Assessing the usefulness of Water Conserving City Planning: A case of Inner City Durban, South Africa

by

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INSPIRING GREATNESS

Abstract

Since the beginning of industrialisation, urban areas have been rapidly growing. Recently, a paradigm shift has become noticeable, away from unchecked city growth toward more sustainable solution to problems rooted in urban water scarcity, subsidised by climate change and a plethora of anthropogenic activities. In the light of numerous negative trends of urban water conservation, the aim of this study is to suggest a far-reaching redefining approach of city planning predominantly focusing on water conservation in urban areas. To achieve this aim, the efficiency of fresh water supply in the city of Durban was examined; the usefulness of the existing water conservation plans was described and the urban land use contribution to water conservation was explored. The researcher used a qualitative research technique in both data collection and analysis. According to the findings, the city of Durban, South Africa as the case study area, made many attempt, drafted plans and policies towards water conservation. These initiatives include water conservation public awareness campaign, water infrastructure improvement, attempts to recycle wastewater and so on, however most these initiatives are seemingly facing challenges in meeting the required end. Consequently, access to water in the near future, if not currently, is becoming contested. To resolve the contestation, an appropriate mechanism is required. By merging both modern water management and city planning, a convincing idea which provide a positive guiding principles and operational framework including measures which will be considerably facilitate a positive move towards a water-secure city can be reached at. To this far, the concept of Integrated Urban Water Management will be recommended

Declaration

This study was undertaken for the fulfilment of Masters of Town and Regional Planning, which represent work originally done by the author. Acknowledgment of other authors or organisations have been made within text and in the reference list chapter.

Mr Edmore Mutsaa	Date
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Dedication

Family, relatives, lecturers, teachers, mentors and friends.

Acknowledgements

"If I had seen a little further, it is through standing on the shoulders of giants" (Isaac Newton).

I would like to extent my sincere gratitude to all those who have assisted me to complete this thesis. I am highly grateful and indebted to my supervisor Dr. Hangwelani Hope Magidimisha, who relentlessly and generously help and guide me throughout this research - with suggestions, encouragement and even time management in the research fraternity. I would like to express my gratitude to my Family for the priceless sacrifices and strive they have made to make this happen. To my friends Xavier Paidamoyo Mhosva, Trylee Nyasha Matongera, Fredua 'Kwame' Agymang, classmates and many others I highly appreciate the support you gave me. Above all, I give my utmost gratitude to the almighty living God for putting the right people in my life and carrying me through this programme even when it seemed impossible to carry on.

Thank you and God bless you.

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List of Acronyms

ANC	African National Congress
BMP	Best Management Practice
DMA	Durban Metropolitan Area
DWA	Development of Water Affair
EWS	eThekwini Water and Sanitation
GDP	Gross Domestic Product
IDP	Integrated Development Plan
IUWM	Integrated Urban Water Management
IWRM	Integrated Water Resource Management
LID	Low Impact Development
MDG	Millennium Development Goal
NDP	Nation Development Plan
NGO	Non-Governmental Organisation
NGWRP	New Goreangab Water Reclamation Plant
NRW	Non-Renewable Water
NWRS	National Water Resource Strategy
OGWRP	Old Goreangab Water Resource Management
PUB	Public Utility Board
SDB	South Durban Basin
SDF	Spatial Development Framework
SDP	Spatial Development Plan
SUDS	Sustainable Urban Drainage System
UDL	Universal Design for Learning
UMI	Urban Heat Island
WCCP	Water Conserving City Planning
WDM	Water Demand Management
WINGOC	Windhoek Goreangab Operation Company
WRM	Water Resource Management
WSA	Water Service Authorities
WSDP	Water Service Development Plan
WSS	Water Supply and Sanitation

WSUD	Water Sensitive Urban Design

Chapter I: Introduction

1.1. General background

More than ever, the 21st century is an urban age and the world is projected to continue to urbanize, leading to an expected 60% of the global population to be living in cities by 2030 (Koester *et al*., 2010). Generates greater competition for limited urban resources, population growth in urban areas will unquestionably put strain on water supply and sanitation in cities. The Millennium Development Goals (MDGs) proposed by the United Nations involve various factors related to urban water management. Among the principal factors is: reduction of the lack of access to potable water and sewage collection and treatment by 50% by 2015. To achieve the MDGs, it was agreed in Johannesburg in 2002 that countries should seek to develop Water Resources Plans. These plans involve developing the management of water resources in the countries (Parkinson *et al*., 2010).

