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**RECYCLED WATER USAGE IN PERI-URBAN AGRICULTURE: AN
EXAMINATION OF ITS SOCIO-ECONOMIC AND ENVIRONMENTAL BENEFITS
IN PORT ELIZABETH**

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DEDICATION

I dedicate this piece of work to my entire Family, mostly my mother who has supported me throughout the research project, my siblings as well, I would like to dedicate this also to my work mentors who supported me throughout by giving me time off to do my work I know it was not easy but they were so patient with me. Also I would like to thank the Lord for granting me with wisdom to do this work; I would never finish this paper if it was not for him.

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ABSTRACT

This study examines whether recycled water (specifically grey water) is used in peri-urban agriculture in greater Port Elizabeth. It also investigates the socio-economic as well as environmental benefits of using recycled water in peri-urban agriculture. Community perceptions and narratives about the use of recycled water for farming purposes were also investigated. Study respondents were purposively selected from Motherwell and Uitenhage in Port Elizabeth.

A qualitative research methodology and methods were used. This involved using purposive sampling to sample, select and interview 22 respondents and eight key informants. All the respondents were interviewed using in-depth semi-structured interviews. The study found that while many respondents have heard about water recycling, they are however not using recycled grey water for their peri-urban farming activities. Instead, peri-urban farmers continue to use water supplied by the municipality. Recycled water is mostly used for watering sport fields around Port Elizabeth. This continued usage of municipal water (instead of recycled water) is not only costly to the municipality but the individual farmers as well. The respondents were however aware of the benefits of using recycled water. These include economic (money saved from not paying irrigation water bills), environmental (nutrient contents found in recycled water) and socio-economic (conserving fresh available for use in other community purposes). The study recommends that the Nelson Mandela Metro Municipality should do more (through educational and environmental campaigns) to encourage peri-urban farmers to use recycled water in their farming activities.

LIST OF TABLES

Table. 4.1:Study Respondents.....

TABLE OF CONTENTS

SUPERVISOR'S STATEMENT.....	i
DECLARATION	ii
DEDICATION.....	iii
ACKNOWLEDGEMENT.....	iv
ABSTRACT.....	v
LIST OF TABLES.....	1
TABLE OF CONTENTS.....	2
CHAPTER ONE.....	4
OVERVIEW OF THE STUDY.....	4
1.1 INTRODUCTION.....	4
1.2 STATEMENT OF THE PROBLEM.....	6
1.3 RESEARCH QUESTIONS.....	6
1.4 RESEARCH OBJECTIVE.....	7
1.5 RESEARCH SETTINGS.....	7
1.6 SIGNIFICANCE OF THE STUDY.....	8
1.7 THEORETICAL FRAMEWORK.....	8
1.8 ETHICAL CONSIDERATION.....	9
CHAPTER TWO.....	12
2.1 INTRODUCTION.....	12
2.2 GLOBAL WATER DEBATES: A REVIEW OF LITERATURE.....	12
2.3 WATER ISSUES ON THE AFRICAN CONTINENT.....	14
2.4 CLIMATE CHANGE AND WATER IN AFRICA.....	17
2.5 IMPACT OF CLIMATE CHANGE ON WATER RESOURCES, AVAILABILITY AND ACCESS.....	19
2.6 CLIMATE CHANGE IMPACT ON TEMPERATURE AND PRECIPITATION PATTERNS.....	20

2.8 IMPACT OF CLIMATE CHANGE ON AGRICULTURE.....	21
2.9 WATER IN SOUTH AFRICA: ISSUES, OPPORTUNITIES AND CHALLENGES..21.....	25
2.10. CONCLUSION.....	28
CHAPTER THREE.....	30
RESEARCH METHODOLOGY AND METHODS.....	30
3.1 INTRODUCTION.....	30
3.2 QUALITATIVE METHODOLOGY.....	30
3.3 RESEACH DESIGN.....	31
3.4. SAMPLING PROCEDURE AND TECHNIQUES.....	32
3.5 DATA COLLECTION INSTRUMENT.....	33
3.6 DATA ANALYSIS.....	34
3.7 CONCLUSION.....	35
CHAPTER FOUR.....	36
PRESENTATION, DISCUSSION AND ANALYSIS OF FINDINGS.....	36
4.1 INTRODUCTION.....	36
Table 4.1 study respondents.....	36
4.2 USAGE OF RECYCLED WATER IN PERI-URBAN AGRICULTURE.....	37
4.3 SOCIO-ECONOMIC AND ENVIRONMENTAL BENEFITS OF USING RECYCLED WATER.....	46
4.4COMMUNITY PERCEPTIONS AND NARRATIVES ABOUT RECYCLED WATER USAGE IN PERI-URBAN AGRICULTURE.....	50
4.5 CONCLUSION.....	50
CHAPTER FIVE.....	52
CONCLUSIONS AND RECCOMENDATIONS.....	52
5.1 CONCLUSIONS.....	52
5.2 RECOMMENDATIONS.....	56

CHAPTER ONE

OVERVIEW OF THE STUDY

1.1 INTRODUCTION

Water is one of the natural resources which are of necessity in order to sustain a living, maintain environment wellness as well as sustain food production (King, 2004:207). Water is at the core of our existence; the economic growth of a nation and sustainable development are maintained and nurtured by the presence of water (King, 2004). There is thus a strong relationship between water and society (Muller (2009). As the world population continues to grow, water sources are beginning to face pressure. There is strong competition for fresh water resources between domestic demands, industry, commerce, institutions such as hospitals and agriculture (Van Veehuizen, 2006). This water demand has increased since the 1950s (Van Veehuizen, 2006:245). Furthermore, economic and social activities have a huge impact on the quality of water resources available through direct and indirect diffuse pollution.

In South Africa, water security issues are also of national concern. The CSIR (2010) report reveals that even though some parts of South Africa receive high rainfall more than others, the country's average rainfall per year is estimated to be 450mm which is way below the global average of 860 mm per year. Golding (2010) adds that indeed South Africa suffers from extreme weather conditions and unpredictable rainfalls. Other factors contributing to the precarious water situation in some localities in South Africa include climate change and water pollution (CSIR, 2010).

However not all is doom and gloom. Due to water insecurity, people across the world have adopted other means of saving and recycling water. Water recycling is the

utilization of treated or untreated wastewater for the purpose other than the one that generated it (Jimenez and Asano, 2008). Water recycling has been practised worldwide for many centuries. Agricultural wastewater, sewage wastewater (including grey water and black water) and industrial wastewater have been used in agriculture after they have undergone some treatment (Van Veenhuizen, 2006).

There are two types of recycled water which are black water and grey water. Grey water is the focus of this study. For purposes of clarity, grey water is defined as wastewater that is produced from household processes, e.g., water from washing dishes, laundry and bathing. Grey water does not include sewage water. Murphy (2006) states that using grey water for farming purposes is one of the possible solutions to come up with in order to alleviate water insecurity and stress. He adds that grey water contains nitrogen and phosphorus which are good for the environment. Furthermore, grey water is a potential source of nutrients especially to users who cannot afford fertilizers and pesticides; the soapy nature of grey water has pest-repellent properties (Eriksson et al, 2002).

South Africa is among the countries that have recognised the need to address water insecurity challenges through water recycling (Stoakley, 2013). Grey water farming is used in different parts of South Africa. It is used in middle and high income areas for irrigating gardens and limited vegetable production while in some low-income townships and peri-urban areas; it is used for subsistence urban agriculture. Grey water irrigation in rural areas permits yard crop production to take place on a modest scale (Carden et al., 2007). Grey water is thus of critical importance for low-income agricultural purposes during periods of low rainfall. Against this background, this study therefore examines the extent of grey water usage for peri-urban agriculture in Port Elizabeth in the Eastern Cape. Not only does it map usage, it also seeks to

understand whether there are any socio-economic and environmental benefits to realise from the usage of grey water in peri-urban agriculture.

1.2 STATEMENT OF THE PROBLEM

Some provinces in South Africa are known to be drought prone. This is the case with some parts of the Eastern Cape Province. It is well known that greater Port Elizabeth is prone to erratic rainfall patterns and droughts. These erratic rainfall patterns have been affecting Port Elizabeth water security for a long time. Consequently, greater Port Elizabeth is known as an area usually characterised by water stress. Due to this, there has been growing interest (in government, municipal and NGO circles) of the need to consider and promote water recycling in Port Elizabeth. This is also in response to the huge growth in water recycling around the world (Stoakley, 2013). As Finley (2008) observes; grey water use is one of the main strategies used to tackle water shortage especially in water insecure areas. Given that greater Port Elizabeth is known to be water insecure, this study therefore investigates whether water is recycled for use in agriculture. It specifically focuses on purposively selected peri-urban communities which practice agriculture. It also investigates the benefits of using recycled water, not only for the concerned communities, but the Nelson Mandela Metropolitan Municipality as well.

