitted in partial fulfilment of the requirements of a BSc Honours Degree in Geography and Environmental Studies.

STUDENT……..... ……..... DATE……

SUPERVISOR…….....…… DATE……

CHAIRPERSON…… DATE……

EXTERNAL EXAMINER…… DATE……

Dedication

I dedicate this research to my parents, Mr and Miss Muswati and my beloved sisters Linda and Hazel for their diligent support towards the fulfilment of my education goals. Above all, I thank Jehovah for his unconditional love and grace.

Acknowledgements

I extend special acknowledgement to my supervisor DR WINMORE KUSENA for her unparalleled support, guidance and commitment throughout the development of the research. I also salute the GES department for its sincere guidance and co-ordination. A special thank you goes to the Muswati family and friends (Blessing and Tanatswa), for their love and support respectively. Last but not least my sincere gratitude goes towards the Windsor Park and Coolmoreen communities for their co-operation and contributions without which this study would not have been successful.

Abstract

The study assessed the environmental impacts associated with urban agriculture in selected residential areas of Gweru Urban. Qualitative research methods were prominently utilised throughout the research and were complimented by quantitative methods. Questionnaires, structured interviews and direct observations were used in soliciting significant information relevant to the study objectives. Self-administration of questionnaires was done to 35 household units which were selected through a combination of convenience, random and referral sampling methods. Purposive sampling was also employed in selecting key informants (interviewees) from the Environmental Management Agency and Gweru City Council. The study accomplished that economic turmoil was a predominant factor that drove people into informally or formally securing land for agricultural purposes in Windsor Park 2 and Coolmoreen Plots. Research findings indicated that the majority of the farming practices employed by informal landholders had negative implications on the biophysical environment. The commonly noted ones included damage caused by veld fire, surface water pollution as a result of increase in phosphate levels, land degradation and acute deforestation. Although the Coolmoreen community was largely engaged in licenced agriculture, significant environmental implications were noted as a result of their activities. The most prominent challenges included soil contamination owing to the use of nitrogen based fertilisers and deforestation as a result of plot extension. Overall, land use and cover results from ArcGIS 10.5 indicated that drastic land cover changes were experienced in Windsor Park 2 due to urbanisation and agriculture development from the period of 2005 to 2016. The study concluded that an integrated urban land use approach can potentially minimise environmental degradation as a result of agro-activities. This can only be realised through the formulation and implementation of a comprehensive policy involving all the relevant stakeholders in the sector (including informal landholders). The drive to implement a suitable Gweru urban agriculture policy by the responsible bodies has to be explored since ignorance concerning the implications of agricultural activities on urban ecology can hinder sustainable development at city level.

Table of Contents

List of Figures

List of Tables

List of Plates

List of Acronyms

AN	Ammonium Nitrate
EIA	Environmental Impact Assessment
EMA	Environmental Management Agency
FAO	Food and Agriculture Organisation
GIS	Geographic Information Systems
NP	Total Nitrogen
TP	Total Phosphate
UA	Urban Agriculture
UN	United Nations
WHO	World Health Organisation
ZimStat	Zimbabwe National Statistics Agency

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

On a global scale, the United Nations Development Program (UNDP) approximates that more than 800 million people are involved in urban agricultural activities. 25% of these produce their food primarily for the market, and provide 20% of the world's food (Kamwele; Onyango; Wagar and Nystron, 2014). However, the majority raise food for household consumption (Meerman and Aphane, 2012). Many citizens have turned to urban agriculture as a livelihood strategy and source of income as a result of the gradual increase in food insecurity, malnutrition and urban poverty (Kamwele et al, 2014).

The Food and Agriculture Organization (2016) defines urban and peri-urban agriculture as the growing of plants and the raising of animals within and around cities. It is the practice of cultivating, processing, and distributing food in or around a village, town, or city. It can also involve animal husbandry, aquaculture, agroforestry, urban beekeeping, and horticulture. Since Zimbabwe's economy is agro-based, farming, which is usually dominant in rural Zimbabwe, contributes enormously to the country's GDP (Gross Domestic Product) (Chisita; Chinyemba and Malapela, 2016). However, urban agriculture has also gained wide-spread recognition, over the years for its contribution to food security and wellbeing of urban residents (Poverty Reduction Forum Trust, 2017). Hence, the growth of the phenomenon of urban agriculture cannot be overemphasised since almost all third world countries practise it.

Urban agriculture is distinguished from its rural counterpart because it is integrated into the urban economic and ecological system (RUAF Foundation, 2015). Urban agricultural activities are constantly interacting with the urban ecosystem. This is because it relies on urban resources like organic wastes for compost and municipal waste-water for irrigation. It also depends on urban residents for labour. The sector also involves interactions with urban consumers. Other significant facets of the sector include its impacts (positive and negative) on urban ecology, its affiliation into the urban food system, competition for land with other urban functions and influences by urban policies and plans. Hence, most studies agree that urban agriculture is not a relic of the past that will fade away but an integral part in the livelihood of urban populations.

Though urban agriculture also exists in developed countries such as the United Kingdom and Germany, it is largely about social, community and environmental regeneration (Hungwe,

2004). Most food programs and related interventions introduced in developed cities utilise urban agriculture as a tool for social development. It has since become more than just a way to access food, but also a convenient approach for communities to connect. Contrastingly, in the third world and generally under developed countries, urban agriculture is a sector specifically geared towards food production for household sustenance and income generation (FAO, 2012). It is therefore important to take into account that the continuous increase in the number of urban farmers in Zimbabwe is a response to a decline in the nation's economy, following the failure of Structural Adjustment Programmes (SAPs) resulting in the general increase in the population of the urban poor.

Like most developing countries, a majority of Zimbabwe's rural population depends primarily on agriculture for sustenance, however as urban residents continue to struggle to purchase food from supermarkets because of intrinsically low incomes, they imperatively resort to actual production of food at household level (Hungwe, 2006 and Moyo, 2013). As a result, over the past decade, urban agriculture in Gweru has assumed a new image, from small vegetable gardens for household consumption; which comprise of fresh vegetables meeting specific household tastes and requirements, to a strong shoulder for urban household food security and a major income-generating source (Hungwe, 2004). This has been realised by the intensive occupation and utilisation of 'free' and 'unused' land for agriculture purposes by residents in suburban locations such as Riverside, Athlon, Bradley, Coolmoreen, Harben Park, Southdowns and Windsor Park.

Hungwe (2004) shares the view that, despite the existence of by-laws restricting urban agriculture because of its perceived ecological side effects, more and more residents in Gweru, like others in urban areas across the nation continue to grow crops hoping to provide their families with food amid severe shortages and ever-rising living costs. Urban agriculture is a sector that produces, processes and markets food largely in response to the daily demand of consumers within a metropolis, on land and water, dispersed throughout the urban and peri-urban area. The industry applies intensive production methods, using and recycling natural resources and urban wastes to yield a diversity of crops. Hence, the research shall explore urban agricultural practices utilised by residents to establish possible impacts on the environment.

1.2 Statement of the Problem

Sustainable agriculture is one of the greatest challenges in most urban communities in developing countries (FAO, 2014). There is lack of specific policy geared towards addressing the development of this sector (Kamwele et al 2014). In Zimbabwe, there is no clearly defined policy on urban agriculture since it is not classified as an urban activity, hence in Gweru, the city and town planning systems do not cater for it (Moyo, 2013). Although farming in plots and within individual residential space is recognised and supported by the Government of Zimbabwe through the Gweru City Council designations, the absence of an existing regulatory policy that in-cooperates socio-economic and environmental considerations raises a lot of concerns and issues particularly in the context of sustainable urban agriculture. While providing food security in the short term, it has been concluded that unsustainable urban agricultural practices and activities can consequently hinder the ability of urban residents to secure food for their households (Hungwe, 2004).

Whilst there is existence of by-laws restricting unlicensed agriculture in Gweru, residents, fueled by lack of adequate income to secure buying power, are forced to illegally exploit 'unused' pieces of arable land whether surveyed or awaiting development (Hungwe, 2006). For most informal farmers, planting is done along roadsides, railway lines, hill slopes, on wetlands, along stream banks, dumpsites and near electricity and sewer infrastructure. Although urban agriculture for self-consumption relies less on the use of agrochemicals, more intensive market gardening production rely heavily on synthetic fertilizers and other toxic agrochemicals (Gondo et al, 2017). Citizens either are not aware of the impacts of their actions or regard environmental degradation and associated risks as secondary to meeting their food requirements (Poverty Reduction Forum 2017).

This study is limited to the growth of crops and animal husbandry is not within the scope of the study. The research shall explore the practices used by both informal and formal landholders in two suburbs namely Windsor Park 2 and Coolmoreen Plots in order to determine the impacts of their farming activities on the surrounding environment.

1.3 Research Objectives

1.3.1 General Objective

The general objective:

- To assess the environmental impacts associated with urban agriculture in Gweru.

1.3.2 Specific Objectives

Specific objectives:

i) To identify the farming practices utilised by residents in Windsor Park 2 and Coolmoreem Plots.
ii) To establish the impacts of specific farming practices on the biophysical environment.
iii) To test surface water quality for possible pollution.
iv) To assess the changes in land use/cover in Windsor Park 2 from the period of 2005 to 2016.

1.4 Justification

Land use development in Gweru has intensified over the past decade following the general demand for farming space. The purpose of the research is to establish the environmental implications of urban agriculture activities in the City of Gweru. The research will generate scientifically derived, policy relevant data that has the potential to assist policy makers in making informed decisions when planning sustainable urban agriculture in the City of Gweru. The research is a call to relevant stakeholders in the sector to make an integrated effort in ensuring urban agriculture is carried out in an environmentally sustainable and suitable manner.

Sustainable development (in agriculture), conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable (FAO, 2014). Hence, the research shall be of great significance in providing relevant information geared towards sustainable use and conservation of urban resources. Housing and industrial development are viewed as the more traditional and progressive projects for urban areas. However, agriculture is the primary and most fundamental means to food security in Zimbabwe; hence an understanding of its environmental implications requires a comprehensive study of its dynamics; which this research seeks to explore.

Furthermore, the research is based on prevalent issues occurring within sample middle density areas in Gweru; hence, the facts and figures presented are centered on timeous information and data. It was the researcher's supposition that the outcomes of the study will be of particular relevance to Gweru City Council and the Environmental Management Agency (EMA) in understanding the implications of urban agricultural practices on the biophysical environment. It is the researcher's perception that a majority of the residents

informally or formally involved in the sector have little to no idea of the perceived environmental impacts associated with the practice. Hence, it is the researcher's wish that the study shall yield pertinent results that will raise awareness on the environmental impacts associated with urban agricultural activities in order to assist in the nation's movement towards Sustainable Development Goal (SDG) 11, which endeavors to, "make cities and human settlements inclusive, safe, resilient and sustainable."

1.5 Description of the Study Area

The research was confined to two residential areas in Gweru; namely Windsor Park 2 and Coolmoreen Plots. These are low density suburbs located in Gweru East. The city is an administrative capital of the Midlands Province, one of ten provinces in the country. It is ranked fourth in terms of population after Harare, Bulawayo and Chitungwiza. It has direct links to all the other cities and towns of Zimbabwe. It is 164 km from Bulawayo, 183 km from Masvingo, 471 km from Beitbridge and 275 km from Harare. It has Shurugwi District to the south-east, Chirumhanzu District to the east, Insiza District south-west, Bubi District to the west, Nkayi District north-west and Kwekwe District north (Dube, 2013).

The original Matabele settlement was named iKwelo (*the steep place*), after the Gweru River's high banks (Revolvy, 2010). Founded in 1894 as a military outpost, it developed as an agricultural center and became a municipality in 1914. The district occupies an area of 49,166 km² with an estimated population of over 231,675 people (Ministries of Local Government International, 2016). It has 49 residential suburbs and 29 973 housing units (Kusena, Beckedhal and Desai, 2017). The local authority in Gweru is the Gweru Municipality (City Council). Due to its geographic location, the city assumed a trade center status with some significant industrial development. Its major products include ferrochromium, textiles, dairy foods, footwear, and building materials. The training section of Zimbabwe's air force is also within this city.