The MDGs target year, 2015, came to pass but still the goal to reduce lack of access to potable water failed to meet the eyes of many and most of the developing countries are at the brink of being in the most serious water crisis the world has ever seen. According to research by the Institute of Security Studies released in 2014, South Africa was already the 30th driest country in the world with an average annual rainfall of only 495mm, whereas the world average is 1 033mm (Savides, 2015). Already, South Africa uses over 30% of its available water; at 40% it will probably have reached the limit of what can be exploited economically (Muller, 2012).

This constrained resource supports a population of over 50 million people and one of the major economies in Africa in a state that approaches water security hitches (Muller, 2012). Officials in the Western Cape, Free State, Limpopo and the Northern Cape are currently considering applying to be declared drought areas. KwaZulu-Natal was officially given drought status late 2014 (Savides, 2015). Not even a single dam in KwaZulu-Natal currently has as much water as it did in 2014, just a year ago (ibid) and this direct predicts a water crisis in the city of Durban, which is in KwaZulu-Natal province.

1.2. Problem statement

Durban continues to lose hundreds of millions of litres of water every day, despite the city and province being in the grip of the fiercest drought in 30 years. According to The Mercury (2015), Durban lost just more than 40% of its water in November 2015. The head of water and sanitation, Ednick Msweli detailed that municipality would need about R300 million a year for

the next five years to deal with the water loss nightmare. Most of the losses were attributed to unmetered connections, connections not on the Coins billing system or not monitored; inadequate capacity (human and financial resources) and vandalism of infrastructure. In January 2015 the auditor-general revealed how the city was losing 237 million litres of water a day due to leaks. The losses by then had amounted to R602.6 million a year. According to a study released in 2013 by WRP Consulting Engineers for the Water Research Council on water use revealed how Durban's loss had deteriorated in the past years. In 2005, Durban lost 29.1% of its water, 31.8% the following year and 33.5% in 2007. In 2011the city lost 36.4%, 38.9% in 2012 and 37.5% in 2013. Of the country's four leading metros Durban seconds, Johannesburg as the worst offenders of water loses. As if it is not enough, the key Hazelmere Dam, north of the city, dropped to below 27.5% of its capacity. Midmar Dam, which provides a significant amount of water to the city, is suspended just above 50% (The Mercury, 2015). This is to mention a few among other challenges facing the city of Durban as far as water security as concerned.

In the light of this problem at hand, this article thrives to reach a synergy by merging both modern water management and city planning after an intensive understanding of the root cause of the problem. It shall also seek to understand the water policies and legislation and their effects as they apply in the study area. Furthermore, it tries to reveal the best way to use urban landscape in conserving water and maximize the use of available water supplies before attempting to explore and expand new supplies at higher costs, particularly in selected representative areas around the city of Durban, South Africa.

1.3. Aim and Objectives

1.3.1. Aim

The research aims at finding ways to optimize the use urban landscape in conserving water and maximize the use of available water supplier before attempting to explore and expand new supplies at higher costs.

1.3.2. Objectives

i. To examine the efficiency of fresh water supply in the city of Durban.

ii. To describe perceived usefulness of existing water conserving plans in the City of Durban.

iii. To explore ways in which inner city Durban's land use has contributed to water conservation.

iv. To examine recommendations for interventions on water conservation from key informants

1.4. Research Questions

1.4.1. Main Question

To what extent can Water Conserving City Planning contribute to water conservation in urban areas to achieve a long-term demand and supply goal of the city?

1.4.2. Sub-questions

i. How efficient is the fresh water supply in Durban inner city?

ii. How active (useful) are the existing water conserving plans and policies?

iii. To water extend is the inner city land use is being used to conserve water sustainably?

iv. What recommendation can be drawn from the key informants in order to deal with the water problem?

1.5. Hypothesis

Water Conserving City Planning can be a noble way to mitigate the long-term water supplies goals, in cities facing future water shortage threats.