1.3 RESEARCH QUESTIONS

This study is guided by the following research questions:

1. To what extent is recycled water used in peri-urban agriculture in Port Elizabeth?

2. What are the socio-economic and environmental benefits of using recycled water for peri-urban farming purposes in Port Elizabeth?
3. What are the community perceptions and narratives about recycled water usage in peri-urban farming?

1.4 RESEARCH OBJECTIVES

The objectives of this study are the following:

1. To examine the extent to which recycled water is used in peri-urban agriculture in Port Elizabeth
2. To investigate the socio-economic and environmental benefits of using recycled water for peri-urban farming purposes
3. To understand community perceptions and narratives about recycled water usage in peri-urban farming.

1.5 RESEARCH SETTING

This study was conducted in Port Elizabeth. Port Elizabeth falls under Nelson Mandela Metropolitan Municipality. According to the 2011 census, the population of Port Elizabeth is estimated to be 1,152,115; with 60.13% black Africans, 23.56% coloureds, 1.11% Indians and 14.36% whites (IDP, 2013/14). Water security remains a concern in greater Port Elizabeth with many communities still relying on untreated raw water from rivers, springs and boreholes (DEEA, 2009). To the west of Port Elizabeth, the climate is mainly dominated by winter rainfall, whereas to the east it

changes to summer rainfall regime; however in the Great Karoo (north of Port Elizabeth) it does not rain much at all (Hamann and Tuinder, 2012).

1.6 SIGNIFICANCE OF THE STUDY

This study focuses on a niche area which is rarely researched in the Eastern Cape in particular and South Africa in general. While a lot of research has been done on water issues in general, there is a dearth of research focusing on recycled water usage (especially grey water). This study therefore contributes knowledge on grey water usage within the Eastern Cape context. This knowledge is not only a contribution to the sociological field but also to social science research in broad terms. Secondly, this study also has potential to contribute to policy. Its policy proposals in chapter four and five about how Port Elizabeth peri-urban community members need to be educated further about the benefits of recycled water usage can potentially influence policy. This policy contribution potential was also confirmed by some of the key informants from Nelson Mandela Metropolitan Municipality as discussed in chapter four.

1.7 THEORETICAL FRAMEWORK

This study uses the Integrated Water Resources Management (IWRM) conceptual framework as its analytical tool. Integrated Water Resources Management emphasizes the coordinated development and management of water, land as well as related resources in a reasonable manner without bargaining the sustainability of vital ecosystems (Global Water Partnership, 2000). The main purpose of IWRM is to reach a consensus between the utilization of resources for livelihood sustainability and its protection for future generations, at the very same time promoting social equity, conservation of environment and economic efficacy (DWAF, 2003) .The

IWRM is a means to increase the benefits found from scarce water resources, financial as well as human capital by transforming water resources into an operational product (Rees, 2006).

The concept of IWRM is a leading world paradigm that has been promoted in order to address past injustices especially when it comes to water management (Haigh & Fox, 2008). This concept aims to challenge the root causes of water management crises, such as inadequacies and conflicts that arise from un-coordinated development and the use of water resources (Haigh & Fox, 2008). The IWRM works towards re-thinking systems that administer water management, these include means to formulate new laws, policies and institutions and extensive partaking of stakeholders (Haigh & Fox, 2008).

The IWRM approach encourages a well-planned tactic of distributing water which requires subordinating the needs of individual sectors and user group to the larger goals of society (WWC, 2006). The IWRM aims to enable people (men & women) to benefit from the resources that they actually manage. The conceptual framework assumes that water management should involve the whole water cycle and its entire natural features as well as taking into consideration the interests of water consumers in different sectors of society (Van de Zaag & Savenje, 2000).

The IWRM is a relevant conceptual approach especially when it comes to problem solving in water insecure situations. This makes it ideal for research focusing on a city such as Port Elizabeth faced with water-related challenges such as erratic rainfall and droughts. Such causes of water crisis often require the interaction of different sectors (and actors), hence the usage of IWRM which provide various strategies for dealing with water insecurity (WWC, 2006).

The use of IWRM in this study has potential to benefit the environment of Port Elizabeth community. This is because the IWRM can help the environment sector by raising awareness amongst users (Leendertse et al., 2008). It (IWRM) also has the advantage bringing people together, i.e., communities, industrialists as well as people working in the water sector so as to focus on one goal which is to protect and sustain water and the environment (Leendertse et al., 2008). The IWRM is relevant in this study since it promotes stakeholder participation, cross agency coordination and a variety range of innovative tools to improve and manage water (Hooper & Neela, 2003) in crisis situations. The use of IWRM has the potential to address and highlight the drawbacks in water governance structure. What further makes this conceptual framework relevant to this study is that it aims to overcome inefficiency mechanisms between government departments and communities especially when it comes to water resource management and sustainability (Agyenim, 2011).

1.8 ETHICAL CONSIDERATIONS

This study observed a variety of ethical considerations. Firstly, informed consent was sought and obtained from all study participants. Secondly, participation in this study was on a voluntary basis . This is in line with Babbie and Mouton's observation (2001: 522) that "social research should never injure the people being studied, regardless of whether they volunteer for the study or not". Thirdly, the privacy and anonymity of respondents was observed at all times. This resonates with Denscombe (2010) who argues that the researcher is required to respect the privacy of respondents. This also includes respondent anonymity in data coding and analysis. All respondent submission were also treated high confidentiality so as to prevent any harm on them. Lastly, the study was also conducted within the

guidelines of the University of Fort Hare's ethical guidelines for social science research.

CHAPTER TWO

IMPACT OF CLIMATE CHANGE ON WATER RESOURCES: REVIEW OF LITERATURE

2.1. INTRODUCTION

Human and natural activities impact practically all sectors of the water cycle, often with permanent effects than cannot be reversible. Over time, human activities such as forest clearing, afforestation, agriculture, etc, have troubling impacts on the water cycle including evapotranspiration, flow systems, groundwater table and sea level. Also, human activities influence cloud formation via the emission of aerosols and their gaseous precursors (Krüger and Graßl, 2002). Climate forecasts offer plentiful indication that water resources are exposed and have the potential to be strongly impacted by climate change, with wide-ranging costs for human societies and ecosystems (Bates et al., 2008). This chapter discusses the issues underpinning the use of water and how it is affected by climate change especially in Africa where droughts are persistent.

2.2 GLOBAL WATER DEBATES: A REVIEW OF LITERATURE

According to Srinivasan et al. (2012) fresh water scarcity and security have been identified as major global environmental problems of the 21st century. Water is a fundamental aspect for human existence, as well as the environment. According to PAI (1997), water is the core of life as well as developmental changes on earth. Lalzad (2007) states that water is also a precious natural resource, when this resource is managed properly it can be a tool for economic growth and survival. It can also act as a tool for poverty alleviation and also bringing prosperity to all in the

continent. However, the very same resource, if it is inadequate in quality as well as quantity it can serve as a distorting factor in poverty alleviation and economic recovery, which may result poor health, low productivity, food insecurity and distorted economic development (AWV, 2005).

Water is one of the resources that is under a lot of pressure. Ohlsson (1995) contends that globally the point has been reached where water scarcity is more and more being seen as a looming threat to development. According to Maxwell (2009) almost half of the world's population is expected to be hit by severe water insecurity by the year 2050. Water Views (2009) adds by stating that with the water that is available on earth less than 1% of that water makes fresh water, which in turn makes far too less than 1% for human consumption. Some of the major contributors to this challenge include climate change, which contributes to severe droughts, storms and flooding which in reality affects the quality of available water (WaterViews, 2009).

Globally the population increase, migration and changing in human consumption patterns are viewed as the major contributors or drivers of the increased demand for fresh water (ICA, 2012). Gleick (2003) suggests that global fresh water demand has doubled and increased rapidly since the 1950s, he suggest that all most half billion people worldwide reside in areas that are water scarce and stressed, it is also projected that by 2025 that the current number of people in these areas will increase rapidly to 3 billion due to population increase, he continues to note that agricultural sector is the main user of water which accounts about 80% of global water usage, the population growth will double and increase the demand for water to meet production demands as well as industrial and household needs. A growing population, increasing water pollution and changing consumption patterns, associated to food production, provide the basis for the concern that water scarcity

and waning water quality will become a main restriction on economic and social development and environmental sustainability. Despite the growing population, Postel et al. (1996) argue that the planet's endowment of accessible renewable freshwater has been and will remain more or less constant.

WaterViews (2009) further argues that the challenge of water scarcity is perpetuated by the increasing costs of developing new water resources. Rosegrant, Cai & Cline (2002) state that water challenges are heightened by degradation of soil especially in agricultural friendly areas, water pollution and the degradation of water related ecosystems. The availability and distribution of fresh water is estimated to be falling short in keeping pace with demand for freshwater as well as effective management of water resources (ICA, 2013).