Gweru District gets its name from Ikwelo River (now Gweru River) which has the city as its source and primary drainage basin. Gweru lies in agro-ecological region 3 of Zimbabwe, which is characterized by the savanna type of climate. The city receives average rainfall amounting to 700mm, distributed over five months of the year from November to March (World Weather Information, 2015). Temperature averages 30 Degrees Celsius during summer and 14 Degrees Celsius in winter. In August to November, the district is recurrently

affected by south-east prevailing winds, with mean speed ranges of 8.0 to 9.3 knots (Matsa and Marambanyika, 2010).

There are three types of soils found in Gweru namely, black basalts, red loams, sands and gravel. The city is dissevered by several watercourses which discharge into the Gweru River (Matsa and Marambanyika, 2010). The surrounding area is rich in mineral deposits. These are mainly gold, chrome, iron, asbestos, and limestone, and they support a number of mines. The city has an abundance of flora and fauna. Flora species include Poinsettias, Bougainvillea, Jacaranda and Acacia. In spring, Msasa *(brachystegia spiciformis)* trees dominate the landscape.

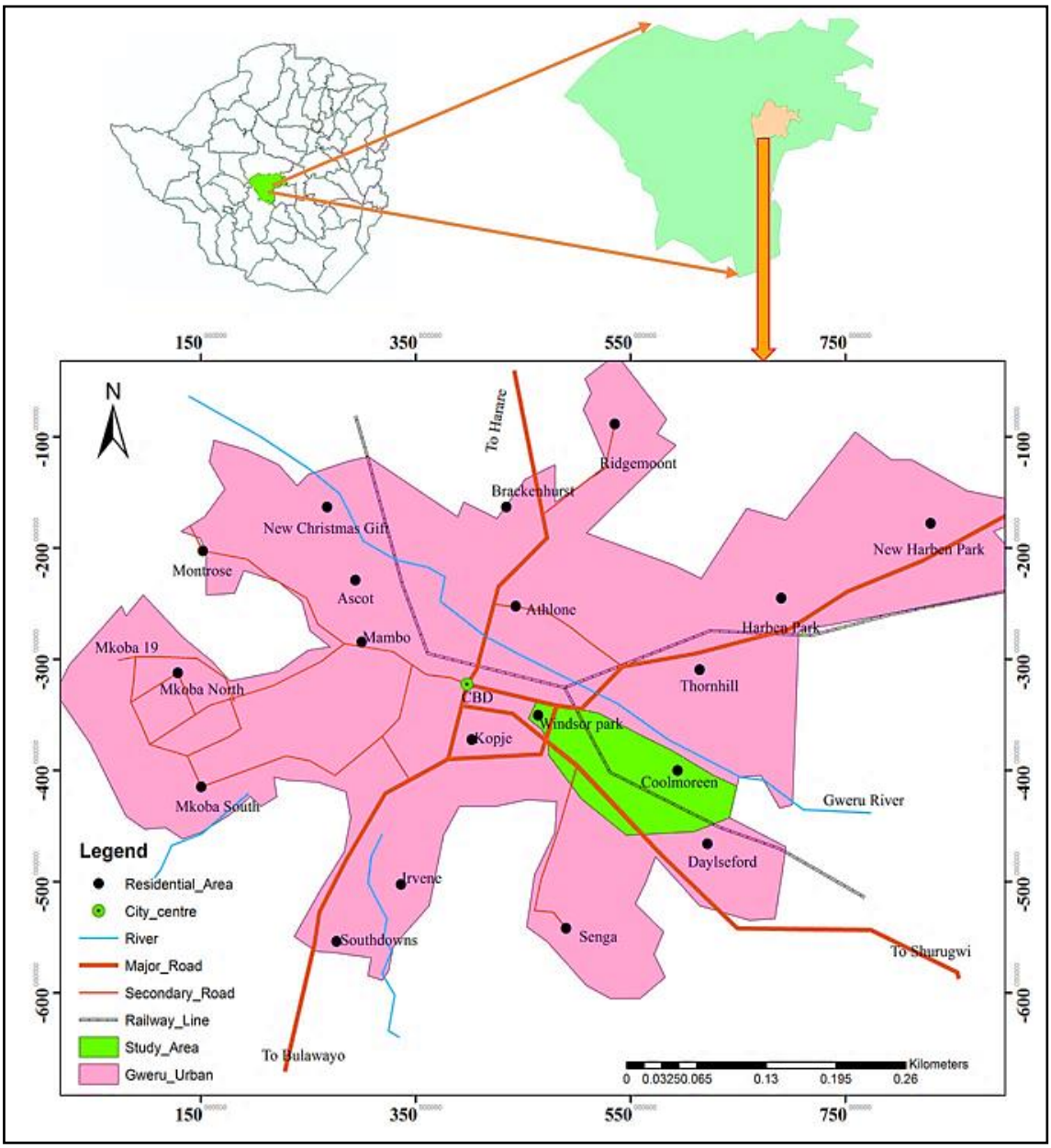

Figure 1.1: Map showing location of Windsor Park 2 and Colmoreen Plots in Gweru Urban

CHAPTER TWO: LITERATURE REVIEW

2.1 Urban Agriculture in Developed and Developing Economies

Urban agriculture as an industry reflects varying levels of economic and social development between developed and developing countries across the globe (Wayland, 2013). Because developed countries like the United States, Germany and Australia have better economies, education, quality of life and access to resources, urban agriculture plays a different role than it does in those of less economic stability. In most developed countries, urban agriculture is often introduced as a form of social movement for sustainable communities (Smit, Brown and Bellows, 2013). It involves formulation of social networks that evolve because of formal support from institutions; hence becoming incorporated into city planning systems for sustainable urban development (Smit et al, 2013). Argentina, Canada, Ghana, Zimbabwe and Thailand are commonly used as case studies in reflecting nations of different economies experiencing urban agriculture.

Canada is one of the prominent countries engaged in urban agriculture within the United States. Literature indicates that there are approximately 97 community gardens located in the city of Montreal. The gardens offer residents the much needed space and area to cultivate their crops (Bailkey and Nasr 2000). Land boroughs who offer training on the sustainable use of land and water resources manage these plots. The soil, water supply and farming tools are all provided by the City Council. Sometimes landholders from the urban areas interact; through business networks; with landholders from rural areas in order to bring some of the rural produce to the urban markets.

The urban city of Rosario which is located in Argentina, amalgamated agriculture into its urban land use planning strategies (FAO, 2014). Specific provisions are made in the city's land use plan for the use of public land for agricultural purposes. Various 'green projects' have been initiated throughout and around the city. The projects mainly consist of a wide variety of community and commercial vegetable gardens including orchards. 3 years ago, more than 30 hectares of land was leased to grow fruits, medicinal plants and a variety of vegetables (FAO, 2014). The city has five garden parks, which consist of large, landscaped green areas covering a total of 72 hectares of land. They are mainly used for agriculture and other socio-cultural activities. Hence, urban agriculture in the cities of developed countries assumes a more social nature rather than an economically motivated one.

Contrastingly, a significant driver of the demand for agricultural land in developing countries emanates from a combination of nationwide financial and food crises. The major key motivations behind urban agriculture are, food security, nutrition and income generation, particularly in Africa. Hence, the practice is a response to the poor and unsatisfactory economic backbone typical of developing nations. Over the past few years, there has been a rapid increase in the demand for urban land suitable for agriculture (Haralambous, Liversage and Romano, 2009). In response to these crises, most food-importing nations in developing countries purchase or lease land in order to directly outsource their own food production. Through this alternative and long-term strategy, they aim to secure food supplies at lower costs, reduce their exposure to high prices and uncertain supplies, and overcome protectionist barriers (Hiralambous et al, 2009).

Studies show that in Ghana; a developing country, urban farming in Accra assumed prominence between 1972 and 1976 when the then government, through the Operation Feed Yourself (OFY) programme, encouraged farming in the cities due to the harsh economic conditions and related acute food shortages (Kwasi, 2010). These conditions resulted in the devaluation of the Ghanaian currency, which in turn created huge external debts. Nationwide food supply became an issue as prices of food items became exorbitant, especially in the cities. Hence, urban agriculture was promoted and encouraged and urban farming activities were tolerated. Stringent regulations and by-laws that curtailed the practice were relaxed. Presently, urban farming in Ghana continues to contribute to city food supply, employment creation and achievement of sustainable livelihoods through poverty reduction.

In Zimbabwe agriculture is the backbone of economy and food security for the majority of the populace (RUAF Foundation, 2007). The implementation of urban agriculture (UA) in major cities such as Bulawayo, Harare and Gweru is envisaged to alleviate poverty and provide a means for food security for the city's urban community. In Bulawayo, urban agriculture stands as a significant economic function that influences the livelihood of the majority. Hungwe (2014) purports that residents engage in agriculture in order supplement their meagre income and provide food for their families. For most households, crops that are cultivated within and outside residential space provide nutritional benefits (RUAF Foundation, 2014). The majority of households in the high-density suburbs of Bulawayo grow traditional vegetables that form an imperative part of the daily meal.

2.2 Types of Urban Agriculture

In most cases, urban agriculture is typically an informal practice and is often done under extremely difficult conditions. Significant sectors of urban and peri-urban agriculture include horticulture, livestock, milk production, aquaculture, and agro-forestry (Andres and Bhullar, 2016). The commonest crops produced are perishable leafy vegetables such as covo, cabbage, amaranths, pointe noire (solanum nigrum), cassava leaves and lettuce, particularly in South-east Asia and Africa (Birkhofer et al, 2014). The most common types of urban agriculture include rooftop gardening, informal crop production and community gardening (plots).

2.2.1 Informal Agriculture

Informal agriculture is usually seasonal and involves intensive and rigorous urban farming activities occurring mostly during the rainy season (PTRF, 2015). In countries like Zimbabwe, residents grow perennial crops such as maize; intercropping with other food crops like sweet potatoes, pumpkins, beans, sugar cane, and watermelons. According to the Poverty Reduction Forum, during the rainy season, residents usually utilise practically every available piece of land without much regard to anything else. Any unused piece of land is a target during this time with residents gardening on roadsides, along stream banks, under high-tension wires, dumpsites, empty lots, wetlands and near water and sewer infrastructure (Heimer, 2013).

2.2.2 Rooftop Agriculture

According to Kurtland (2001), rooftop gardening involves farming on man-made green spaces on the topmost levels of industrial, commercial and residential structures. Rooftop gardens are usually designed to grow produce. Rooftop gardening is an urban agricultural practice common in most developed countries such as Singapore, Japan, Germany, Canada and the United Kingdom. Trent University (2009) propound that, in an accessible rooftop garden, space becomes available for localized small-scale urban agriculture, a source of local food production. Rooftops are a target since they come equipped with the three fundamental requirements for effective farming, which are flat land, unobstructed access to sunlight and a reliable source of water. An urban rooftop garden can supplement the diets of the community it feeds with fresh produce and provide a tangible tie to food production.

2.2.3 Community Gardening

A community garden is a single piece of land gardened collectively by a group of people. (American Community Garden Association, 2007). Community gardens consist of individual or shared plots allocated on public or private land in order to produce vegetables, crops and fruits. The gardens are commonly located in neighbourhoods, schools and on residential housing grounds. Plot allocation and size varies from place to place. For example in Maryland's Montgomery Parks, plots from 20 up to 60 square metres are listed (Community Gardens Program, 2015). In Canada, in the city of Vancouver, plots of 20x20 and 10x10 feet, as well as smaller raised beds are listed (Community Gardens, 2015). In Zimbabwe, plots in Douglasdale, Montgomery and Umguza in Bulawayo occupy 2 hectares and are subject to the city's local and master plans. (RUAF Foundation, 2007).