1.6. Conceptual framework

This section pursues to find common grounds between water management and contemporary urban planning. In this regard, its will explore a wide range of topic, i.e. general performance of the water security in the study area, the water management legislations and policies, condition and contribution of water infrastructure, existing and proposed water conserving plans, initiatives to conserve water within the study area, general causes of the crisis and challenges to achieve the desired outcomes. The discourses of Integrated Urban Water Management is used to inform the conceptual framework.

1.7. Theoretical framework

In due course, the usefulness of any research programme is to be judged on its ability to explain an increase number of hitherto unexplained phenomena. A progressive research programme possesses an expanding empirical context. Theories within a progressive research programme are able to explain novel facts or regularities that were previously unexplained. On the contrary,

a “regressive” research program is one w hose theories require continuous ad hoc changes in order to shore up the fundamental axioms upon which they are based. The theories in a regressive research program continually confront empirical refutation, and they must be amended accordingly. In this section, neoclassical theory and neoliberal theory are going to form part of the theoretical framework on which this research is founded. These theories are going to apply in progressive research programme context. In this paper, these theories deal with the arguments with which they approached the problems of water scarcity, giving life to that branch of political economy that studies the problems related to the use of natural resources and environmental externalities.

1.8. Conclusion

From a global to a local scale cities are facing water crisis. In the developing world, the population in cities is growing at an alarming rate in the face of a dwindling scarce water resource. The reasons for this scarcity ranges climate induced to poor resource management by the government as well as the ordinary citizens.

According to the South African Millennium Development Goals (MDGs) Country Report, it is indicated that South Africa is well on track to meet the goals and targets to provide water and sanitation to everyone (Peter-Varbanets et al., 2009). The targeted year for the MDGs was 2015, and the reality in the post 2015 reflects that South Africa and its cities are on the brink of a water crisis and much need to be done.

Water conservation is a prominent issue challenging communities throughout cities in South Africa. Local governments are grappling with the design and development of water conservation plans and strategies that will permit continued economic development and social welfare in the face of limited and in some cases dwindling water resources (Alcamo et al., 2008). It will take a concerted effort on the part of decision-makers across sectors and institutions to find a way to provide sustainable water services to African city dwellers (Jacobsen et al., 2012). In the City of Durban, plan and policies have been put in place ever since, but seemingly not yielding to the required target, worse of when the situation has been exacerbated by drought conditions.

In the light of this problem at hand, the research will thrive to merge both modern water management and city planning after an intensive understanding of the root cause of the problem. It shall also seek to understand the water policies and legislation and their effects as they apply in the study area. Furthermore it tries to reveal the best way to use urban landscape

in conserving water and maximize the use of available water supplies before attempting to explore and expand new supplies at higher costs, particularly in selected representative areas around the city of Durban, South Africa.

1.9. Outline of the dissertation.

Chapter I

This chapter is the introduction chapter. It covers the general background of the research study. It is in this chapter where the aim, research questions and objectives are stated.

Chapter II

This chapter consists of the conceptual and theoretical framework which make up and support the study. Concept(s) which forms part of the study is extensively discussed in this chapter. Theories, which support the research, are critically discussed in this section and their relevance to the research are outlined.

Chapter III

This chapter covers the methodology section of the research. In this chapter, the background information of the study area is highlighted. The methods used in for the purpose of this research are discussed in this section for example data collection and sampling methods, as well as the tools used during the research. The limitation or challenges faced during the research are also mentioned in this chapter,

Chapter IV

This chapter is composed of the literature review. Secondary information on the research topic was gathered extensively in order to have an understanding of what other researchers have found on the topic. Example from developing and developed countries were given for the purpose of comparisons, analysis and learning in relation to the research

Chapter V

This chapter covers data presentation and analysis. Firstly data was presented as it was collected from the field, however under subheading for the easy of reading to the readers. Secondly, the presented data was analysed using the themes. This analysis was therefore helpful in formulating recommendations.

Chapter VI

This chapter comprises the summary of the findings, recommendations and conclusion of the entire research.