Arid and semi-arid regions in some countries are increasing the challenges of water scarcity. According to IPCC (2007) areas such as Mediterranean Basin, Western United States, Southern Africa, Northern Brazil, Southern and Eastern Australia that are semi-arid and arid areas are more prone to effects of climate change, especially in terms of water scarcity (ICA, 2012). This notion is supported by Hynes who states that water resources in arid and semi-arid areas are very scarce due to low rainfall and high evaporation. Some countries like China with huge a population as well as arid and semi-arid areas are under much pressure because of water issues.

2.3 WATER ISSUES ON THE AFRICAN CONTINENT

Africa at large appears to have plenty of water, since it consist of 17 rivers, more than 160 lakes and a large number of wetlands, also it receives large amount of rainfall but in reality water for agriculture, domestic uses and industry is limited (PACN, 2010). According to a study done by PACN (2010), it was evident in 2009

that the African population alone had increased to 1 billion and it continued to increase at a rate that is 2.4 annually, amongst this population 341 million have no access to safe drinking water. The share of the population of Sub-Saharan Africa living in water stress countries will rise from 30 to 85% by 2025 (Waititu, 2009). The view is supported by PACN (2010) which indicates that the demand for water has increased as such it has become difficult for Africa to produce enough food for the entire population. PACN (2010) further states that a quarter of all people in Africa are facing water stress, with population increasing so is water scarcity which is becoming a major obstacle in achieving development in many African states.

One of Africa's Millennium Development Goals is to reduce by half the proportion of people without sustainable access to safe drinking water by 2015. According to Waititu (2009) "water resources management is a critical factor for meeting the MDGs, not only goal 7, target 10, but also the broader goals of eradicating extreme poverty and hunger, achieving universal primary education, promoting gender equality and women's empowerment, reducing child mortality, improving maternal health, combating major disease, improving environmental sustainability and cooperation". Achieving this MDG is depended on number of factors like management of resources and political leadership in the African countries. It has become evident that the distribution of water resources in Africa is highly flexible and water distribution is unequal when comparing to the rest of the world (Ashton, 2002). The current situation is showing that there is a lot of mismanagement in water management and the political leadership is not fully implementing fair laws to safe guard the water resources. This then makes it more difficult to proudly say that the MDG will be met by 2015 due to the current state of water scarcity that is hard hitting Africa at large.

Many African countries still fall back on water reserves and end depending on water reserves that are generated from outside their own territories in order to cover water needs (Scheumann, 2006). Almost the entire climate of Africa has a tropical climate, it has warm temperature but humidity and level of rainfall differs from one area to the other (WAEC, 2008). WAEC (2008) further reveals that the temperatures are high throughout the year in most countries in Africa. Climate variations results in uneven distribution of rainfall. The uneven distribution of rainfall in African continents denotes the water delinquent that the continent is faced up with, of all the water that is withdrawn it is estimated that 85% of it is directed towards agricultural use and this percentage is said to be higher in more arid and semi-arid regions of the continent. (WAEC, 2008). More than half of Africa is projected to receive less than 5 centimetres of rainfall yearly. (WAEC, 2008), but in areas that are desert in nature such (Sahara and Namibia deserts) receive 25 centimetres of rainfall a year but it usually happens that in some parts of the deserts do not receive rainfall for some time ranging from six to seven years in a sequence (WAEC, 2008). In some parts of the African continent, rainfall distribution diverges and changes from year to year instead of changing seasons (WAEC, 2008), there has also been a huge increase in droughts and floods for the past four decades. It is estimated to be only 64% of the entire population that have access to improved water quality, the situation is worse in rural areas where coverage is only 50% compared to 86% in urban areas (WAEC, 2008).

Amongst the African countries only few can afford the financial investment in efficient irrigation systems and water losses through leaking pipes and evaporation are as high as 50% in South Africa only. According to IPCC (2007), access to clean fresh water is indeed a challenge that is facing many African countries recently,

almost one-third of all the people in the continent resides in drought-prone areas and regions, about 200 million people are faced up with water challenges.

In countries such as Ethiopia and Somalia the population have suffered many deaths that are caused by severity of droughts over the last century. The scarcity of water has resulted in water conflicts. Water conflicts are related to a wide range of other socio-political tensions, such as border disputes or mega-projects such as dams and reservoirs, environmental problems, or political identity (Tamas, 2003). Some of these conflicts in these countries have been internally, intra-state as well as externally inter-state. These conflicts are caused by different factors such as climate change, rivers, reservoirs and water basins. For instance the Nile River has caused tension and conflicts in some African especially among Eastern African countries.

Poor management of water sources and distribution of water is one of the major challenges that are faced by many African countries. Marshall (2011) adds that also Kenya is amongst the African countries that has the largest population of about 40 million people, out of that number 17 million has no proper access to clean fresh water, it seems as that the water challenges in Kenya have been severe for some time, which are a result of recurrent droughts, poor management of water resources and poor distribution of water in the country and contamination of the available water and the sudden increase in demand that is caused by population increase in the country. The World bank (2010) has emphasised that in Kenya, the recurrent droughts that the country is experiencing has impacted many families to such an extent that those who rely on farming and crop production suffered and died every year as a result of hunger and thirst.

2.4 CLIMATE CHANGE AND WATER IN AFRICA

Climate refers to the long-term average of the individual weather conditions that are experienced on daily basis. It is the average individual weather states, taken over long periods of time. Whilst climate impacts the daily well-being and influences the decisions made every day. Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer) (IPCC, Climate Change, 2001). Malla (2008) argues that climate change is a real threat to lives in the world as it largely affects water resources, temperatures, agriculture, food security, freshwater habitats, human health, vegetation and forests.

Furthermore climate change is viewed by Spore (2008) to create a great challenge and threat to the African climate, and the very same continent that is being threatened by climate change is home to 14% of the world's population, which basically means that it contributes only about 3.8% of greenhouse gas emissions. According to UNECA (2011) climate change is one of the leading causes of severe poverty, water scarcity, food insecurity as well as weak economic growth in the African continent. Davis (2011) asserts that the African continent is expected to be greatly impacted by future climate change with the latest projections indicating that both temperature and evapotranspiration are highly expected to increase into the 21st century. (DEAT, 2000 and Fauchereau et al., (2003) explain that climate change is more likely to alter the magnitude, timing as well as creation of storms that results in floods and develop at the end severe drought amongst the affected regions.

According to IPCC (2007) the African continent is mostly semi-arid region with high rainfalls distribution, which are characterised by recurrent droughts and floods, it has been also noted that the very same continent is prone to climate change because of

low levels of capacity especially in rural areas, combined with high dependence on rainfall for agricultural activities which is the main source of livelihood maintenance in the region. Much of Africa is exposed to flooding.

2.5 IMPACT OF CLIMATE CHANGE ON WATER SOURCES, AVAILABILITY AND ACCESS

Climate change is strongly associated with increased water scarcity and stress (Waititu, 2009). The African continent is described as a semi-arid region with high intra-seasonal and inter-annual rainfall variability, which is associated with recurrent extreme events with droughts and floods. (Davis, 2011). It is also stated that the amount of rainfall that the continent at large receives an average of 670 mm per year (UNESCO; 2011). The amount is less by 1000 mm per year than the expected rainfall. UNESCO (2011) further indicates that the highest rainfall is being received by Island countries receiving 1,700 mm per year, followed by the central African countries receiving 1,430mm per year and Guinea receiving 1,407 mm per year. UNESCO (2011) also notes that water availability and distribution in different parts of the continent varies according to significantly. Arid regions of the continent such as North Africa which are known to be water scarce receive less amount of rainfall which means that there is not enough water that is available and the water that is usually available is less than 1,000m per person per year.

However in Sub-Saharan African countries, majority of the people are not as exposed to water scarcity as the ones in North Africa due to the rain distribution and they have better ways of managing the limited water resources that is available and proper ways of distributing it (UNESCO, 2011). MPH (2010) argues that the water resources from some parts of Africa are highly influenced and affected by climate

change. The population in Sub-Saharan Africa is expected to increase rapidly from 700 million in 2007 to 1 100 million by 2030 and 1 500 million in 2050 and the population is expected to more in urban areas therefore that means the overall water demand increase can be expected to be more than double than the original number.

According to Finley (2008) storage of grey water is not advisable prior to reuse because it can have a negative impact on the pathogens entailed in the grey water.

Dixon et al (2000) also suggests that storage of grey water for 24 hours could potentially improve water quality but more than 48 hours storage could deplete the oxygen.

According to Allen, Christian-Smith and palaniappan (2010), grey water may contain pathogens that are derived from fecal contamination, food handling as well as opportunistic pathogens such as those found on the skin, but there has not been any documented case of public health impacts of grey water reuse levels and could lead to aesthetic problems and odours. Carden, Armitage, Winter, Sichone & Rivett, (2007) not enough is known at present about health challenges that may be presented by the use of grey water for farming of food crops.