Community gardens are usually formal in nature and largely influenced and governed by policies at city level. However, sometimes zoning and land use policies lag behind the development of community gardens. In such cases, community gardens may exist illegally. An example of such a case is in Detroit, when hundreds of community gardens sprouted in abandoned spaces around the city (Kaffer, 2010). According to Kaffer (2010), the city of Detroit created agricultural zones in 2013 in the middle of urban areas to legitimize the over 355 illegal community gardens. Community gardening is practised in almost every economy around the world. Major examples of countries engaged in the practice are Zimbabwe, Spain, United Kingdom, Taiwan and Mali (Hans-Heinrich, Freyhold and Weisskoeppel, 2013).

2.3 Urban Agricultural Practices

Overall, the urban agriculture sector involves numerous agricultural practices, part of which may necessitate land clearance through felling of trees and hence lead to deforestation (Mutisi, 2014). Irrigation development in community gardens and plots is also employed to supplement erratic rainfall patterns (Feresu, 2011). In plots, residents rely on borehole water for irrigation whilst in the informal sector there is evidence of use of municipal waste water. Residents who own relatively large farmland will often implement the use of heavy farm machinery such as combine harvesters, tractors and loaders, especially during land preparation and harvest.

Additionally, the heavy use of synthetic fertilizers and chemical pesticides is vastly acknowledged in the production of crops within peri-urban plot land. Akhmad and Sheihk (2015) indicate that an extensive utilisation of pesticides and herbicides in agro activities is

usually a toxic pollution source. Increase agricultural land use and the loss of nutrients associated with urban agricultural practices, are some of the chief drivers of water quality loss and degradation. Hence, they inherently increase the vulnerability of water that is responsible for transporting these nutrients. Most literature agrees that synthetic fertilisers are often utilised by both sectors however it is mostly substituted for organic manure in the informal sector since access to agricultural input is comparatively limited.

2.4 Impacts of Urban Agriculture on the Biophysical Environment

There has been scientific debate encompassing urban agriculture focused on competition for non-renewable resources like soil, water, land and its economic viability. However, various schools of thought and existing research seems to indicate that the environmental benefits of urban agriculture outweigh the costs. The major challenges in this sector lie in determining how to monitor, control and reduce risks in the physical, economic and social environment and understanding how urban agriculture can be a sustainable component of the global urban food systems (FAO, 2014).

Globally, there is a general sense that urban agriculture can benefit the environment, in terms of waste reduction and biodiversity thus producing sustainable cities; however, there has been limited research to directly substantiate this claim (FAO, 2014). Two key environmental concerns of urban agriculture lie in the risk of pathogen and heavy metal contamination to consumers due to the high dependency of production systems on the large amount of cheaply available organic wastes and a lack of a clear policy regarding the practice and planned management of urban agriculture in most African cities (Ezedinma and Chukuezi, 1999)

According to Urban Harvest (2006), urban agriculture is a key part of the urban ecological system, generating risks through the use of toxic inputs in densely populated residential areas. At the same time, it can become a pathway for biological and chemical contaminants in the ecosystem, directly via soil or water and indirectly facilitating the passage of contaminants into urban food systems. Research carried out in the city of Lima (Peru) and Kampala (Uganda capital) on the impacts of urban activities on water bodies shows evidence of biological and heavy metal contamination of irrigation water. Table 2.1 shows some of the common impacts of urban agriculture activities on surface water sources.

Table 2.1: Impacts of urban agricultural activities on surface water sources

Source: Food and Agriculture Organisation (2014)

Activity	Impacts on Surface water
Tillage/ploughing	Soil sediments carry phosphorus and pesticides absorbed to sediment particles; siltation of river beds and loss of habitat, spawning ground,
Fertilizing	Runoff of nutrients, especially phosphorus in water may lead to eutrophication causing taste and odour in public water supply and accelerated algae bloom leading to deoxygenation of water and high aquatic mortality.
Manure spreading	Carried out as a fertilizer activity; spreading on frozen ground results in high levels of contamination of receiving waters by pathogens, metals, phosphorus and nitrogen leading to eutrophication and potential contamination.
Pesticides	Runoff of pesticides leads to contamination of surface water and biota and disfunction of ecological system in surface waters by loss of top predators due to growth inhibition and reproductive failure; public health impacts from eating contaminated fish. Pesticides are carried as dust by wind over very long distances and contaminate surrounding areas.
Irrigation	Runoff of salts may lead to salinization of surface waters; runoff of fertilizers and pesticides to surface waters results in ecological damage. High levels of trace elements such as selenium can occur with serious ecological and potential human health impacts.
Clear cutting	Erosion of land, leading to high levels of turbidity in rivers. Disruption and change of hydrologic regime, often with loss of perennial streams; causes public health problems due to loss of potable water.

Significant opponents of urban agriculture, caution the excessive use of inputs with high levels of nitrogen, phosphorous and raw organic matter with heavy metals. Excessive nutrient input and poor handling and application of organic manure from livestock can lead to environmental problems (FAO, 2014). The Food Agriculture Organisation asserts that urban dwellers may be at risk as a result of air pollution from emissions of carbon dioxide, methane,

ammonium, nitrous oxide, nitrogen oxide, odour nuisance, overuse of chemical spray, zoonotic diseases, veterinary public health issues from livestock, and cumulative negative effects because of no legal controls of urban agriculture particularly in most developing countries.

Hence, the adoption of inappropriate agricultural practices pose environmental and health risks. Additionally, intensive farming may also reduce the capacity of the environment to absorb pollutants. Most of the studies agree that these problems are commonly exacerbated by a lack of appropriate city planning and regulation of urban agriculture.

2.5 Other Socio-Economic Impacts of Urban Agriculture

Social impacts are the way something influences or affects the social fabric of communities and their residents (Golden, 2013). In the context of urban agriculture, social impacts incorporate human relationships and interactions with each other and their built environment. Research carried out by Bradley and Galit (2013) in the United States found that community gardens and urban farms create safe spaces to recreate and improve the physical space of the neighbourhood. This results in the creation of safe spaces that are less likely to be vandalized or crime-ridden (Bradley & Galt, 2013). Urban community gardens in particular generally encourage cooperation and are fundamental in building human relationships (Teig et al., 2009)

Access to land is a significant economic benefit of urban agriculture. Urban agriculture creates access to land, which is often limited in urban areas through the creation of space within and around cities for residents to cultivate (Golden, 2013). Corporations or private entities often own the majority of urban land. Hence, space for residents (particularly in high-density housing and low-socio economic neighbourhoods) is difficult to secure for them to grow their crops. According to Patel (1991) most participants feel that the most important benefit of urban agriculture is the provision of land for people to call their own for a season; where they could develop a sense of pride and ownership (Armstrong, 2000). Peri-urban farms and plots (which are often smaller compared to conventional farms) also provide residents with land for agricultural production.

Although literature exists on the economic impacts of urban agriculture, it is very limited. According to Gold (2013), the majority of economic research is commonly centred on farmers' markets. The most frequently discussed economic impacts in literature are employment creation, skill development and business incubation (Bradley & Galt, 2013).

Urban agriculture provides non-market access to food for low-income families and creates agricultural jobs. In Africa, urban agriculture has played a crucial role in helping people cope with economic crises. Many of the urban food projects are located in suburbs where poverty and unemployment is high hence; they serve as viable employment and catalysts for entrepreneurial endeavours. A significant study from the United Kingdom indicated that participants of urban agriculture felt that the job related skills they developed were the most significant outcome of their experience (Holland, 2004).

2.6 Sustainable Urban Agriculture

It has been observed that declining productivity often induces farmers to shift to forms of land use that are both more intensive and more sustainable. According to Gold (2009), sustainable agriculture is farming in sustainable ways based on an understanding of ecosystem services, the study of relationships between organisms and their environment. Sustainable development in agriculture, conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable (FAO, 2014). Hence, it can be defined as an integrated system of crop (and animal) production practices having a site-specific application that will last over the long term.

In context, sustainable urban agriculture is agriculture that satisfies human nutritional needs, enhances the quality of the environment and natural resource base upon which the agricultural economy depends. The goal of sustainable urban agriculture is towards the efficient utilisation of non-renewable resources such as land and water and integrating natural biological cycles and controls. According to the Food and Agriculture Organisation (2014), it also seeks to sustain the economic viability of farm operations and enhance the quality of life for urban farmers and the community at large. Additionally, urban agriculture development also includes economic diversification and expansion of agricultural post-production operations. The Food and Agriculture Organisation summarises four major issues relating to sustainable development for both urban and peri-urban agriculture zones as shown in Table 2.2 and 2.3 respectively.

Table 2.2: Major areas of concern for sustainable agriculture in urban areas

Source: Food and Agriculture Organisation (2014)

Urban Agriculture	
Critical Issue	**Explanation**
Land-use Planning	Land-use planning and management systems should be developed to promote the use of land for the most productive sustainable use, including provision of environmental services, such as buffer spaces, run-off management and erosion control.
Environmental Pollution	Urban agriculture should be managed to minimize air and water pollution, including contamination of water supplies by nitrates and phosphates from fertilizers, and other undesirable environmental impacts.
Food Safety	Urban agricultural practices should be managed to protect food safety and health by preventing contamination of food with excess pesticide and herbicide residues, heavy metals, pathogenic organisms and other toxic materials.
Waste Recycling	Efforts should be made to recycle urban wastes for use in agriculture, through waste handling and treatment facilities for sewage, organic solid wastes and other wastes. Such recycling could provide employment opportunities as well as useful materials.

Table 2.3: Major areas of concern for sustainable agriculture in peri-urban areas

Source: Food and Agriculture Organisation (2014)

Peri-Urban Agriculture	
Critical Issue	**Explanation**
Land Use Change	Conversion of land from agricultural to non-agricultural uses should be managed to promote the conversion of land with marginal agricultural productivity and preserve the best agricultural land for agriculture, taking into account the need to manage water use for agriculture and competing uses.

Support Services	Advisory and support services should be provided to support a shift to sustainable intensive production for urban markets, and to develop agricultural processing enterprises and other non-farm employment opportunities
Agro-Forestry	Critical forest areas around cities should be protected, and sustainable intensification of agriculture and agro-forestry should be promoted to meet urban demand for forest products and substitutes and reduce pressure on forest resources
Biodiversity	Changes in plant and animal species composition associated with changing land use and intensified cultivation in urban and peri-urban zones need to be assessed with respect to biodiversity.

2.7 Knowledge Gaps in Literature

While a general lack of knowledge in relation to urban agriculture is often noted in literature, more gaps that are specific can also be identified. Understanding the importance of urban agriculture as a source of income and how this varies by gender, wealth and area of residence, is one such gap (Holt-Giménez and Shattuck, 2011). Understanding this knowledge has implications for what kind of policy priorities are relevant and best suited for the sector, in relation to crop science, marketing structures and food safety interventions. If urban agriculture is practiced primarily to raise incomes through the sale of crop products to other urban residents, the policy priorities need to be quite different from subsistence based urban agriculture (Gliessman, 1998).

Additionally, despite the positive economic benefits of urban agriculture, the literature about urban design and planning has not paid enough attention to its effect on the urban environment. Arguably, this is partly because there is a perception that urban agriculture is somehow considered a third world activity (Birkhofer; Ekroos; Corlett and Smith, 2014). The scarcity of empirical research on urban agriculture might be another reason why urban practitioners have neglected the application of urban agriculture to urban design and development. The few studies available have each mainly focused on one particular relationship between urban agriculture and the environment, and none provides a

comprehensive frame of analysis (Tuck; Winqvist; Mota; Ahnstrom; Turnbull and Bengtsson, 2014)

Lastly, much of the literature available focuses on urban agriculture in developing countries, whereas research on the benefits of urban agriculture in developed cities would be significantly useful in achieving policy changes to promote urban agriculture in the developing and underdeveloped economies. Furthermore, understanding the environmental, social and health costs and benefits of the sector will contribute to the development of defined metrics for comprehensively evaluating the sustainability of urban agricultural systems, which are still lacking (World Bank, 2008). This would make significant contributions to business and policy decisions, as well as regulatory approaches that impose minimum environmental standards and stimulate good practice.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

3.1 Research Design

According to the University of Southern California (USC) (2017), the research design refers to the overall strategy that one chooses to integrate the different components of the study in a coherent and logical way, thereby, ensuring one will effectively address the research problem. For the purpose of this study a descriptive research design was used. Descriptive research can be explained as a statement of affairs as they are at present with the researcher having no control over variables (Dudovskiy, 2017). This type of research aims at shedding light on current issues or problems through a process of data collection that enables the researcher to describe the situation more completely than was possible without employing the method. Descriptive research was used in describing the various farming practices used by informal and formal landholders. It was also used in describing visible impacts on surface water sources, vegetation and soil.