Chapter II: Conceptual and Theoretical Background

2.1. Introduction

On a global scale cities are challenged by tight water supplies and swelling populations, hence create high demand. In Africa, cities are growing quickly, and their current water management systems cannot keep up with this growing demand (Alcamo et al., 2008). In many fast-growing cities, wastewater infrastructure is non-existent, inadequate or outdated. Water storage, treatment and distribution systems are often poorly maintained. In many countries of the developing world, water losses, due to technical leakage and water theft, often exceed 40-60% of the total water distribution (UNW-DPAC, 2011), and therefore often worsen the crisis. In some instances, the water crisis is contributed by the recent droughts, water shortages and the threat of climate change. .

The recent drought, water shortages and the threat of climate change have put water management squarely at the top of the public agenda (Smith, 2003). Water conservation is a prominent issue challenging communities throughout cities. Local governments are grappling with the design and development of water conservation plans and strategies that will permit continued economic development and social welfare in the face of limited and in some cases dwindling water resources (Alcamo et al., 2008). It will take a concerted effort on the part of decision-makers across sectors and institutions to find a way to provide sustainable water services to African city dwellers (Jacobsen et al., 2012). On the same note, countries should seek to develop Water Resources Plans, to fulfill the already missed 2015 MDGs target.

On the origins of these plans, planners have to think globally and act locally; there is a need to cope with major global trends, which potentially unfold huge impact on urban areas. Accordingly, the pressure to rethink, reiterate and modify the standards and principles for local urban development, concerning water security, is mainly generated by the global trends. Furthermore, the world-wide climate change will definitely have a significant impact upon the environment and specifically upon the natural and local urban water cycle (Koester et al., 2010). However, there is unavoidable need to handle a rising urban water crisis, to mitigate the negative impacts of climate change and adapt to changing climatic conditions. . To come closer to the vision of a water secure city and sustainable urban development, new approaches and starting points are urgently needed.

Wong (2006), states that there are three separate water systems, in urban environments i.e. (1) the potable water supply consisting of a piped system delivering water which is treated to drinking standard, from catchments which are outside of the urban area, (2) the sewerage system, consisting of a piped system collecting and transporting wastewater to treatment plants, and (3) the storm water drainage system, consisting of various elements, from natural waterways through to constructed channels and underground piped systems mainly transporting storm water. Water managers, therefore in this regard, should aim at addressing the two fundamental concerns of water quantity and water quality (Smith and Cartin, 2011). Information is needed to better develop and target municipal water conservation program (Alcamo et al., 2008).

Considering already existing options such as "best management practices" (BMP), or "low impact development" (LID) in the US, sustainable urban drainage systems (SUDS) in the UK, and "water sensitive urban design" (WSUD) in Australia, worldwide first steps in the right direction were done and relevant interfaces between city planning and water became obvious (Wong, 2006). Just like urban greening, urban water conservation is broadly accepted and perceived as a "creative element" for urban areas and its bigger use can be legitimised by actual threats i.e. driven by climate change or droughts. Therefore, planners put forward the idea to merge both urban water management and conventional city planning into a comprehensive sector approach of Water Oriented City Planning (WOCP) (Mitchell, 2003).

WOCP includes a comprehensive bundle of different measures such as modern rainwater management, innovative urban surface design, new greening concepts, urban rainwater harvesting and water reuse, an urban hydraulic cross-linking system, and finally completely new types of housing and architecture (Koester et al., 2010). In particular, water management, city planning, and residents take a centre stage involvement to select measures to adapt inner cities to improve water security.

With the above being said, this section pursues to find common grounds between water management and contemporary urban planning. In this regard, its will explore a wide range of topic, i.e. general performance of the water security, the water management legislations and policies, condition and contribution of water infrastructure, existing and proposed water conserving plans, initiatives to conserve water, general causes of the crisis and challenges to achieve the desired outcomes. Thus, the nature of this research requires an underlying theoretical driver that encompasses all of these topics. In that regards neoclassical and

neoliberal theories are going to for bases of this research. The discourses of Integrated Urban Water Management is going to be used to inform the conceptual framework.

2.2. Concept(s)

Consequently, to the rising urbanisation of the South African population, the social, economic, and environmental vitality of its growing cities are wholly dependent upon the planning and management of water. The water sector and the planning and development community have a symbiotic relationship that usually goes unrecognised, and therefore, not realised at all. Without adequate water resources and water infrastructure, urban development and redevelopment can be hindered. Conversely, land use and development impacts the use of and need for water. It takes more than turning on the tap to bring safe, reliable drinking water to an urban area.