2.6 IMPACT OF CLIMATE CHANGE ON RISING SEA LEVELS

According to IPCC (2007) coast are estimated to be more exposed to varying and increased risks that are resulting from coastal erosion, climate change and rising sea levels, this is going to be more visible and have a major impact on cities that are located near major rivers, deltas and estuaries (Stern, 2006). A practical example is Lagos, currently the fifth largest city in the world and Africa's second most crowded

city, is highly affected by sea-level rise, coastal erosion, saltwater invasion and flooding. Studies have revealed that sea-level rise in Lagos mega-city showed that severe coastal erosion which removed over 2 kilometres of the popular Lagos beach fronts and at times the adjacent road has been on the increase since 2004, causing an acute distraction of traffic and flooding of properties. Also, the rock moles built between 1908 and 1912 to keep the natural Littoral Drifts at the Bar beach were regularly worn away by the coastal flow, leading to an annual erosion rate of 25 to 30 metres (Shagun et al, 2009).

The heating of the earth's surface has also played a role to the vanishing of ice covered areas in recent years, an ever accelerating phenomenon over the last few decades. Satellite images show that the average annual extension of the arctic ice caps has dropped by 2.7% per decade since 1978, and that it drops most rapidly during the summer months. The average rate of ice loss from glaciers around the world, excluding glaciers on the periphery of the ice sheets, was very likely 226 [91 to 361] Gt yr⁻¹ over the period 1971–2009, and very likely 275 [140 to 410] Gt yr⁻¹ over the period 1993–2009 (IPCC 2013). This translated into simple terms means that the planets frozen water reserves is melting away due to climate change. Warm sea surface temperatures, more extreme weather events, and sea-level rise will lead to the damage of coral reefs, which are critical for coastal protection (IPCC, 2001). Mangroves are at threat from deforestation, coastal erosion and extreme weather and have been identified as one of the most exposed species to sea-level rise and flood (IPCC, 2001).

2.7 CLIMATE CHANGE IMPACT ON TEMPERATURE AND PRECIPITATION PATTERNS

According to Davis (2011) that there is strong evidence that the regions temperature is increasing, meaning that the region is getting warmer. Davis (2011) continues to argue that trends analysis of temperature across the continent reveal that annual minimum and maximum temperatures have increased at an estimated average of 0.057 degrees Celsius per decade and 0.046 degrees Celsius per decade from the year 1901 up to 2009. Warming temperatures are predictable to create more recurrent and more intense extreme weather events, such as heavy rain storms, flooding, fires, hurricanes, tropical storms and El Niño events (IPCC, 2001). Greenhouse gases cause increased temperatures in the world because these gas molecules absorb outgoing long wave radiation and therefore less radiation are lost to space (Ngaira, 2007).

2.8 IMPACT OF CLIMATE CHANGE ON AGRICULTURE

According to Waha, Müller & Rolinski (2013) temperature and precipitation changes might have an impact on crop growth and development to a different extent depending on the current growing conditions and the amount of climate change. As the temperatures increase in the continent, precipitation patterns will change, with most areas becoming wetter and some areas that are being used for agriculture become drier (Ackerman and Stanton, 2013). Agriculture is one the most important economic activities in Africa. According to Mendelsohn (2000) the agricultural sector in the African continent is the main contributor to the continent's economy in many African countries which adds about 10% up to 70% of GDP. There are serious concerns that seem to be threatening the economy of Africa such as water supply variability, soil degradation as well as recurrent droughts events and floods. Some of the African countries are faced with semi-arid conditions that pose a threat to the

agricultural sector, also it has been reported that the African agricultural sector has the slowest record of productivity increase in the entire world (Mendelsohn, 2000).

Davis (2011) agriculture in the African continent is an important source of formal as well as informal economy as it sustaining rural livelihoods and providing food security. However, the agriculture sector is directly dependant on climatic variables such as temperature as well as rainfall which are the ones that dictate crop production. Changes in these two climatic variables may impact the agricultural productivity or production in various ways. Mendelsohn (2000) has also noted that there are concerns that the agriculture sector in Africa will be sensitive and be severely affected by climate change due to the fact that if there will be further increase in temperature in arid areas of the continent will create a devastating situation to the agricultural sector.

Agriculture is anticipated to pay a substantial cost of the impairment caused by climate change. Progress on rural development has already been hit hard by the mutual effect of the global financial downturn and the food crisis; as a result, hunger and malnutrition trends remain stubbornly high. Without extensive adaptation the effects of climate change on agriculture is expected to exacerbate Africa's deepening food crisis, lessening channels of food access and slowing efforts to expand food productivity (Ngaira,2007). The extreme effect is likely to be visible in most peripheral areas where irregular rainfall is already experienced, also developing small-scale farming is also linked with high risk and indistinctness, due to the high dependence on rain-fed agriculture as well as fewer capital resources and management of technologies that are available to the farmers (Davis, 2011). Environmental change related to climate change has altered the rainfall patterns, amplified drought cycles, increased the frequency of severe weather conditions and

increased agricultural pests and diseases (Yanda, 2010; Hewitson, 2010; Unganai, 1996; Makadho, 1996).

According to Molua (2009) what is of concern is that agricultural productivity growth in Africa during the past 40 years has not kept pace with population growth. Cereal yields on the continent have deteriorated at about 1 metric ton per hectare over this period, while in East Asia cereal yields increased more than fourfold. The per capita growth rate of agricultural GDP in Africa was moving in a low pace during the 1980s and 1990s, though there were improvements which were visible in early 2000. Production growth of the major food crops, especially for maize and root crops, is based solely on expanding the cultivated area, with only minor assistance from growth in yield per hectare. Rainfall changes are also affecting crop production. Rainfall patterns in many countries have been changing as a result of rising temperatures. The changing rainfall patterns are negatively affecting crop production world over. Bergaoui (2010) mentions that rainfall irregularity and variability has a spatial and temporal influence on agricultural production. Scarcity in rainfall affects the growth of crops reducing yields. Water availability governs the physiological active period of crop production (Malla, 2008). Extreme cases of lack of rainfall result in agricultural drought. Agricultural drought occurs when low level moisture in soil, coupled with the scarcity of water around plant roots stops growth and reduces crop yields (Bergaoui, 2010). The net change in crop yields is determined by the balance between these negative and positive direct effects (of climate variability) on plant growth and development, and by indirect effects that can affect production (Adam et al., 1998).

Uneven rainfall distribution affect the crop production, in many countries different rainfall distribution have been experienced due to rising temperatures and climate

variability According to Bergaoui (2010) has emphasised that uneven rainfall distribution and variability has the potential to impact crop production negatively, that includes low distribution and scarcity of rainfall which can have a serious impact on the growth of production. The change in rainfall patterns is likely to have a serious impact on crop production and this has a turning effect on food security. Van Rooyen and Sigwele (1998) argue that the precarious food situation that has been afflicting the Southern African region in recent years stems from a combination of factors including unfavourable climatic conditions (erratic rainfall, drought and floods); poor and depleted soils; environmental degradation; failed sectoral and macro-economic policies; inadequate support systems; and political upheavals.

Molua (2009) argues that with climate change already hitting the continent, communities face the approaching challenge of having to find alternative ways of combating the risks and challenges caused by climate change. However, an excess of factors are responsible for adaptive capacity in African farms and rural households such as low incomes and unstable land distribution, absence of formal social safety nets and reliance on rain-fed agriculture. While farmers will be struggling with direct effects on their farm harvest and produce, the expected sea level rise will affect those residing along coastal areas, causing flooding and coastal erosion, especially along the eastern southern African coast.

2.9 WATER IN SOUTH AFRICA: ISSUES, OPPORTUNITIES AND CHALLENGES

South Africa is approaching the point where water deficit is the dominant condition, with basin closure being a stark reality (Turton, 2003). Moreover, South African is one of the countries known to be water-scarce, with an average of annual rainfall estimated to be 500mm, which is way below than the world average of 860mm,

which most of the rainfall is seasonal (Rodda, Carden & Armitage, 2007). Rodda, Carden and Armitage (2007) further state that the distribution of this seasonal rainfall is uneven with regions such as the North West receiving less than 200mm per year and the Eastern Highveld receiving 500mm to 900 mm, also the sources of water in South Africa is found to be decreasing which then means that new sources are supposed to be established. Furthermore, it has been projected that recently the rainfall is likely to decrease in many regions of South Africa (Christensen et al., 2007). Most of the summer rainfall that is received in South Africa's drier regions is projected to decrease. These areas are expected to be drier in spring and autumn as a result of the more frequent formation of mid-level high pressure systems over the regions.

Louw (2002) supports this view by adding that water scarcity in South Africa is result misallocations of natural resources by development planners. Louw (2002) adds by arguing that the issue of resource management has turned out to be influenced by political, social as well as economic nature. Dinar (2003) has also noted that water scarcity is not only resulting from measurable and qualitative scarcity but from mishandling and poor distribution and supply of water and water resources.