The researcher also used both qualitative and quantitative methods in the development of the study. Qualitative research is primarily exploratory research. It is used to gain an understanding of underlying reasons, opinions and motivations (Wyse, 2011). The most preferable respondents may be learned or exposed to the subject under examination (Creswell, 1994). Hence, the researcher selected respondents that would provide information relating to the phenomena under investigation, which is urban agriculture. Quantitative methods were employed in the study. Quantitative Research is used to quantify the problem by way of generating numerical data or data that can be transformed into usable statistics (Wyse, 2011). This method was used to quantify respondents' answers in defined variables and draw statistical conclusions in comparisons such as land cover changes over time. Overall, a combination of significant research methods were employed in the study to ensure that appropriate data is collected.

3.2 Target Population

The target population for a survey is the entire set of units for which the survey data are to be used to make inferences (Lavracas, 2008). For the purpose of this study, the target population constituted both formal and informal landholders from select middle to low-density suburbs in Gweru Urban. These are Athlone, Gweru East, Harben Park, Windsor Park, Coolmoreen Plots, Bradley Plots, Ridgemont, Riverside and Southdowns. However, in coming up with a practical population size, the researcher considered 2 suburbs which constituted a total

population of 187 households; from which 35 respondents were selected. The research also targeted professional respondents; namely the District Environmental Management Officer and a Gweru City Council official.

Since one of the study objectives is to identify farming practices used by urban residents involved in the urban agriculture sector, it was only logical that the target population comprised of a sample of urban farmers on which insightful interpretations were made and less distorted primary data was gained. Direct engagement with urban farmers enhanced a better understanding of the phenomena.

The Gweru City Council was also part of the target population. City Council officials were targeted particularly because they are responsible for the provision and extension of plot-land, securing of licences, allocation and authorisation of farming land scattered around the suburbs. This was aimed at determining the criteria for allocation of land and the municipal bylaws associated with urban agriculture.

Engaging the Environmental Management Agency facilitated answering of some key research questions. The study was aimed at assessing the environmental implications of urban agriculture; hence, the researcher found it fit to involve EMA in order to ascertain the nature and severity of impacts and their views on the subject matter since they are the country's major environmental body.

3.3 Sampling Procedure and Size

Sampling refers to a process or technique of choosing a sub-group from a target population to participate in the study (Ogula, 2005). Initially the research utilised convenience sampling in selecting two study areas (Windsor Park 2 and Coolmoreen Plots) from the overall target population. Convenience sampling is when subjects are selected because of their immediate accessibility and proximity to the researcher (Explorable, 2009). The two suburbs were close (in terms of distance) to the researcher's residential area. Hence, this facilitated efficiency in data collection from field observations and questionnaires.

Simple random sampling was employed in sampling respondents from Coolmoreen Plots. The suburb consists of approximately 33 household units (Gweru City Council, 2014) and the researcher randomly selected 15. This type of probability sampling procedure was employed since all of the households in these two suburbs displayed a homogenous characteristic. The majority were licenced landholders involved in the agricultural sector. Hence every housing

unit stood an equal chance of being selected. The sampling method was also chosen for its simplicity and convenience.

Furthermore, purposive sampling was used in the study. It is done basing on knowledge and study of the population. This type of non-probability sampling procedure was used in the selection of professional respondents from the City Council and the Environmental Management Agency. The main objective of purposive sampling is to arrive at a sample that can adequately answer the research objectives. Hence, the researcher included the District Environmental Management officer and a City Council official in the sampling frame. These respondents were best suited in answering planning, policy and regulation related questions.

Snowball (referral sampling) was also used in selecting respondents from Windsor Park 2. It is a nonprobability sampling technique where existing study subjects recruit future subjects from among their acquaintances (Heckathorn, 2002). Snowball sampling was best fit since informal land owners in Windsor Park 2 were distributed haphazardly. The researcher was not sure concerning the identity of landowners mainly because of the perceived illegal nature of the practice; hence snowball sampling; where the researcher was referred from one landowner to the other. Through snowball sampling, the researcher came up with 20 respondents from 154 household units in the suburb.

3.4 Sample Elements and Respondents

Table 3.1: Summary of Sample Elements and Household Respondents

Category	Population	Sampled	Sampling Method
Households (Coolmoreen Plots)	33	15	Random
Households (Windsor Park 2)	154	20	Snowball/Referral
TOTAL	**187**	**35**	

Table 3.2: Summary of Sample Elements and Professional Respondents

Category	Population	Sampled	Sampling Method
Gweru City Council	2	1	Purposive
Environmental Management Agency	2	1	Purposive
TOTAL	**4**	**2**	

3.5 Data Collection Instruments

Data collection instruments are methodologies used to identify information sources and collect information during an evaluation (Development Co-operation Directorate (DCO), 2002). They can be either primary or secondary. Primary data sources used were questionnaires, interviews and field observations whilst secondary sources were aerial maps and remotely sensed images. The validity and reliability of the research project was largely dependent on the appropriateness of the instruments used.

3.5.1 Questionnaire Survey

A questionnaire is a research instrument consisting of a series of questions (or other types of prompts) for gathering information from respondents (Burns and Bush, 2010). The research used a combination of open ended and closed questions. Open-ended questions were specifically designed to allow respondents to answer freely. The questionnaire solicited information on the major variables under study which included farming methods and impacts on land, vegetation and water quality. A total of 35 questionnaires were issued from 187 respondents from the two study areas. The questionnaires were self-administered in order to ensure the elaboration of complex questions particularly to the illiterate groups. Questionnaires were administered during a convenient time dictated by the respondents in order to promote cooperation and yield a high response rate in the long term.

3.5.2 Interviews

Interviews are a method of collecting information from people, through face-to-face interaction (Lu, 2002). Structured interviews consist of an orderly set of premeditated questions or guidelines. Unstructured interviews appear to be more informal and flexible since they are conveniently formulated during the course of the interview.

The researcher used structured interviews to engage the District Environmental Management Agency officer and the City Council official. This benefited the research since questions were asked in the same way and manner using an interview guide, for each target group. This allowed the two respondents to answer more effortlessly and straightforwardly. Interview guides were also used to serve time and as such, the researcher prepared an interview guide in advance to determine how much time each question would take. A total of 2 key informants were selected from the institutions that have an understanding of urban agriculture and land-use planning.

Unstructured interviews were used to collect data and information from households. This allowed the researcher to go beyond the confines of structured interviews resulting in a more flexible dialogue. Interviews were largely useful in identifying unsustainable farming methods and farmer's perceptions or attitudes towards environmental issues. The informal nature of these interviews gave adequate room for respondents and participants to answer questions in as much detail as they want, which in turn significantly benefited the validity of the research.

3.5.3 Direct Field Observations

Direct observation, also known as observational study, is a method of collecting evaluative information in which the evaluator watches the subject in his or her usual environment without altering that environment (Holmes, 2013). The researcher (being a non-participant) observed participants as they were engaged in their agricultural activities. Specific attention was focused on their access and utilisation of natural resources (land and water), methods employed during different stages of farming and organic and inorganic materials that they utilised.

The procedure was unobtrusive in order to allow informants to share their reality directly with the researcher. This approach was of significance since it enabled gathering of first hand data and also permitted supplementing of the data through photographs. This ensured some form of evidence to support the study findings (Sibanda, 2015). Direct observations were used in checking the validity of other data collection methods in order to reduce bias. The research benefited significantly from field observations since they exposed indisputable actions as they occurred. The researcher used a checklist that guided the observations.

3.5.4 Water Sampling

During the collection of water samples, the researcher followed predetermined sampling protocols (Chemistry 130, 2005). Aspects such as sampling point, the number of samples to be collected, and the timing of the sampling were considered in preparation of the sampling procedure in order to meet the purpose of the survey. To ensure that the selection was in relation with the research, one factor was considered; which is the dominant type of land use and activity. Therefore, collection of water samples was from an intermittent stream in Windsor Park 2 that was potentially affected by urban agriculture activities.

A visual inspection of the condition of the source was performed in order to note pollution indicators. Sampling equipment included a rope and sampling bucket, cooler-box, 2litre polyethylene bottles and labels. Polyethylene bottles were used in place of glass bottles since they are cheap and comparatively easy to acquire. At each sampling point, the researcher recorded the location, date, time, sample number and took some notes. The chemical parameters under study were total nitrogen and total phosphate. The physical parameters were temperature, pH, turbidity and conductivity as shown in the table 3.3

Table 3.3: Physio-Chemical Parameters of Surface Water

Parameter (Chemical)	**Explanation**
Total Nitrogen	(NP) is a measure of all forms of nitrogen (organic and inorganic). The importance of nitrogen to aquatic plant and animal species varies according to the proportions of the forms present. (ammonia, nitrite, nitrate, or organic nitrogen)
Total Phosphates	This is a measure of both inorganic and organic forms of phosphorus. Total phosphorus is considered the most critical nutrient for aquatic plant species.
Parameter (Physical)	**Explanation**
pH	pH is the measurement of the hydrogen-ion concentration in surface water. A pH below 7 is acidic and a pH above is basic/alkaline. Although levels vary, the general range is 6 – 9.
Conductivity	Conductivity is the measurement of the ability of water to conduct an electric current. It is influenced by the amount of dissolved ions present in water bodies. The greater the number of ions, the higher the conductivity.
Temperature	Temperature affects solubility of many chemical compounds found in water. Increased temperatures elevate metabolic oxygen demand, which in conjunction with reduced oxygen solubility, affects many aquatic species.

Turbidity	Turbidity is the cloudiness or haziness of water caused by suspended particles that are generally invisible to the naked eye.

During sampling, the collection bucket was rinsed 3 times with a bucketful of river water. The researcher chose to sample two points from either side of the bridge (downstream and upstream). GPS coordinates for each point were recorded. For each sampling point, 2litres of water were sampled and at a sampling depth of 5cm. The researcher avoided direct contact with sampled water by wearing rubber gloves, as this would potentially ruin validity of results. Turbidity, temperature and PH were immediately tested and recorded soon after sampling since they are prone to change during storage and transportation. Sampling containers were rinsed three types to rid impurities. Samples were stored in a cooler-box at 4 Degrees Celsius awaiting transportation to the laboratory for physiochemical analysis.

3.6 Land Cover/Land Use Change Determination

Land cover changes were determined for Windsor Park 2 from 2005 to 2016. The study benefited from the use of ArcGIS 10.5 and Google Earth Pro. Land cover/land use changes were observed using multispectral satellite data obtained from Landsat and Digital Globe for the years 2005 and 2016 respectively. Data were pre-processed in ArcGIS 10.5 for geo-referencing. The study area was classified into five major land cover/use classes namely Agriculture, Bare land/soil, Settlements, Vegetation and Forests through ISO unsupervised classification.

The Google Earth images of the study area before it was disturbed were presented. Google earth images of study area after establishment of settlements and intensive urban agriculture were also presented. This helped in showing the difference between the undisturbed and disturbed areas in the decade period. ArcGIS 10.5 was used in determining changes for each of the five classes. Spectral signatures for the respective land cover types were recorded by using the pixels enclosed by the polygons. The delineated classes are shown in Table 3.4

Table 3.4: Classes considered on the basis of unsupervised classification.