An approach gaining favour with water managers is Integrated Urban Water Management (IUWM). IUWM principles recognize that water from all sources must be managed holistically and cooperatively to meet social, economic, and environmental needs. However, for IUWM to be fully effective, water managers need to cooperate and collaborate with other professionals and sectors, notably planners.

2.3. Integrated Urban Water Management

Integrated Urban Water Management (IUWM) is an approach for urban water utilities (ideally in concert with the planning community) to plan and manage urban water systems to minimize their impact on the natural environment, to maximize their contribution to social and economic vitality, and to engender overall community improvement. According to Mitchell (2006), IUWM consider:

- All parts of the water cycle — natural and man-made, surface and subsurface, and recognized them as an integrated system
- The full range of demands for water, both anthropogenic and ecological requirements
- The impact of water cycle management on the overall planning and management of cities
- The full range of water supplies available over time
- The practices which can provide water fit for purpose both in quality and quantity, and reduce the demand for potable water
- The sustainability of water service provision
- The local context and stakeholder views
- The scale, engineering, and functional aspects of the water system
- The means by which transition from current practice can be achieved

Integrated urban water management (IUWM) seeks to develop efficient, flexible urban water systems by adopting a holistic view of all components of the urban water cycle (water supply, sanitation, storm water management), in the context of the wider watershed (Jacobsen *et al*., 2012). With urban water shortages that are projected to get worse over the next century, there is need to integrate solutions across scales (household, neighborhood, city, catchment, and transboundary), domains (economic, social, and environmental), and institutions (government, private sector, and civil society). IUWM is an adaptive approach in which decisions reached by consultation with all stakeholders are part of a long-term vision (Mitchell *et al*., 2008). It seeks to provide sustainable solutions that can respond to the increasing uncertainty about future conditions created by climate change and rapid growth (Khatri and Vairavamoorthy, 2007). The rapidly expanding cities of Africa are particularly suited to IUWM solutions because new infrastructure and management frameworks can be designed from the start using IUWM principles.

2.4. Principles of IUWM

The principles of Integrated Urban Water Management include urban water cycle, management of water across institutions, water used suitable for a specific purpose, diverse sources water, wastewater value, innovative technologies etc. These principles are going to be described in details below. Figure 2.1 below shows the urban water cycle.