Current water uses in South Africa are beyond sustainable natural available water resources, as a result of this the South African Government has introduced National Water Act (NWA), the act endorses and enables and Integrates and decentralised water resources management, focusing mainly on economic efficiency, environmental conservation, equity and empowerment and involvement of the people in all the decision making processes (Hassan & Crafford, 2006). Due to this scarcity of water and water resources in South Africa, people turn to water recycling reuse, as an alternative strategy in order to cope with water stress. This approach

offers the people with an opportunity to enhance existing water stress supply and focus on the benefits of restructured system by creating environmental and economic benefits (FAO, 2009).

Since South Africa receives less rainfall per annum, the agriculture sector has been affected. The agriculture sector and other economic services are trying to find ways to adapt to the semi-arid conditions prevalent in the country. Almost the entire population of South Africa depend heavily on agriculture for their livelihood. According to Durand (2004) climate change is expected to have an impact on agriculture which is estimated to be more severe for decades to come, frequent periods of droughts are expected also there will be high variability in rainfall distribution in the country. This will have a negative impact on crop production especially those who are rain-fed (Du Toit et al, 1999). The increased pressure that is caused by climate change which reduces the amount of available water is also expected to cause dry land which will affect the agricultural activity in terms of water supply (CSIR, 2010).

Water pollution is another challenges impact on water availability in South Africa. The issue of water pollution seem to be on the rise and it is growing in high levels of industrial production and mass consumption in South Africa. There are many things that are associated to water pollution, ranging from municipal pollution through the number of informal settlements that are closely located to the water points, and the industrial waste water that is being released to the fresh water systems. According to GBIM (2014) about 70% of gross domestic products (GDP) in South Africa rely on water for their success and growth, looking at the current water usage and pollution of available water resources, it is also expected that water demand will exceed water supply and availability in South Africa. This is due to the pressure that is being

placed on water resources by growing population as well as industrialization unless strict measures are taken in order to prevent the water challenge and scarcity. The total amount of available water in the country is estimated to be about 49 200 million m per year. GBIM (2014) also states out that one of the main water challenges in South Africa is poverty in a sense that those who are living under poverty are unable to pay for water services therefore poverty is interconnected with water resources, poverty is also followed by the inability to access water when necessary, it is estimated that only 44.7 % of South Africans have a tap that is inside their households, 16.7 % have a tap in yard, whereas 19.8% travel to a public tap in order to access water, and 14% travel to fetch water from dams which are situated from far places (GBIM, 2014).

Province such as the Eastern Cape was estimated to have the lowest percentage of households with access to clean fresh water, around about 53.5 percent compared to the national average of 79.8 percent (Binns, Illgner and Nel, 2001). This is due to the movement and relocation of people from rural areas to big cities in the province such as Port Elizabeth, which has caused increase in urbanisation of about 6 percent between 1996 and 2000 which was estimated to be the largest in the country. According to Binns, Illgner and Nel (2001) reviewed that the areas of Port Elizabeth and Uitenhage which was the study area of the research was expected to have a slightly increase in the number of population. With regards to the foregoing statement it is evident that if the population of Port Elizabeth had increased from the past decades this means a lot of pressure has been put on natural resources in the area, more especially water resources, this in broader terms reveals why the Port Elizabeth area has been experiencing water challenges.

2.10 CONCLUSION

The chapter reveals that there is an immediate cause for concern as water sources are dwindling. One of the major causes of the water crisis is the climate change. The reviewed literature shows that the growing global population is impacting on water sources as projected scenarios are showing that in the near future the water levels are decreasing. Africa is one of the continents that will be affected by water scarcity. The semi-arid and arid regions of the continent are likely to be the most affected regions. African coastal areas are also going to be affected as the sea levels and temperatures rise, water sources will deplete. The situation is highly likely to affect the main economic activity of the region, agriculture. South African like most countries in Africa is also faced with the water predicament. The mismanagement of resources in the country is exacerbating the water crisis. In addition to mismanagement of resources, the growing populations in urban areas is putting pressure on the water sources available the urban areas. Pollution is one of the factors that is also increasing the water management crisis. Much of the industrial and municipal waste is emitted water sources. This study investigated on the situation in one of the urban areas in South Africa that is facing water challenges.

CHAPTER THREE

RESEARCH METHODOLOGY AND METHODS

3.1 Introduction

This chapter discusses the research methodology and methods used in the study. It defines and justifies why a qualitative methodology was the most suitable in this study. The research design and sampling procedure (purposive sampling) are also discussed. The chapter further defines and discusses why in-depth semi-structured interviews and key informant interviews were the most appropriate primary data collection methods for use. Data analysis techniques used are also examined.

3.2 Qualitative methodology

This study uses a qualitative research approach. Qualitative research is defined by Daymond & Halloway (2002) as a method that uses inductive data analysis. This means that qualitative researchers have no intention to test any hypothesis or base their study on already prearranged theory; rather they are open minded and flexible. Mouton (2001) adds that qualitative studies involve the use of research methods to investigate certain behaviours and performance in their own natural settings. These methods focus on evaluation and analysis rather than quantifiable outcomes (Barbie and Mouton, 2001). Hennink et al., (2011) further define qualitative research as an approach which gives the researcher an opportunity to examine the participant's experiences in more detail by applying a certain set of research methods such as in-depth interviews, focus groups discussions, observations, content analysis, visual methods and life histories and biography.

Qualitative research was suitable for this study because it granted respondents the opportunity to give their views and opinions about the research subject matter. It also allowed them to give richer detailed insights to questions posed by the study. This would not have been possible had the study used some quantitative research methods. The use of qualitative research was also appropriate for this because it allows findings to be analysed and to be understood in context. Barbie & Mouton (2001) add that the researcher not only attempts to study the respondents in their natural setting but also attempts to fully understand and make sense of their actions and decisions.

Qualitative research is also linked to the subjective nature of social reality; it provides clear information from the participants' experience, allowing researchers to see things as the informants do, to explore the insider's views (Barbie and Mouton, 2001; Harris, 1976). This is reinforced by Denzin and Lincoln (2003) who argue that qualitative research involves an interpretive and naturalistic approach to the subject matter. This suggests that researchers try to make sense and interpret the meanings that a certain group of people attach to certain events and values as well. This in broad terms means that the researcher had to examine the experiences, feelings and perceptions of the study participants about recycled water usage, rather than imposing their own ideas, and make assumptions that might hinder the ideas of the participants. This allowed the study to uncover the meaning peri-urban farmers in Port Elizabeth attach to recycled water and how community members perceive food produced using such grey water.

3.3 Research design

Babbie and Mouton (2001) define research design as a plan or a blueprint of how the researcher intends to conduct the research. Henning et al (2004) state that a research design is a reflection of the methodological requirements of the research question and the type of data that will be collected and processed. Research design is that point of departure in research where all the parts of the research meet or come together; the research design holds all the parts of the research. Research design involves having an idea in mind and bringing those ideas into some type of design. Bhattacharjee (2012) also adds that a research design is a plan that is put into place as to how data is going to be collected using it in an empirical research project. He further regards research design as a 'blueprint' of the research which is intended for answering certain research questions or testing specific hypothesis (Bhattacharjee, 2012).

Research design can also be termed as a logic or master plan for a research that gives a clear indication of how a research is to be conducted. According to Mouton (1996) the research design is a strategy or structure of how the research will be executed to maximise the validity of findings; it gives guidelines from the underlying philosophical assumptions to data collection. Yen (2003) elaborates: research design can be seen as an action plan on how to get from "here" to "there", where "here" can be viewed as a departure point for the questions to answered, whereas "there" is the conclusions drawn from the responses and data that has been collected in relation to the initial question.

3.4.Sampling procedure and techniques

Sampling in social research is defined as the process of selecting the people or objects that will take part as respondents in the subject that is under research (Umejesi, 2012). The sample is drawn from the population and the sample number should have the same attributes as the population (homogeneity of variance). Mugo (1995) adds that this is a method of selecting a representative part of the population which possesses the characteristics of the population at large. In this study, the sample was drawn from Port Elizabeth peri-urban communities who are facing water challenges when practising peri-urban agriculture.

The sampling method that was used in this study is purposive sampling. Purposive sampling is when groups of participants are selected according to preselected criteria relevant to the particular research question (Marshall, 1996). Using purposive sampling is advantageous to study a broad range of subjects that includes people who have specific expertise (Marshall, 1996). In this study a sample of 22 respondents were purposively selected from the peri-urban communities of Motherwell and Uitenhage.

In addition to the 22 respondents, 8 key informants were purposively selected from the Nelson Mandela Metro Municipality. According to Micklip (1987), key informants are either experts in a particular field or knowledgeable community members who know the research community as a whole. Bealieu & Carter (1992) add that key informants are people who have an informed idea about what is going on in the community or village. They are thus able to provide informed opinions and insights about the subject matter under investigation.

3.5. Data collection instruments

In-depth semi-structured interviews and key informant interviews were the primary data collection instruments. Shnelderman and Plaisant (2005) state that interviews are a very useful mode of collecting data since the interviewer can pursue issues of concern. Gcnise (2002) adds that interviews have a benefit which is the direct contact with the study respondents which can lead to specific, constructive suggestions. They are also a good form of collecting rich data.