No	Class	Description
1	**Agriculture**	Crop land (mainly informal agriculture)
2	**Settlements**	Residential housing units

3	**Bare land**	Land areas of exposed soil and barren area influenced by human activity
4	**Vegetation**	Lower vegetation, shrubs and bushes around the suburb
5	**Forest**	Forest resources, woodlots

3.7 Data Analysis and Presentation

Questionnaire data was analysed through the content analysis. It involves systematic reading or observation of texts or artefacts, which are assigned labels to indicate the presence of interesting and meaningful patterns (Hodder, 1994). Hence, all data from the questionnaires collected was categorised in terms of the driving objectives in order to ensure exhaustion of information. It was followed by a critical in depth analysis which enabled the researcher to derive differences and similarities in the nature, practice and impacts of agriculture in the two study areas. Information and interpretations made from questionnaires responses was qualitatively presented and quantitatively analysed and presented through. The researcher mainly used descriptive statistics such as tables and pie charts in the presentation of data. Tables were used in presenting socio-demographic data relating to sex, employment status, age and level of education of the respondents.

Interview data was analysed using the thematic method. According to Braun and Clarke (2006), thematic analysis is a method used for identifying, analysing, and reporting patterns (themes) within the data. The study utilised this method since rigorous thematic approach can produce an insightful analysis that answers particular research questions. Firstly, familiarisation with data was internalised through interpretation of the interview results. The most important consideration was identifying themes emanating from the interview data collected from official respondents from Gweru City Council and EMA, for example, the legal and environmental considerations arising from the practice. Similar information arising from a research question or topic was assigned to a specific theme. Lastly, an in depth analysis and comparison of classified data was made to come up with integrated answers to research questions.

Data gathered from direct field observations was analysed through the logical method. According to Miles and Huberman (1994) in Sibanda (2015), in this method, conclusions are made from generalised rational reasoning and information should be represented using descriptions as well pictorially. Thus, observations captured during field visits allowed the researcher to arrive at certain conclusions in relation to the actual situations on the ground. Logical explanations arose from the description of phenomena and activities captured in field

notes. Photographs taken during observations provided vivid evidence to clarify the nature of urban agriculture and its associated environmental impacts. The photographs were also used as a yardstick in validating the researcher's perceptions concerning urban agriculture and its implications on urban ecology.

CHAPTER FOUR: RESULTS ANALYSIS, PRESENTATION AND DISCUSSION

4.1 Response Rate

The questionnaire survey yielded a 100% response rate which was highly significant in generating a considerable measure of the desired sample to draw research conclusions.

4.2 Socio-Demographic Characteristics of Household Respondents

Table 4.1: Socio-demographic characteristics of household respondents

WINDSOR PARK 2			COOLMOREEN		
Variable	**Frequency**	**(%)**	**Variable**	**Frequency**	**(%)**
Gender			**Gender**		
Male	5	25	Male	5	33.3
Female	15	75	Female	10	66.6
Age			**Age**		
18-20	0	0	18-20	0	0
21-30	4	20	21-30	2	13.3
31-40	9	45	31-40	3	20
41-50	2	10	41-50	5	33.3
51+	5	25	51+	5	33.3
Education Level			**Education Level**		
Primary	3	15	Primary	4	26.6
Secondary	10	50	Secondary	7	46.6
Tertiary	5	25	Tertiary	3	20
None	2	10	None	1	6.6
Household Size			**Household Size**		
Below 4	3	15	Below 4	2	13.3
4-6	13	65	4-6	4	26.6
7-9	4	20	7-9	9	60
Employment Status			**Employment Status**		
Employed	12	60	Formal employment	3	20
Retired	5	25	Retired	7	46.6
Unemployed	3	15	Unemployed	5	33.3

4.2.1 Windsor Park 2

Results shown in Table 4.1 indicate that the majority of land owners in Windsor Park 2 are females. They account for 75% of the sample size. This purports that the informal urban agriculture sector is dominated by women. This can be attributed to the fact men are comparatively engaged in formal occupations in order to provide steady income to their respective households. The 25% of males involved in the informal sector have no formal employment and hence resort to informal agriculture activities in order to fend for their families. Such a scenario validates Hungwe (2004)'s assertion that the unfavourable economic status of the country has largely motivated urban residents in Gweru to rely on urban agriculture as an alternative livelihood source. Results statistics also indicate that majority of informal landholders are in the economically active age groups which validates that a majority of the economically active citizens in urban areas are struggling to secure employment in the formal sector and hence resort to informal agricultural practices.

4.2.2 Coolmoreen Plots

Statistics in Table 4.1 highlight that women also constitute the majority of landowners in the formal sector of agriculture. They constituted 67% of the total respondents. Questionnaire results indicated that most of the women were aged and had a poor education background and hence could not secure employment in other sectors of the economy. They had to engage in formal agriculture in order to sustain the livelihoods of their comparatively large households. This supports Keliang and Prosterman (2012)'s view that many urban and peri-urban farmers are frequently women, who tend to be economically vulnerable. Their male counterparts were employed in the industrial and commercial sector. The income generated was used to secure agricultural inputs. This seconds the common view that urban agriculture in developing countries is a copying strategy perpetuated by the poor economic standards which are characteristic of developing economies.

4.3 Farming Practices Utilised by Residents in Windsor Park 2 and Coolmoreen Plots

4.3.1 Cultivating on Wetlands

Research findings revealed that 30% of informal farmers in Windsor Park 2 undertook their activities on wetlands. This practice was largely concentrated in the eastern parts of the suburb where wetlands dominate the ecosystem. Wetlands provide a large variety of ecosystem resources, nutrients and functions. Hence the wetland areas provided their crops with the much needed water and nutrients which are generally scarce during the dry season.

Land was secured informally without the jurisdiction of the local authorities. The City Council official noted that the local authorities were not involved in leasing agricultural land on wetlands and that this practice was done illegally. This scenario was noted by PRTF (2015) indicating that residents in the informal sector of urban agriculture utilise almost every piece of 'free' and undeveloped land in order to produce their crops which may put them at loggerheads with the local authorities.

4.3.2 Clear Cutting of Trees

Observational study indicated that residents in Windsor Park 2 and Coolmoreen Plots were collectively engaged in tree felling. All agricultural activities are accompanied by clear cutting of trees to facilitate crop production. Methods used in clearing the land were largely dependent on the economic status of landholders. Risky and laborious methods such as use of fire and axes respectively; were more utilised by the poorer households who could not afford to hire labour. Hence, 70% of informal farmers in Windsor Park claimed they used fire since it was a low cost method. Use of tree cutting machines was noted in Coolmoreen Plots. Most farmers in Coolmoreen Plots indicated that tree felling and bush clearance was normally done to ward off robbers. Conclusively, field observations showed that burning and heavy deforestation left the land bare and exposed to agents of erosion.

4.3.3 Use of Waste Water for Irrigation

Questionnaire results indicated that 20% of agricultural land in Windsor Park 2 was located on sewer infrastructure. Respondents pointed out that this was a strategic way of accessing and redirecting municipal waste water for irrigating crop fields. Municipal waste water was also channelled towards irrigation of small vegetable gardens. Informal landholders noted that during periods of erratic rainfall, municipal waste water played a vital role in supporting agricultural activities. As proposed by Chimbari et al (2003) and Mubvami (2008), irrigation with municipal wastewater is practised in many urban and peri-urban areas of developing countries. This exposes farmers to a plethora of health risks especially if the water is untreated. Farmers were not sure whether exposure to untreated sewage water posed health risks. This indicated a general lack in information dissemination on health issues related to informal urban agriculture.

4.3.4 Use of Chemical Pesticides and Herbicides

A majority of landowners in Coolmoreen Plots relied on pesticides and herbicides when managing pests and weeds. Herbicides, also commonly known as weed killers, are chemical

substances used to control unwanted plants. Informal interviews with participants indicated that combinations of selective and non-selective herbicides were used to control weeds. Non selective herbicides targeted specific weed species, while leaving the desired crop relatively unharmed. Non-selective herbicides were used to clear waste ground. Samples of insecticides and pesticides containers indicated that the chemical substances were toxic to humans. This was in agreement with Unsworth (2010)'s proposal that many of the agrichemicals are toxic, and bulk storage and use may pose significant environmental and/or health risks, particularly in the event of accidental spills. The EMA official indicated that the use of agrichemicals is highly regulated in Zimbabwe. Farmers in Coolmoreen Plots showed a general understanding on use and handling of agrochemicals. One farmer indicated that used pesticide and insecticide containers are disposed of in designated landfills following standard procedures. The researcher also noted the use of protective gear and equipment during chemical treatment.

4.3.5 Use of Organic and Synthetic Fertilizers

Questionnaire results indicated that various agents were used in fertilizing the soil by formal and informal landholders in the two study areas. Amongst them was the use of synthetic fertiliser which provided micronutrients namely potassium, nitrogen and phosphorus in varying proportions. All participants agreed that the most common type of fertiliser used was Compound D (Ammonium Nitrate). The researcher also encountered the use of agricultural lime and acidifying agents which were significant in achieving a favourable soil pH. Organic waste such as cow dung was introduced mainly in vegetable gardens. The respondent from EMA expressed concern on the impacts of organic and synthetic fertilisers on soil and river quality; indicating that results from previous soil quality tests from sample plots showed presence of high nitrogen values. The discussion led to the conclusion that environmental concerns arose from the heavy application of nitrogen and phosphorus based fertilisers in terms of soil quality.

4.3.6 Use of Simple and Sophisticated Agro-Equipment

The research results indicated the collective use of low and high cost machinery in land preparation. A combination of simple and sophisticated agro-equipment included hoes, axes, dibbers, machetes, ox-drawn ploughs, tractor drawn ploughs, combine harvesters, planters and boom irrigation systems. There was correlation between the type of equipment used and the size and location of the land. Observations revealed that tractors and ox-drawn ploughs were used in situations where the field was large in area (particularly in Coolmoreen Plots).

Hoes, machetes and slashers were used in situations where either the field was located near electricity or sewage infrastructure or was reasonably small enough to be cultivated easily. This was a way of avoiding damaging local infrastructure in rare cases of accidental collision. Roughly 10% of the population of informal farmers used hired tractors in ploughing. Such a case supports the view that informal urban agriculture maximises low cost inputs and processes. Questionnaire results indicated that 44% of farmers in Coolmoreen Plots harvested their produce using machinery such as combine harvesters. This was specifically noted in the harvesting of maize. It can be attributed to the fact that combine harvesters are efficient and hence significantly reduce post-harvest losses which is highly necessary for market-end produce.

4.3.7 Intercropping and Crop Rotation

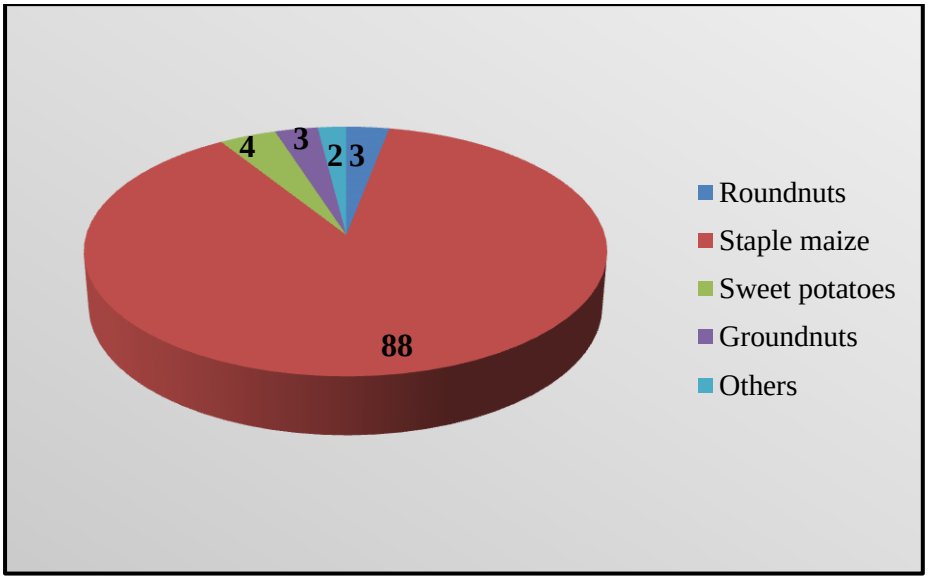

Fig 4.1: Major crop products from Windsor Park 2 and Coolmoreen Plots

Fig 4.1 shows percentage of crop content in the two study areas. Field observations indicated evidence of intercropping and crop rotation. The major crop grown in the two study areas was maize as shown in Fig 4.1. It was intercropped with other food crops such as sweet potatoes and sugar-beans. This was solely done in order to take full advantage of the growing season and to provide nutritional variety. The majority of informal landowners in Windsor Park 2 rarely practiced crop rotation. This was because the land was moslty used during the rainy season and discarded afterwards. Overall, results indicated plot owners practiced mixed-farming to maximise on yields. Farmers also benefited from traditional vegetables such as wild spinach (nyevhe), derere (triumfetta angolensis) and black jack (tsine) which occurred naturally in the fields.

4.4 Impacts of Urban Agricultural Practices on the Biophysical Environment

4.4.1 Destruction of Wet Lands

Plate 4.1: Heavily disrupted wetland due to informal banana plantation, Windsor Park 2

Source: Field Observation (2017)

Plate 4.1 shows impacts of agricultural activities on wetland soil structure. Most wetlands in Gweru East where Windsor Park 2 is located were converted into informal maize, banana and potato fields. Clay soils in wetland areas are fairly saturated and generally humid all year round, hence tilling and ploughing results in heavy soil compaction and loss of soil structure as established in Plate 4.1. Field observations indicated that substandard contour ridges were also constructed downslope in order to drain off excess water. This has a negative effect of turning wet land areas into dry lands. Destruction of wetland vegetation was also noted. Due to accelerated drying of soil and disruption of soil structure and texture, there was visible loss of small plant species and potential reduction in microbial activity (an important aspect of nutrient fixing). Owing to the reduced bush cover, the land was left to be baked under the scorching summer sun. From observations carried out in the research, many areas which were once perennial wet lands have since dried up due to anthropogenic activities. This led to the conclusion that unregulated informal agricultural practices result in loss of wetland ecosystems.

4.4.2 Eutrophication

Plate 4.2: Eutrophication of a tributary stream, Windsor Park 2

Source: Field Observation (2017)

Plate 4.2 shows heavy colonisation of a stream in Windsor Park 2 by foreign plant species. This was largely attributed to heavy use of synthetic fertilisers. Questionnaire survey indicated that 95% of land holders from the two study areas relied on the use of inorganic fertilizers. Eutrophication resulted in the accelerated growth of aquatic evasive species. The dominant specie was the water fern *(salvinia auriculata)* which usually uses most of the oxygen in these water bodies; subsequently suffocating present aquatic life. Eutrophication also resulted in high turbidity levels of the stream as evidenced by water sample results. An analysis of sample results showed increased phosphorus yield in rivers; potentially owing to the excessive use of phosphorus based fertiliser containing Ammonium Polyphosphate (APP) which is particularly 100% soluble in water. An EMA official concluded that some of the fertiliser is not sufficiently utilised by crops and hence the excess ends up leaching into nearby water sources in the rainy seasons through sub-surface and surface runoff.

4.4.3 Deforestation and Loss of Important Tree Species

All agricultural activities are preceded by clear-cutting of trees and clearance of bush and grass. Observations and land cover analysis indicated a general reduction in vegetation cover in Windsor Park 2 and Coolmoreen as a result of tree felling. Interview results with the City Council official indicated that cultivation takes place on almost any ‘available’ piece of land such as stream banks and other green spaces, consequently resulting in heavy loss of flora species from agents such as human-induced veld fires. The EMA official argued that

ignorance of sophisticated issues like urban climate change and global warming means that these problems may go on unabated for a long time regardless of efforts from the environmental body. The researcher concluded that important urban forest resources were at risk from tree felling and veld fires. This conclusion stemmed from an analysis of land cover changes in Windsor Park 2 which showed significant decrease in a gum tree species - *eucalyptus globulus* - which once dominated the urban landscape. Discussion with the EMA official revealed that tall trees act as wind breaks and the cutting down of such trees exposes the elements and ultimately leads to desertification.

4.4.4 Soil Erosion

Plate 4.3: An exposed sun-baked soil surface, Coolmoreen

Source: Field Observation (2017)

Plate 4.3 depicts an exposed soil surface from a field in Coolmoreen. Human activities accelerate the rate and scale at which natural soil erosion takes place. Research results showed that exposed surfaces in the study area accelerated the rate of soil erosion. The EMA official also pointed out that the SAZ standard for *Soil and Water Conservation and Erosion Control* asserts relevant measures such as; using cover crops, mulches and not ploughing against the slope must be taken to prevent soil erosion. Unfortunately, results indicated that such measures were loosely adopted by landholders. Literature on agriculture reveals that a reduction in vegetation cover exposes soil to weathering agents such as surface runoff. Field observations indicated acute risks of downstream river system siltation due to sheet erosion and sediment deposition which would otherwise be prevented by surface vegetation cover.

The high level of conductivity in the sampled stream was potentially a result of eroded soil entering the river system.

4.4.5 Health Risks (Exposure to Pathogenic Hazards)

Plate 4.4: Cultivation on sewage infrastructure, Windsor Park 2

Source: Field Observation (2017)

Plate 4.4 shows cultivation on sewage infrastructure. Observational research and questionnaire results indicated that the practice was less common in the formal sector since it's comparatively more regulated. Hence in Windsor Park 2, this practice has become a common scene. Some of the septic tanks like the one depicted in Plate 4.14 showed signs of leakages. This was a critical condition in terms of exposure to bacteria. The EMA official pointed out that few studies have been carried out to ascertain food safety risks associated with farming on sewer infrastructure and using municipal waste water. However, the common perception was such practices likely increased farmers' risk of directly contracting water borne diseases. Some crops were grown in sewage effluent that is not adequately treated and which potentially contains micro-organisms and hazardous bacteria, creating health hazards such as cholera, dysentery and diarrhoea. The City Council official expressed concern on the use of waste water especially without authorisation. He agreed that informal landholders target these specific areas due to the availability of water and nutrients for crops.

4.4.6 Destruction of Multiple Ecosystems Due to Uncontrolled Veld Fires

Plate 4.5: Destruction of an ecosystem due to uncontrolled veld fire, Windsor Park 2
Source: Field Observation (2017)

Plate 4.5 indicates one of the many impacts of agricultural practices on multiple ecosystems in the study area. Rampant veld fires often occur in the summer season during which farmers prepare their fields for the next planting season. Uncontrolled veld fires often result in the destruction of the untargeted areas in which diverse mosaics of plant, animal and insect species are found. The City Council official expressed great concern on the prevalence of uncontrolled veld fires within peri-urban and urban landscapes of Gweru. He noted that veld fires are one of the major causes of deforestation in Gweru and result in the defacing of urban landscapes. The EMA official also elaborated that veld fires are sources of atmospheric emissions such as carbon dioxide and soot which results in the increase of greenhouse gases. Fire also poses danger to human beings resulting in the loss of life.

4.5 Surface Water Quality in Windsor Park 2

The parameters analysed in the study were selected on the basis of the dominant land use activity. In essence, the parameters were selected on the potential pollutants that are associated with agricultural activities. In this case, agriculture is associated with the use of fertilisers and as such Total Nitrogen (NP), Total Phosphate (TP), conductivity and turbidity were selected as major pollution indicators. Other physical parameters considered were temperature and pH. Sampling was done in the month of September 2017 (dry season) from an intermittent tributary stream in Windsor Park 2.

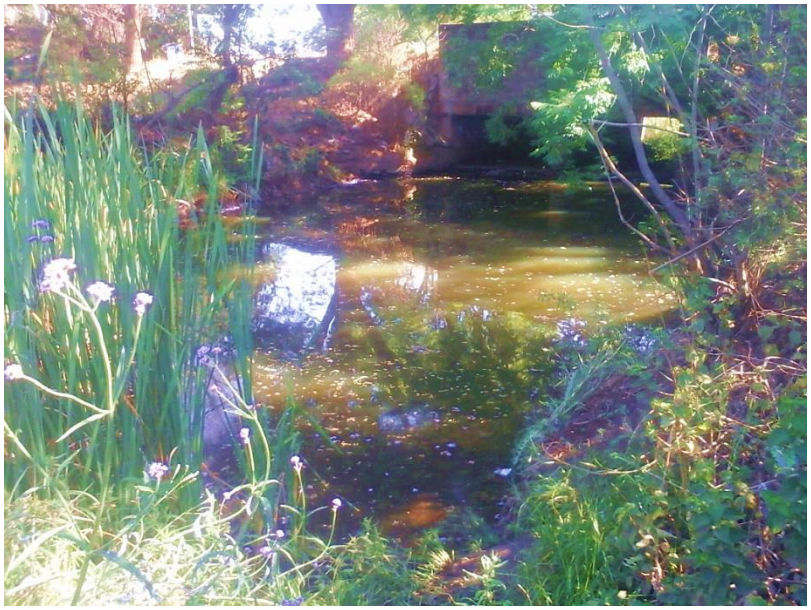

Plate 4.6: Sampling source (upstream), Windsor Park 2

Source: Field Observation (2017)

Plate 4.6 shows the stream from which water samples were collected. A visual inspection of the stream showed signs of heavy pollution. Pollution indicators such as high turbidity, eutrophication, presence of algae and discolouring were clearly visible to the eye. This was largely due to prolonged stagnancy. Absence of channel velocity provided a favourable breeding ground for algae; since it was the dry season and the water level was significantly low. The stream also showed signs of anthropogenic activities. There were vegetable gardens near the stream indicating that it was a source of irrigation. Its banks were also used as waste dumpsites.

Table 4.2: Water Quality Results

Sampling Point	**Total Phosphates mg/L**	**Total Nitrogen mg/L**	**Conductivity µS/cm**	**Turbidity NTU**	**pH**	**Temp**
Point A (Upstream)	0.149	5.064	573	54	9.2	26.3
Point B (Downstream)	0.152	5.044	596	55	8.9	25.5
Mean	0.150	5.054	585	55	9.05	26
Standard (for surface water)	**≤0.1 mg/L**	**2 – 6 mg/L**	**150 – 500**	**1 – 50**	**6.5 – 8.5**	**25**

4.5.1 pH (potential of hydrogen)

A mean pH (potential of hydrogen) value of 9.1 at 26 Degrees Celsius was recorded as shown in Table 4.2. pH levels of 6.5 to 8.5 are generally optimal for most aquatic organisms. With reference to the classification of pH ranges; a value of 9.1 indicates that water from the stream was strongly alkaline. The high pH level recorded potentially emanated from the rapidly growing algae or submerged aquatic vegetation which acts by removing carbon dioxide from the water during photosynthesis, significantly increasing the pH levels. This concluded that water from the sampling source was significantly polluted.

4.5.2 Turbidity

A mean turbidity value of 55 NTU was recorded. Turbidity, or cloudiness in water, is mainly caused by suspended materials that scatter light passing through the water. A visual inspection of the stream also indicated that the level of turbidity was high as depicted in Plate 4.6. The main source of turbidity was silt and clay deposition from disturbed and eroded soil due to agricultural activities (mainly streambank cultivation). The turbidity levels were aesthetically unpleasant, potentially blocked out the light needed by submerged aquatic vegetation and increased temperature levels. Conclusively anthropogenic activities taking place in the area negatively impacted on river water quality and increased the risk of aquatic specie losses.

4.5.3 Conductivity

Sample results indicated that the level of conductivity averaged 585µS/cm at 26 Degrees Celsius as shown in Table 4.2 showing that ions and solids were present in the water. A higher conductivity was most likely due to water abstraction. The wetland was dominated by a variety of human activities and common was informal subsistence agriculture. Water abstraction is considered as one of the main causes of wetland degradation (Mutisi 2014). Water abstraction reduces surface water quality. This is because during water extraction for irrigation, organic matter from the bottom of the river mixes with clear surface water. This in turn increases the level of ions in the water. Water extracted from the river was used in the irrigation of stream bank gardens. Hence a higher conductivity level indicated water pollution from human activities.