The in-depth semi-structured interviews used in this study have many advantages. For the sake of consistency with all respondents, the interviewer has a set of planned discussion topics that act as guidance such that the same areas are covered with each interviewee but that does not prohibit the interviewee from getting an opportunity to elaborate more relevant information if they desire to (Woods, 2011). Woods (2011) continues to note that semi-structured interviews allow for the replication of interviews with others and they are less controlled. In total, 22 in-depth semi-structured interviews were conducted with respondents who were selected purposively. These 22 respondents who were selected purposively were interviewed because they are involved in peri-urban farming. In addition to the 22 in-depth semi-structured interviews, eight key informant interviews were also conducted. All eight key informants were Nelson Mandela Metro Municipality officials who are experts in different fields like water services, effluent services and urban agriculture. All the interviews were recorded using a digital audio recorder. These recorded interviews were later transcribed and the data was cleaned and coded. Hand written notes were also taken down during the data collection process. Since all the respondents were Xhosa speaking, there was no language barrier between the respondents and the researcher who speaks the same language.

3.6.Data analysis

Data analysis is a process that aims to bring order, structure as well as meaning to large amount of data that has been collected (De Vos, et al., 2005). On completion of all the in-depth semi-structured interviews and key informant interviews, all audio recordings were transcribed. This transcribed data was then cleaned and coded. Coding allowed the researcher to begin to see main themes emerging from the raw data. These identified themes were answering the three study research questions. These themes therefore formed the qualitative data analysis which forms the main arguments of this dissertation. These qualitative study findings were also analysed within the context of available literature within the broad field of enquiry.

3.7 Conclusion

This chapter has discussed the qualitative research methodology used in this study. It also discussed the research design and purposive sampling techniques used. The chapter also fully explained why in-depth semi-structured interviews and key informant interviews were the most appropriate primary data collection methods for use in this. Lastly, the qualitative data analysis techniques used were also explained.

CHAPTER FOUR

PRESENTATION, DISCUSSION AND ANALYSIS OF FINDINGS

4.1 .Introduction

The purpose of this chapter is to present, discuss and analyse the findings of this study. The study was guided by three research questions which are:

- To what extent is recycled water used in peri-urban agriculture in Port Elizabeth?
- What are the socio-economic and environmental benefits of using recycled water for peri-urban farming purposes in Port Elizabeth?
- What are the community perceptions and narratives about recycled water usage in peri-urban farming?

A total of 22 respondents from three different peri-urban agriculture projects in Port Elizabeth were interviewed. In addition, 8 key Informants from the Nelson Mandela Metro Municipality were interviewed (see table 4.1 below)

Table 4.1: Study respondents

NAME OF PROJECT OR INSTITUTION	NUMBER OF RESPONDENTS
Zanethemba Nursery (Motherwell	5
Sandile Agricultural Cooperative	10

(Tinarha)	
Njongweni Agricultural Cooperative (Motherwell)	7
Nelson Mandela Metro Municipality	8
TOTAL	30

Source. (Author, 2014)

The study found that indeed there are water challenges in Port Elizabeth. The area has been experiencing low rainfall for some time. Low rainfall results in crop failure for most of the surrounding agricultural farms and peri-urban agriculture projects in the area. Due to that, these peri-urban agricultural projects resort to using municipal water (fresh water) for watering the crops. Most of this water is being paid for by the municipality but up to a certain limit. If the projects exceed that limit, they have to pay for the excess amount of water that they have used.

4.2. Usage of recycled water in peri-urban agriculture

Among other objectives, the study sought to examine the extent of usage of recycled water in peri-urban agriculture in Port Elizabeth. This was motivated by that Port Elizabeth is generally known as an area characterised by water insecurity. Most of the peri-urban farmers, twenty six in total, including the key informants who are Municipality officials stated that rainfall distribution in the area has changed drastically in the past ten years. The rainfall that the area is receiving has decreased

dramatically; statistics of rainfall distribution from South African weather services confirm this.

With regards to recycled water usage in peri-urban agriculture, respondents indicated that they are aware that recycled water can be used in agricultural activities. This was supported by one of the key informants who noted that;

The concept of recycled water usage is not a new concept amongst this community. When we had drought two years ago we encouraged the communities to use recycled water for irrigation purposes as to save the little fresh water that was available at that time (Key Informant 1, NMMM)

Other respondents from one of the peri-urban agricultural projects in Motherwell added that while they knew about recycled water usage, they have not used it for farming purposes before. As one respondent indicated:

We were once called to attend a workshop that was hosted by the department of Water Affairs which was to equip all the farmers in Port Elizabeth and surrounding arrears. This is where we heard about recycled water use in agriculture. We were given all the necessary information but we have never taken time to try and use the water for the projects. I guess we were not ready yet (Respondent 1 Motherwell)

From the majority of responses received, it became evident that currently even though peri-urban farmers are aware of the benefits of using recycled water, they use fresh municipal water that the Municipality supplies for agriculture. The bill for this water is being paid by the Municipality. One of the respondents highlighted this:

Even though our area is faced with water challenges, the municipality is supplying us with water to irrigate the project gardens and is paying the water bill for us. But there are conditions though, if we reach a certain limit we pay the excess amount from the little we make from the produce that we sell. Also with the water that is being supplied by the municipality we do face some challenges with it because at times when there are serious water shortages we are told to water the gardens once a week and switch off the taps. This becomes problematic because the plants wilt and we lose a lot of production (Respondent 2, Motherwell)

Recycled water is however being used for other activities other than watering agricultural crops. This was confirmed by one of the key informants who indicated that *currently there is not much use of recycled water in the metro for agricultural activities. Rather the water is currently used to water Golf courses and sports fields at Nelson Mandela Metropolitan University (Key Informant 2, NMMM)*. This was supported by another respondent who indicated that some of the waste water is released into the sea:

Most of this wastewater is being released to the sea in this area except the one that is collected and supplied to the Golf courses as well as industrial area. However, instead of discharging the water to the sea it could be used for agricultural activities. (Respondent 3, Motherwell.).

The study thus found that even though there are water challenges in this area they have not come to a point where they have to use recycled water for agriculture activities. Instead this water is being used for other activities such as watering sport fields. Recycled water was used in agriculture before when there was serious drought in the region but people stopped using it once the municipality intervened by supplying the local farming community with fresh water.

The usage of recycled water in watering sport fields in Port Elizabeth also indicates that it can be used for other useful purposes other than agriculture. According to WHO (2006) and Ilmobade et al (2009), wastewater reuse has been practised in many countries in the world for a number of years. However the practice has recently gained popularity due to several factors that include degradation of freshwater resources, droughts that are due to climate change, the increase of freshwater competition in many regions, growing industrial use, agricultural use as well as domestic use and the highest cost of supplying enough water to arid regions. This is supported by GCSAA (2008) who indicate that almost 12 percent of golf courses do in the United States of America use recycled water for irrigation.

The very limited use of recycled water in peri-urban farming in Port Elizabeth is contrary to popular practice in many developing countries. Hamilton et al (2005) note that recycled water usage in agriculture has been practised in many developing countries for so many years. They add that the activity is getting much attention recently due to urbanisation and climate change, the increased competition for fresh water, the frequent droughts and irregular rainfall patterns over the years. All these have resulted in the need to look for other alternative water sources and water recycling has emerged as a major option to fill the widening gap between water demand and water supply. Pescod (1992) adds that wastewater is best suitable for agriculture and its use agriculture can relieve the pressure that is placed upon fresh water.

4.3. Socio-economic and environmental benefits of using recycled water

An examination of whether there are socio-economic as well as environmental benefits that can be derived from using recycled water in peri-urban agriculture is one of the key questions answered by this research. Respondents were asked whether they are aware of the economic gains that they can derive from the use of recycled water in agriculture. Twenty two respondents confirmed that even though they do not use the water but based on the educational campaign they received from the Department of Water Affairs they know the benefits of using recycled water. These economic benefits were better explained by one of the key informants who pointed out that:

Yes there are economic benefits from using recycled water for agriculture. Firstly it saves the available fresh water in the area, it would be a bonus for the community of Port Elizabeth to have a place where the water will be stored for agricultural purposes as we all know the water challenges the area is facing. Secondly it would play a big role in economic development of the area because instead of discharging the water to the sea, the community will use it instead of using the fresh water that is currently supplied by the municipality. In turn, this will save the municipality a lot of money. (Key Informant 2, NMMM).

Another respondent supported the above response by saying that:

If we start to use recycled water that will be an advantage to our Municipality's economy. The municipality will not have to worry about paying the bill for peri-urban agriculture projects; instead recycled water will be utilised to substitute fresh water. In that way the municipality will save a lot of money and the local economy will grow. (Respondent 4, Uitenage.).

The above responses indicate the economic benefits that can be realised from recycled water usage in peri-urban agriculture. Fresh water supplied to the peri-urban agriculture projects by the municipality is costly for the municipality. If recycled water could be utilised instead of freshwater, the municipality would gain a lot financially. The money saved could be redirected to other essential services of Nelson Mandela Municipality. This observation is supported by the Water Corporation (2013) which argues that recycled water can be a relatively low cost

supply option compared to fresh water. Anderson (2000) adds that using recycled water instead of freshwater can lower the pressure that is put on existing water supply systems' capacity to cater for new water needs. This in turn helps by saving the cost of developing new water sources, water transfers as well as supply systems.

Other respondents also pointed out that recycled water contains nutrients which can act as a substitute for fertilizers while some have chemicals which act as pesticides. This means if you use recycled water there is a possibility of reducing costs of fertilisers and pesticides. This was confirmed by one of the respondents who noted that:

Yes there are economic benefits of using recycled water because one does not need to buy chemicals to kill all the insects, and you do not have to pay the extra service charges to the municipality for the water that has been used excessively (Respondent 2, Uitenage). Another respondent added that:

Using recycled water could save us a lot of money as we will not have to pay the municipality the extra changes we get by exceeding the limit of free water that is supplied by the municipality (Respondent 3, Motherwell). In terms of economic benefits, recycled water may benefit farmers in various ways ranging from higher yields, additional water for irrigation that becomes available, and value of fertilizers saved. The foregoing observations are in line with a statement by Jacobi (2009) who indicated that using wastewater for farming can contribute to local economic development since the use of wastewater enhances local livelihood security. Redwood (2004) also adds that wastewater has a lot of economic value which remains untapped at local level.

Respondents also indicated that not only do they receive economic benefits from using recycled water in peri-urban agriculture; there are also environmental benefits that can be achieved from using recycled water for agricultural purposes. One of the respondents indicated that:

if we start to recycle the water and use it, I think it will play a major role in environmental conservation because there will be less dump water sites in the community. Instead the water will be recycled and stored in one place so that it will be used for watering the crops in our projects and in our own back yard food gardens at home. Also the less dump water sites the less chances of developing health hazards and diseases due to the water that is dumped in the neighbourhood (Respondent 5, Motherwell).

The above comment suggests that using recycled water leads to avoidance of stagnant water ponds in local communities. This has many environmental benefits that include avoiding water borne diseases and breeding grounds for mosquitoes. It also leads to the avoidance of local environmental pollution. These observations are in line with a statement by Wimpenny et al (2010) who notes that recycled water has potential for environmental benefits and conservation through the reduction of pollution downstream. They further note that recycled water provides the potential triple dividend to urban farmers and the environment by preventing the flow of untreated water into the local community.

Other respondents indicated that the usage of recycled water will not only make them conserve water and reduce water pollution but they will also reduce harm caused to the local environment by chemicals such as pesticides and insecticides.

As one of the respondents explained:

I believe that by using recycled water to water the plants and crops, we are able to harvest crops that are close to pure organic. This in turn benefits the environment because there are no chemicals which were released directly to the land and environment because the water itself acts as the fertilizers (Respondent 6, Uitenage,)

Another respondent elaborated the above point stating that:

I think one of the ways of using recycled water which is beneficial to the environment is the fact that the water used does not contain hard chemicals so it is not harmful to the land. It will therefore make the land more fertile and suitable for farming for many years to come” (Respondent 7, Uitenage,)

The above environmental benefits are also supported by other available evidence. For example, the UNEP (2010) maintains that wastewater has the potential to improve soil fertility and the ability to reduce water contamination; it could also benefit the urban farmers with no access to water for irrigation. Recycled water is a rich source of nutrients and it provides all the moisture that is needed for growing crops (Hussain, et al 2002). As a result most crops give higher than potential yields

when irrigated with recycled water. Furthermore, one of the least mentioned benefits of recycled water is the fact that it is a potential resource.

4.4. Community perceptions and narratives about recycled water usage in peri-urban farming

After establishing the economic and environmental benefits of using recycled water for farming, the study sought to establish and understand general community perceptions about the use of recycled water for agricultural purposes. Some of the respondents had some cultural reservations about the use of recycled water for farming purposes. One of respondents indicated that:

Using this recycled water for farming would pose a challenge for us in the community because most community members would not want to buy our produce since they would claim that we use dirty water since some of the water is from the water we use to bath. For hygiene reasons, people in the community would be reluctant to buy the vegetables that we produce and sell (Respondent 8, Motherwell).

Another respondent added that; *“if people were to hear that we are using this type of water for the vegetables that we sell to them, I believe that will affect the sale of our*

produce. As a result people will not come to buy our crops because of the fear that we are not using clean water for the vegetables (Respondent 5, Uitenage). These responses indicate that even though the peri-urban farmers do have knowledge about the benefits of recycled water, they fear that there may be some issues that may arise from the community if they were to start using recycled water for farming. They fear that people would think that the food they produce is not healthy due to the recycled water they will be using for irrigation. These community perceptions are crucial in determining whether recycled water will fully utilised in Port Elizabeth in future. This is in line with the observation that public perception is a key factor to water recycling and its implementation in many countries (Donli & Hurlimann 2009; Bridgeman, 2004; Gibson & Apostolidis 2001).

Some of the peri-urban farmers also indicated that there are cultural concerns that may arise from the community about the use of recycled water. One of the respondents indicated that:

If some of the community members were to have knowledge that we are using recycled water for watering the produce, people would develop ideas that we want to bewitch through the water they use that we collect from them (Respondents 9 , Uitenage).

The above responses indicate that peri-urban farmers suspect that community members have little knowledge about the possibilities of using recycled water. This

suggests that community members together with the urban farmers need some form of education on what is recycled water and how it can be used for farming. There is a need for educational campaigns in the area so that they understand the importance of recycled water. This is more-so in a place like Port Elizabeth which has a recorded history of water insecurity..

Other respondents expressed health concerns that are likely to arise from using recycled water. They thought that they will be exposing themselves to diseases such as HIV/AIDS which they would contract from the wastewater. One of the respondents indicated that:

People would wonder about the risks they would be put under especially these days there are so many health concerns and many people are scared of contracting Hiv/Aids. Since the water will be collected from people, one will not even be sure whether the person who was using this water was HIV positive or not, meaning that we are not sure of the person's health status (Respondent 10, Uitenage ,).

Such community perceptions about contracting HIV/AIDS through recycled water are obviously incorrect. They however demonstrate that there is not only a lack of knowledge about how HIV/AIDS is transmitted, but also a failure to understand that there is no way HIV can be transmitted via recycled water. All this points to the need to educate the peri-urban communities in Port Elizabeth more about recycled water and its potential benefits. This view is shared and emphasised by some of the respondents who showed interest in using recycled water. These respondents

indicated that some sort of training and educational campaign is needed in the area in order for them to have a clear understanding of recycled water and its benefits. As one of the respondents explained:

We have never received any educational training on this type of water. The only time we heard about water recycling is when we attended a workshop that was held by the Department of Water Affairs where we were made aware of using recycled water and some of the benefits. We do need environmental campaigns as well as educational campaigns for the usage of recycled water. In that way we would be able to educate our community about water recycling so that the people will be on the clear side especially to the issues pertaining to diseases such as HIV/AIDS and how people get it. By so doing the community would be able to use the water for farming especially in this area that has water problems (Respondent 11, Motherwell,)

Furthermore, one of the key informants supported the need to educate the community about recycled water. He indicated that:

People need to be given appropriated training about this initiative and how to support it. We as local government whatever advice we give to the community they are willing to take it and practise it. We as the local government we see this initiative as a way to save fresh water and to deal with the water shortage challenge that is facing this area. We have before influenced the community into taking decisions that are

sound for their well-being even this time I think we would have a huge impact in the community (Key Informant 4,NMMM).

From the foregoing responses and discussion, it is evident that people have not been given training and information about water recycling. It is therefore important that the municipality begins to train and equip Port Elizabeth peri-urban community members with information about the benefits of using recycled water. If people are given the correct information, it is possible that their thinking and hence community perceptions about the merits and limitations of recycled water will also change.

4.5. Conclusion

This chapter has shown that as a result of water challenges in peri-urban Port Elizabeth, people partly rely on the Municipality to supply them with water especially for peri-urban farming purposes. There is no widespread use of recycled water for farming purposes. Instead the water is being used for other activities such as watering sport fields. The main reason for this is that people have not been educated formally by the local municipality about the benefits of using recycled water. However, some respondents were aware of recycled water's socio-economic benefits (reduction of farming costs, saving fresh water etc) as well as the environmental benefits which include the water's nutrient value. There are also negative community perceptions of recycled water. These include cultural concerns about using bath water for irrigating food for human consumption as well as the fear of being bewitched through usage of recycled water. However, these negative

perceptions simply confirm that there is need for the local municipality to educate peri-urban farmers in Port Elizabeth about the benefits of using recycled water. If these farmers are fully and properly educated about the benefits of using recycled water, it is possible that some of their negative perceptions will gradually disappear.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The study found that indeed greater Port Elizabeth is an area which experiences recurrent water insecurity. This water insecurity is due to poor erratic rainfall, droughts and recently climate change. These natural causes are compounding pressure on water resources caused by the increasing population (hence increased demand), water pollution and industrial demand. However, even though peri-urban farmers are aware of this pressure on water resources, they are not yet utilising recycled water for agricultural purposes. A majority of respondents (twenty six) indicated that they have never used recycled water for farming purposes with only four of the respondents confirming that they once used grey water. Even though many respondents were not using recycled water, they however knew that this water could be beneficially used in agriculture.