4.5.4 Total Nitrogen

Total Nitrogen (NP) averaged 5mg/L and was generally within the upper limit of permissible values for surface water. However if other nutrients are present, algal blooms can occur with

as little as 0.5mg/L NO3 value. The presence of algae was potentially due to dead biomass accumulating at the bottom of the stream where it decayed. The nitrogen values were generally acceptable since sampling was done off-season in September. However vegetable gardens nearby and agriculture run-off also gave a high nitrate value in the stream compared to other present forms of nitrogen. Literature on urban agriculture agrees that cropland contributes largely to the nitrogen component due to fertilizer application.

4.5.5 Total Phosphate

Total Phosphates (TP) recorded were 0.2 mg/L as indicated in Table 4.2. A small amount of phosphorus is an essential nutrient for all aquatic plants but in high levels, phosphorous can be considered a pollutant. The phosphorus concentrations in the water were high hence determining the accelerated level of eutrophication due to an excess of nutrients. The high value was arguably as a result of phosphate containing fertilisers which contain high levels of orthophosphates that enter water through runoff and erosion. This is proven by Ahmad and Sheikh (2015) who indicate that phosphates from fertilisers flow into main streams and ultimately end up in water bodies causing an increase in algal bloom.

4.5.6 Temperature

Table 4.2 shows that temperature was insignificantly above the limit at 26 Degrees Celsius. Temperature is an important parameter to consider when assessing water quality. It influences several parameters and can alter the physical and chemical properties of water such as pH, salinity and conductivity. The temperature reading was strongly influenced by the time of the month in which samples were collected (which is September summer season). The temperature value most likely influenced the high conductivity level in the stream.

4.6 Land Cover Changes in Windsor Park 2 (2005-2016)

Plate 4.7: Windsor Park 2 before intensive agriculture activity (Google Earth Pro, June 2005)

Plate 4.8: Windsor Park 2 after intensive agricultural activity (Google Earth Pro, Nov 2016)

Plates 4.7 and 4.8 depict aerial photographs of Windsor Park 2 before and after significant land cover change, respectively. A comparison of historical and current aerial photographs of Windsor Park 2 showed significant changes in land use and cover within the classes of Agriculture, Forest, Vegetation, Settlement and Bare land. Results indicated that there was notable decline with respect to surface area coverage in Windsor Park 2 observed in vegetation and forest resources and an increase in the area occupied by residential settlements, bare land and most importantly agricultural land. This is indicated in Table 4.3 which shows the percentage cover for the 5 classes in 2005 and 2016.

Table 4.3: Percentage change in land cover in Windsor Park (2005 and 2016)

Class	2005	Class	2016
	Percentage Cover (%)		Percentage Cover (%)
Vegetation	15	Vegetation	14
Forest resources	33	Forest resources	20
Agriculture land	22	Agriculture land	27
Bare land/soil	25	Bare land/soil	33
Built up area	5	Built up area	6

4.6.1 Vegetation

As indicated in Table 4.3, vegetation land shrank from 15% to 14% of the total area from the period of 2005 to 2016. The decrease in vegetation cover was dominantly as a result of informal agricultural activities. Field observations and land use analysis through GIS indicated that much of the open green space along the Gweru-Shurugwi railway line; dissecting the residential area; was occupied by informal landholders. This was followed by extensive tree felling in order to facilitate the cultivation of crops; concluding that deforestation is an inevitable phenomenon emanating from agricultural activities and has resulted in the loss of urban green spaces. In addition to deforestation, cutting of fuel wood by the local communities and extensive cattle grazing have deformed the plants present in the area to small bushes and in some areas have left only barren lands.

4.6.2 Forest Resources

With reference to Plate 4.8 there was significant decrease in the area of open forest resources that were sparsely distributed along the borders of Windsor Park 2. Table 4.3 indicates a decrease of 33% to 20% within the decade of 2005 and 2016. Dense forest vegetation was replaced by dark patches of bare land; attributed to uncontrolled veld fires from informal agricultural activities. This resulted in the loss of important tree species which are already limited in residential areas due to urbanisation. The level of deforestation that took place in Windsor Park 2 area reinforces that economic forces are commonly a major stimulus on anthropogenic change of land as indicated by Wang et al (2008).

4.6.3 Agriculture

Table 4.3 shows that Agriculture class was increased from a share of 22% to 27% during the period under study. Initially, agricultural production was only subjected and inclined to residential spaces until physical limitations such as space pushed residents to cultivate formerly wooded areas. It was also observed in the study area that residential settlements and most built up areas were mostly surrounded by agricultural land indicating that the area near the population had been cleared for the cultivation and production of crops in order to meet basic food provisions (Hagler, 2007). This concluded that informal agricultural activities were largely responsible for the general degradation of the landscape from 2005 to 2016.

4.6.4 Bare Land

Table 4.3 indicates that bare land experienced an increment in the total share from 25% to 33%. An increase in the surface area of bare soil was attributed to rapid deforestation in the study area which saw the removal of vegetation cover rendering the suburban area barren and exposed. The losses of soil quality from unsustainable agricultural practices potentially resulted in farmers abandoning the less productive lands due to economic inefficiency. This resulted in the increase in barren land area. Some of the major accelerators of forest decline in the area were anthropogenic activities like illegal tree felling and rigorous use of forest wood for fulfilling household requirements like heating and cooking.

4.6.5 Settlements/Built Up Area

GIS classification results indicated that the built up area increased from 5% to 6% from 2005 to 2016 as referenced in Table 4.3. This was attributed to numerous housing schemes which were developed in and around the study area in the past decade. There was a close relationship between urbanisation and informal agriculture development. With the increase in urban settlers there was also a relative increase in the access and utilisation of land for agriculture due to competition for scarce resources. This is realised by Hungwe (2007); pointing out that as the population of urban dwellers increases so does pressure on available resources resulting in residents scrambling for land to grow food crops.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The research study concluded that there are several environmental challenges emanating from formal and informal agricultural activities in Windsor Park 2 and Coolmoreen Plots. Such development has been aggravated by a high demand for agricultural space in Gweru City resulting in the establishment of informal agricultural activities on undesignated areas of residential suburbs. The need to maximise on agriculture production has also been contributory to subsequent vegetation loss, environmental degradation and water pollution. Conclusively, activities are worsened by two joint factors which are the prevailing economic challenges in Zimbabwe that force residents to look for alternative livelihood sources in the informal sector and the lack of clear policy guiding the urban agriculture sector.

Through an assessment of land cover changes, evidence of acute deforestation and land degradation over a decade period, indicated the negative impacts of agriculture developed under the hood or rather have been seemingly ignored by responsible authorities. Since the communities are characterised by low to medium income groups who primarily and alternatively depend on agriculture for sustenance and income generation, environmental protection comes secondary to food security needs. Thus, unsustainable agricultural practices such as farming on wetlands and streambanks, has become common practice.

The research also revealed evidence of surface water pollution and wetland disruption as a result of agro-activities carried out near streams and rivers; where the phosphate nutrient was found to be slightly above surface water requirements as a result of the use of synthetic fertilizers such as potassium phosphate. Conclusively, it was noted that one of the major constraints to knowledge dissemination on environmental sustainability was inadequate involvement of stakeholders in the sector; resulting in poor attitudes of farmers and a general lack of attentiveness towards environmental threats posed by unsustainable farming practices.

5.2 Recommendations

- The researcher recommends to the Environmental Management Authority and Gweru City Council that an integrated land use planning approach will go a long way in addressing issues of wetland degradation and fragmentation. Reviewing the current environmental policy on wetland preservation may also assist in the protection of wetland ecosystems.

- A comprehensive study of the health and food safety implications associated with cultivating on sewer infrastructure and the use of municipal waste water in agricultural activities should be implemented by the health sector and responsible authorities in order to ascertain the suitability and sustainability of the practice.
- The researcher recommends the community of Windsor Park 2 to consider adopting or cultivating indigenous knowledge systems and conservation agriculture when carrying out their activities in order to push the preservation of important urban vegetation species. Such measures are less costly and at the same effective.
- The Environmental Management Authority must demonstrate involvement in the informal sector of urban agriculture in order to have a clear and well informed perception of its dynamics. This will help in policy formulation through an integrated, sustainability-oriented approach to urban agriculture.
- There is need for a comprehensive policy framework on urban agriculture. Responsible authorities must provide operational guidelines that are aimed at regulating the sector. This will help improve the food security of low income groups and encourage sustainable exploitation of urban ecological resources.
- Environmental impact assessments should be carried out prior establishment of major land use activities. Given to proper land use planning, urban agriculture and the environment can co-exist harmoniously.

REFERENCES

American Community Garden Association (2007). What is a community garden? *Available at http://acga.org . Accessed on 8 September, 2017*

Anati, D. A. (1999). The salinity of hypersaline brines: concepts and misconceptions. *Int. J. Salt Lake. Res. 8: pp 55–70*

Andres, C.; Bhullar, G.S. (2016). *Sustainable Intensification of Tropical Agro-Ecosystems: Need and Potentials*. Environmental Science Front

Armstrong, D. (2000). *A survey of community gardens in upstate New York: Implications for health promotion and community development*. Health & Place

Bailkey, M. and Nasr, J. (2000). *"From Brownfields to Greenfields: Producing Food in North American Cities,"* Community Food Security News. Fall 1999/Winter 2000:6

Bellows, A.; Brown, K.; and Smit, J. (2013). "Health Benefits of Urban Agriculture" (paper and research conducted by members of the Community Food Security Coalition's North American Initiative on Urban Agriculture". *Available at http://www.foodsecurity.org Accessed 12 August 2017*

Birkhofer, K.; Ekroos, J.; Corlett, E.B.; and Smith, H.G. (2014). *Winners and losers of organic cereal farming in animal communities across Central and Northern Europe*. Biol. Conserv.

Bradley, K., and Galt, R. E. (2013). *Practicing food justice at Dig Deep Farms & Produce, East Bay Area and California: self-determination as a guiding value and intersections with foodie logics*. Local Environment

Burns, A. C.; Bush, R. F. (2010). *Marketing Research, Upper Saddle River.* NJ: Pearson Education

Chimbwanda, S. (2012) *Contribution of Urban Crop Production to Household Food Security: A Study of Urban Agriculture in Warren Park Suburb of Harare*. University of Zimbabwe.

Community Gardens Program (2014). Montgomery Parks, Maryland. *Available at http://www.communitygardensprogramm.gov Accessed 11 September 2017*

De Bon, H.; Parrot, L.; Moustier, P. (2008). *Sustainable urban agriculture in developing countries. A review*

Development Co-operation Directorate (2002). *Urban Agriculture*. OECD Publications, Paris

Economic and Social Council Commission on Sustainable Development (2000). *Sustainable agriculture and rural development.* Report of the Secretary-General Urbanization and sustainable agricultural development. Eighth session 24

Explorable (2009). Convenience Sampling. *Available at http://www.explorable.com Accessed Oct 10, 2017*

Food and Agriculture Organization (2014). Growing greener cities in Latin America and the Caribbean. *Available at http://www.fao.org . Accessed July 12, 2017*

Food and Agriculture Organization (2015). Urban and Peri-Urban Agriculture. *Available at http://www.fao.org . Accessed on 19 July, 2017*

Francis, Z.; Romanus, D. (2013). Urbanisation and Its Impact on Agricultural Lands in Growing Cities in Developing Countries: A Case Study of Tamale. *Ghana Modern Social Science Journal, 2*

Game, I.; and Primus, R. (2015). *Urban Agriculture*. State University of New York College of Forestry and Environmental Science

Gault, R.H (1994*).* "A history of the questionnaire method of research in psychology". *Research in Psychology. 14 (3): pp. 366–383*

Gliessman, S.R. (1998). Agroecology and sustainability. *In Proceedings of the INTECOL Symposium, Florence, Volume 8, pp. 1–9*

Gold, M. (2009). *What is Sustainable Agriculture?* United States Department of Agriculture, Alternative Farming Systems Information Centre.