Even though the majority of respondents were not using recycled water, they confirmed that this water is being used for other activities, such as watering golf courses and sports field. Excess recycled water is being released to the sea because it has no other use in the community. This was confirmed by key informants who indicated that indeed recycled water is being used for other activities in the area except for agricultural activities. The key-informants also mentioned that one of the major reasons why recycled water is probably not being used by many people is that it has not being given much focus and emphasis by the municipality. They added that there were never educational campaigns that were conducted in the area to educate peri-urban farmers and general community members about water recycling

and its use for farming purposes. This suggests that there is need for municipal officials to raise awareness about the benefits of using recycled water in peri-urban communities around Port Elizabeth. Furthermore, key informant respondents also indicated that the municipality does not have an official policy about usage of recycled water. If there is no such municipal policy, this means the municipality does not see the need to encourage and support the use of recycled water for farming purposes in this area.

The study also found that there are socio-economic and environmental benefits of using recycled water in peri-urban agriculture. In terms of socio-economic benefits, respondents indicated that when using recycled water one can be able to save some money. This is due to the fact that the recycled water contains nutrients which are good for crops. Therefore, in a sense one does not need to buy fertilizers since the recycled water has nutrients needed by crops. The money that the farmers save is then used for other activities such as hiring more people to work in the urban agriculture gardens.

Using recycled water can also be beneficial to the municipality economic wise. How? Since the municipality supplies some of the water used by peri-urban farmers, it would save a lot of money if farmers started using recycled water instead. The municipality could then use these savings for delivering other essential public services. The peri-urban farmers will also save money because they will not have to pay the municipality for the water it supplies them for using in agriculture activities. This shows that using recycled water will economically benefit local Port Elizabeth residents and their municipality.

The study also found that there are environmental benefits that can be attained by using recycled water for farming purposes. There will be environmental conservation through the use of recycled water for farming purposes. There will be less stagnant water swamps which mean less water and environmental pollution since the grey water will be used in farming initiatives that are useful for the local community as well as the environment at large. By recycling water, the Port Elizabeth community will not only be conserving the environment, but they will be able to protect the community at large against water diseases caused stagnant water swamps. Since recycled grey water does not contain harmful chemicals, it will thus be beneficial to the environment. Rather it will make the soil more fertile and be suitable for productive agriculture for many years to come. Good soils will mean more produce for peri-urban farmers for many years. Furthermore, such production means the farmers will continue to produce more healthy organic food crops.

The findings show that people had different perspectives and narratives towards the use of recycled water for farming purposes. There are cultural concerns and considerations that may emerge through the use of recycled water for farming purposes. A majority 65% of the respondents indicated that they were not comfortable using bathing and washing grey water for watering food they will eat at a later stage. Some of the respondents argued that if they were to collect grey bathing and washing water from neighbours in the community for watering their crops, this would raise 'eyebrows' and 'suspicion' among neighbours as they will start to think the grey water will be used to bewitch them. This is justified fear from the peri-urban farmers since it is well known that so many African cultures have certain beliefs pertaining to witchcraft.

There were also small business concerns raised about selling food crops irrigated using recycled grey water. Respondents were concerned that if they used recycled water for farming purposes, some people will not want to buy vegetables that they produce since they will have the knowledge that it was irrigated using recycled water. This is a genuine concern for those peri-urban farmers who raise some income from selling some of their vegetables. Furthermore, some of the respondents were concerned about issues pertaining to HIV/AIDS transmission through grey bathing water. There was a perception among a few respondents that somehow HIV/AIDS can be transmitted through grey bathing. While this fear is unfounded since HIV/AIDS cannot be transmitted like that, this does however show that a lot of education around grey water benefits needs to be done in Port Elizabeth. This is necessary since it making some peri-urban farmers reluctant to use grey water.

A majority of the study respondents showed interest in water recycling. They see it as a potential resource to use so as to grow their small peri-urban agriculture businesses. They argued that if water recycling is fully implemented, it will enable them to be independent and not always rely on the municipality to provide them with resources such as water for their farming projects. They also imagined their businesses growing to a point where they will benefit them as well as the community of Port Elizabeth through the number of new jobs that they would create. They also saw water recycling as a channel to use for growing their farming activities so as to fight poverty and unemployment.

5.2 Recommendations

Given the foregoing conclusions, this study recommends the following:

- The local municipality needs to take the initiative and prioritise the usage of recycled water for agricultural purposes in greater Port Elizabeth.
- Since the local municipality has a lot of influence in communities around Port Elizabeth, it must use this influence to encourage the local community to recycle water regularly. This can be done through educational and environmental campaigns in the area.
- The local municipality can also provide technical assistance to the peri-urban farming community by providing them with water storage tanks to be used for storing all recycled water.
- The local municipality also needs to consider introducing and implementing policies that encourage the use of recycled water for farming purposes.
- The local community together with peri-urban farmers need to be given proper education on grey bathing water so as to dispel misconceptions like the erroneous claim that HIV/AIDS can be transmitted through grey water.

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APPENDICES

ANNEXTURE A: Semi Structured In-depth interviews

Research Question 1

To what extent is recycled water used in peri-urban agriculture?

1. Where do you draw water for your farming purposes?
2. Do you always get water every time you need it for your farming activities?
3. Given that there are water challenges in this city; what options do you have during times of water scarcity?
4. Have you ever used recycled water for your agricultural activities? If yes what type of recycled water did you use?
5. How often do you use this recycled water?
6. What types of crops do you water using recycled water?
7. Do you think recycling water for agricultural purposes is a good or bad farming practice? if good, why? if bad why?

2. What are the socio-economic and environmental benefits of using recycled water for peri-urban farming purposes in Port Elizabeth?

1. What are the benefits of using recycled water for farming?

2. Are there any economic benefits of using recycled water for urban farming?
 3. Does the use of recycled water for farming affect the sales of the produce harvested?
 4. What are environmental benefits of using recycled water for farming?
 5. Are there environmental awareness campaigns in place in this area about the benefits of water recycling and its usage in agriculture?
 6. Does the usage of recycled water contribute to water conservation in this community?
 7. Are there any economic benefits derived from this water conservation?
- .3. What are the community perceptions and narratives about recycled water usage in peri-urban farming?
1. Does the local community support or condemn your use of recycled water in your farming activities? if they support how and why? If they do not , why?
 2. What are the community perceptions about agricultural produce grown using recycled water?
 3. Have people in this community ever been educated about water recycling and its benefits?
 4. Have there been awareness campaigns about water recycling and its benefits in this community?
 5. How has the community responded to these awareness initiatives?

6. Are any cultural considerations that encourage or discourage water recycling for agricultural usage in this community?

ANNEXURE B: KEY INFORMANT INTERVIEWS

Nelson Mandela Metro Municipality Officials

TO WHAT EXTENT IS RECYCLED WATER USED IN PERI-URBAN AGRICULTURE IN PE?

1. How does the municipality assist with the use of recycled water for farming in this community?
2. How have you motivated local community to use recycled water for farming purposes?
3. Do you perceive recycled water as a valuable fixed resource?
4. Are the recycled water resources being managed well?
5. What is the role of the local municipality in water recycling and usage for farming?

WHAT ARE THE SOCIO-ECONOMIC AND ENVIRONMENTAL BENEFITS OF USING RECYCLED WATER FOR PERI-URBAN FARMING PURPOSES IN P.E?

1. Are there policy awareness campaigns in place that support water recycling reuse initiatives?
2. Are there environmental awareness campaigns in place that support water recycling reuse initiatives?
3. Where have you conducted these environmental campaigns?

4. Has water recycling reduced water demand in the greater p.e area?
5. Are there any future plans to encourage water recycling for agriculture activities?
6. Do you see water recycling playing a role in water conservation in port Elizabeth?
7. Do you see water recycling usage for farming playing a role in economic development of the Port Elizabeth?

WHAT ARE THE COMMUNITY PERCEPTIONS AND NARRATIVES ABOUT RECYCLED WATER USAGE IN PERI-URBAN FARMING?

1. Does the local community partake in water recycling policy formulation?
2. How have water recycling awareness campaigns been received by the community members?
3. When formulation these policies do you take into considerations the values of the local community?
4. How does the community feel about the use of recycled water for farming?
5. How have you communicated these policies with the local community?
6. Are there no cultural restrictions that prohibit the reuse of recycled water for farming?