Hampwaye, G.; Nel, E. & Ingombe, L. (2013) "The role of urban agriculture in addressing household poverty and food security: the case of Zambia". *Available at http://www.gdnet.org Accessed 10 July 2013*

Hans-Heinrich, B.; von Freyhold, K.; and Weisskoeppel, C. (2013). *Water harvesting, tree protection: towards food security in the Sahel, Bremen*

Haralambous, S.; Liversage, H. and Romano, M. (2009). *The growing demand for land Risks and opportunities for smallholder farmers.* Governing Council, 18-19 February

Heckathorn, D.D. (2002). "Respondent-Driven Sampling II: Deriving Valid Estimates from Chain-Referral Samples of Hidden Populations". *Social Problems. 49 (1): pp. 11–34*

Hodder, I. (1994). *The interpretation of documents and material culture*. Thousand Oaks: Sage.

Holmes, A. (2013). Direct Observations pp 980 -981 *Encyclopaedia of Autism Spectral Disorders* Springer: New York

Holt-Giménez, E.; Shattuck, A. (2011). Food crises, food regimes and food movements: Rumblings of reform or tides of transformation? *J. Peasant Stud., 38, pp. 109–144.*

Hungwe, C. (2007). *The Effectiveness of Practicing Urban Agriculture As A Survival Strategy Among Gweru Urban Farmers in Zimbabwe*. Urban Agriculture Magazine Number 18 August 2007.

Kaffer, N. (2010). Planners recommend new zoning, lower tax rate for urban farms. *Available at http://www.lexisnexis.com/hottopics/lnacademic Accessed 12 September*

Keliang, Z.; Prosterman, R. (2012). *"Land Reform Efforts in China"* China Business Review
Kurland, J. (2001). *Rooftop Gardens: Project Overview.* 421 Sharon Hall, Steve Harris

Kusena, W.; Beckedahl, H.; Desai, S. (2017) Civil Society and Residents' Coping Strategies with Water Shortages and Household Food Insecurity in Gweru, Zimbabwe. *Journal of Arts and Humanities Vol 6, (2)*

Lawrence Technological University (2015). *The Value of Urban Agriculture in Urban Design and Development*. Literature Review and Case Study in Detroit

Lu, M. (2002) *The Harvard Business School Guide to Careers in Management Consulting.* Havard

Matsa, M.; Marambanyika, T. (2016). *An Assessment of the Concentration Levels of Toxic Chemicals within and Around Gweru Dumpsite in Zimbabwe*. Midlands State University.

McCaston, M. (1998) *Tips for Collecting, Reviewing, and Analyzing Secondary Data.* Partnership & Household Livelihood Security Unit (PHLS)

Michael, W. (29 August 2013). "GM expanding urban gardening program in Detroit". *MLive*. Retrieved 7 November 2013

Mutisi, L. (2014). *An Investigation into the Contribution of Housing Developments to Wetland Degradation Within The City Of Harare, Zimbabwe*. University of South Africa.

Patel, I. C. (1991). Gardening's Socioeconomic Impacts. *Journal of extension, 29(4), pp. 1–3.*

Research Design (2017) Descriptive Research. *Available at http://research-methodology.net Accessed 13 July 2017*

Research Guides (2017) *The Literature Review: For Dissertations*. University of Michigan Library

Revolvy (2008) Gweru River. *Available at https://www.revolvy.com/main/index . Accessed 6 September, 2017*

Sandelowski, M. (1995). Sample size in qualitative research. *Research in Nursing & Health, 18, pp. 179–183*

Sanderson, A.; Bellamy, C.; and Antonio, A. (2017). *Addressing the Knowledge Gaps in Agroecology and Identifying Guiding Principles for Transforming Conventional Agri-Food System* Published: 23 February

Sibanda, M. (2014). *Environmental Challenges Associated With Low Income Housing Developments In Wetlands: A Case Of Gweru, Zimbabwe*. Midlands State University

Sustainable Development in Agronomy (2010). *Volume 30, Issue 1, pp. 21–32*

Teig, E., Amulya, J., Bardwell, L., Buchenau, M., Marshall, J. A., and Litt, J. S. (2009). *Collective efficacy in Denver, Colorado Strengthening neighborhoods and health through community gardens.* Health and Place

Tool (2010) Direct Observations. *Available at http://www.toolpack.com/d/observations.html Accessed 23 September 2017*

Trent University (October 30, 2009). "Rooftop Gardens". Retrieved March 12, 2014

Tuck, S.L.; Winqvist, C.; Mota, F.; Ahnstrom, J.; Turnbull, L.A.; Bengtsson, J. (2014). Land-use intensity and the effects of organic farming on biodiversity: A hierarchical meta-analysis. *J. Appl. Ecol., (51), pp. 746–755*

Unsworth, John (10 May 2010). "History of Pesticide Use". International Union of Pure and Applied Chemistry.

URBAN HARVEST (2006) Impacts of urban agriculture in La Molina and Lima Peru Highlights of Urban Harvest research and development. *Available at http://www.cipotato.org/urbanharvest Accessed 22 September, 2017*

World Bank (2008). Agriculture for Development. World Development Report. *Available at http://siteresources.worldbank.org . Accessed on 14 July, 2017*

Wyse, S.E. (2016). *Whats the difference between qualitative and quantitatative research?* Snap Surveys

APPENDICES

Appendix 1: QUESTIONNAIRE FOR HOUSEHOLDS

My name is Tafadzwa Muswati. I am an undergraduate student doing an honors degree in Geography and Environmental Studies at Midlands State University. I am undertaking a research project titled **"The impacts of urban agriculture on the environment. A case of Gweru."** As part of the data collection process of this academic research, your participation in this questionnaire is significantly necessary. Please note that your answers will be exclusively used for academic purposes only and your confidentiality needs will be respected.

Place…….. **Questionnaire number.....**

Instructions:

- **Do not write your name on the questionnaire.**
- **Please tick where appropriate.**
- **Answer all the questions in the spaces provided.**

SECTION A: SOCIO-ECONOMIC DATA

Sex: Male [ ] Female [ ]

Age: [15-20] [21-30] [31-40] [41-50] [51 and above]

Employment status: Employed [ ] Unemployed [ ] Retired [ ]

Household size: [ ]

Marital status: Single [ ] Married/Living together [ ]
Widowed [ ] Divorced/Separated [ ]

Highest Level of Education Primary [ ] Secondary [ ] Tertiary [ ] None [ ]

Occupation.....

SECTION B: FARMING PRACTICES AND METHODS

1. How did you acquire your land?

……..

.....

2. What crops do you grow in your field?

.....

……..

3. What is your main source of water for crops?

Borehole [ ] River/Stream [ ] Rain [ ] Dam [ ]

4. What tillage methods do you use in preparing the field?

Tractor-drawn ploughs [ ] Hoes [ ] Ox-drawn ploughs [ ]

Other [ ] *(Please specify)*

.....

5. How do you manage weeds?

Hand picking [ ] Chemical Sprays (Weed Killer) [ ] Hoeing [ ]

Other [ ] *(Please specify)*

.....

6. Do you use any fertilizers?

Yes [ ] No [ ]

If Yes *(Please specify)*

…….....

7. How do you manage organic agricultural wastes produced due to your farming activities?

Stock/Animal feed [ ] Compost/Manure [ ] Burning [ ]

Other [ ] *(Please specify)*

.....

……..

…….

.....

8. How do you clear the field for the next planting season?

Burning [ ] Slashing [ ]

Other [ ] *(Please specify)*

.....

SECTION C: IMPACTS OF URBAN AGRICULTURE ON THE BIOPYSICAL ENVIRONMENT

9. What do you understand by environmental protection?

……..

……..

10. Are you aware of any environmental policy or law that affects urban agriculture?

    Yes [ ] No [ ]

    If yes, identify.

    .....

11. Do you think it is important to protect the environment?

    Yes [ ] Partially [ ] No [ ]

    Explain your answer?

    .....

    ……..

12. Are any of the following features near your farming space or land? *(tick where applicable)*

    Streams/Rivers

    Over-head electricity powerlines

    Sewage infrastructure

    Waste or garbage dump sites

    Railway lines

13. Which of the following environmental effects of agriculture are you experiencing in your area *(indicate your response using a tick)*

Effects of agricultural activities on the environment	**Tick**
Uncontrolled tree cutting and land clearance is resulting in the loss of vegetation and trees.	
Incorrect use and handling of pesticides, weed-killers and other agro-chemicals is causing soil contamination.	
Poor use and application of fertilizers and manure is resulting in the pollution of nearby rivers or water sources.	
Poor farming techniques and methods are causing soil erosion.	
Farming along rivers and streams (stream-bank cultivation) is resulting in river pollution and siltation.	
Use of fire to clear the farm land is increasing the risk of veld fires.	
Farming near sewage infrastructure and waste dump-sites is exposing farmers to health risks.	

14. What are some of the significant challenges you experience as an urban farmer?

.....

.....

.....

15. What must be done to improve both urban agriculture and the environment?

.....

.....

……..

……..

……..

Appendix 2: Structured interview guide for District Environmental Management Agency Officer

Objective 1: To identify farming practices utilised by Gweru urban residents

1. What are some of the farming practices carried out by informal and formal landholders?
2. Generally, are urban agricultural practices considered safe to the environment?
3. Are Environmental Impact Assessments carried out prior to land development for farming purposes?
4. Why is informal agriculture persisting in Gweru suburbs?

Objective 2: To establish the impacts of specific farming practices on the biophysical environment

5. What are some of the biophysical impacts of specific informal and formal farming practices?
6. How severe are these challenges?
7. Are local people aware of these environmental impacts?
8. How has EMA ensured compliance of local farmers to respective environmental laws affecting their field of practice?

Objective 3: To test surface water quality for possible pollution

9. Are water bodies threatened by informal agricultural practices?
10. Does the agency carry out water quality sampling on natural urban water resources?
11. If yes, what conclusions have been made from the results?

Objective 4: To assess changes in land use/land cover

12. Has urban agriculture affected the urban landscape?
13. What are some of the changes noted on vegetation, soil and water resources

Appendix 3: Semi-structured interview guide for Gweru City Council Official

Objective 1: To identify farming practices utilised by Gweru urban residents

1. Is the city council effectively involved in the allocation and distribution of land for agriculture purposes?
2. How are these activities regulated?
3. What are some of the 'illegal' farming activities taking place in Gweru urban suburbs?
4. What measures are being taken by the local authorities in addressing this challenge?

Objective 2: To establish the impacts of specific farming practices on the biophysical environment

5. What are the impacts of some farming activities on the urban environment?
6. Is the use of municipal waste water considered safe for crop and vegetable production?
7. What other health risks emanate from such informal agricultural practices?

Objective 3: To test surface water quality for possible pollution

8. Is the City Council aware of the farming activities taking place in wetlands in Gweru East.
9. Are regular inspections carried out in these important areas?
10. What can be said about the surface water quality in Gweru East?

Objective 4: To assess changes in land use/land cover

11. Have Gweru East suburbs experienced drastic changes in terms of surface cover?
12. How has urban agriculture influenced these changes?

Appendix 4: Observation Checklist

Observation	Explanation
Tilling and ploughing	Use of heavy machinery can result in compaction of soil particles lowering infiltration rates whilst deeper tillage depth can loosen top soil particles increasing chances of soil erosion.
Tree felling	Clear-cutting of trees results in deforestation and loss of important tree species.
Use of synthetic fertilisers	Overuse of synthetic fertilizers can result in pollution of nearby surface water sources especially in the rainy seasons.
Water drainage and contouring (during irrigation).	Uncontrolled water drainage and absence of contour ridges can result in the generation of high runoff levels that can result in erosion of top soil.
Nearby water sources	Encroachment into wetlands and river systems can potentially result in water pollution and wetland degradation
Treatment and disposal of hazardous waste	Incorrect disposal of hazardous wastes such as insecticide containers can potentially result in soil contamination.