2.4.1. Urban Water Cycle

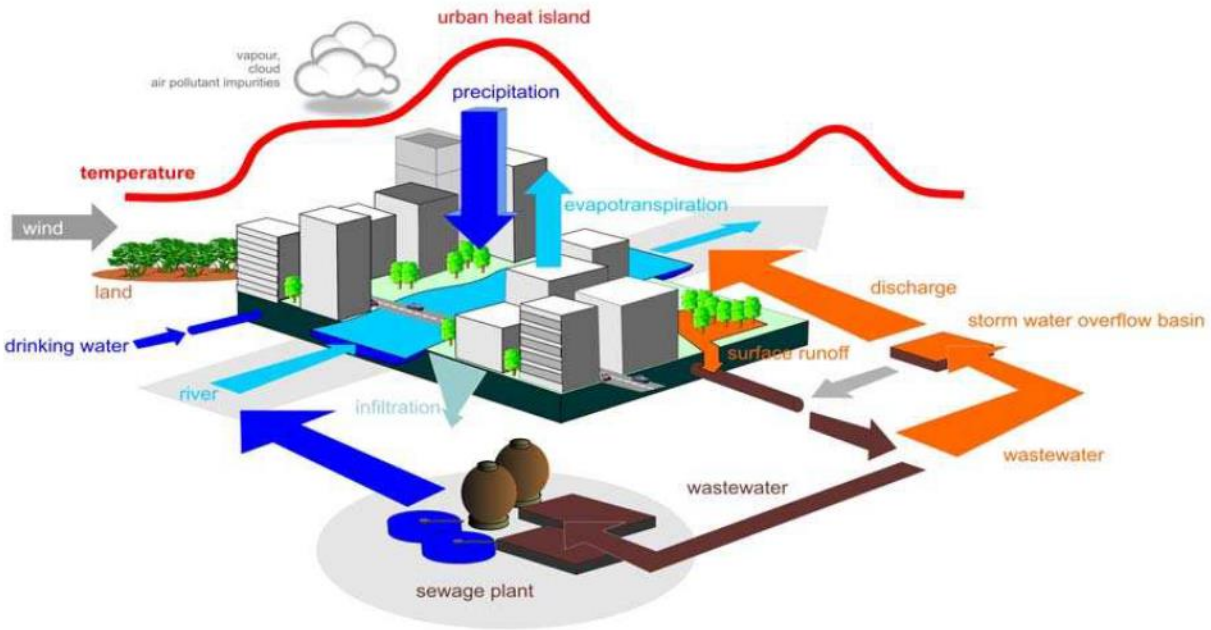

Figure 2.1. Showing urban water cycle. Source: (Koester et al., 2010)

Mainly influenced by the urban heat island (UHI) effect cities are characterized by a specific local climate (figure 2.1.). Due to the interrelation of temperature, humidity, and the feeling of well-being, the management of water is very important to the livelihood within a city (Binney *et al*., 2010). Thus, it is important to understand and articulate the relationship between the various components of the urban water system (water supply, wastewater, and stormwater) and to manage them as a single system. System components have a number of positive and negative interactions. Negative interactions constitute the impact of poor sanitation on the water quality of potential water sources, both surface and ground (Ross, 1978, Parkinson *et al*., 2010) and cross-contamination that takes place between leaky sewers, dirty water bodies, and drinking-water supply pipes, which is particularly a problem with irregular supply (Yassin *et al*., 2009). Positive interactions include opportunities for considering a portfolio of water sources, reuse, recycling, and cascading use of water (Lai *et al*., 2008).

Analysis at different scales exposes different opportunities for example analysis at the household scale exposes opportunities for rainwater harvesting and greywater recycling (Brown et al., 2008); analysis at the neighborhood scale exposes opportunities for local surface water/groundwater use and wastewater recycling using natural systems (Bieker *et al.,* 2010) and analysis at the city scale exposes interactions with road infrastructure and settlement structures and receiving water resources.

2.4.2. Management of Water across Institution

More often than not, many countries delegate the political responsibility for water resource management to national governments, whereas local institutions (local governments) or dedicated national supply companies are commissioned with water supply and sanitation (WSS) services. This division between national resource management and regional and local service delivery has brought a necessary level of specialization, however in most African countries it has also resulted in poorly coordinated planning for water supply management and poorly defined roles and responsibilities (Jacobsen *et al*, 2012). In water scarce and financially stressed African cities, the results of this lack of coordination and conflation of roles have been a lack of strategic planning and accountability. Ingrained in an assumption of abundance in the former restricted-growth urban settings of the colonial era, the planning, construction, and management by the public sector of centralized city water supply schemes were believed to be sufficient to secure water availability. That is, that kind of centralized approach was designed

to adequately serve the requirements of an urban elite, and to some extent of the poorer communities (Bloch, 2012), but with the advent of independence and influx of people into urban area, which automatically triggered urban growth and put pressure on the once deemed sufficient water resources, but now limited - the tables have turned.

In the same fashion, good governance is crucial for the economy of the country; good governance is a critical component to any water management agenda. Institutions need to be accountable and clear about their roles; the criteria for priorities should be made clear; and local governments, regulatory authorities, utilities, and so on, should receive (financial) resource allocations that correspond to the responsibilities conferred upon them by central authorities (Jacobsen *et al*., 2012). Coupled with good governance is lack of sustainable fiscal or financial strength by many cities in the developing world. In most cases the result of these financial constrains is underinvestment, inadequate maintenance, deterioration of assets to mention a few. The absence of clear incentives to deliver responsive services has also worsened the matter.

Good governance policies and strong finance must be accompanied by the tools and capacities with which to make the policies work (Butterworth *et al*., 2011). That is calling for the development of appropriate legislative, planning, implementation, and management tools, as well as the introduction of mechanisms to manage increased revenue for water resource development activities. To a certain extent, it is a question of providing better professional skills and financial resources to address critical areas such as integrated water resource planning and management, as well as the operation and maintenance of water-related infrastructure and services. To reach access targets and long-term sustainable outcomes, a strategic approach is required in linking management and planning of water resources and supply to broader urban planning, management, and financing.

Therefore, it is vital that water professionals understand and appreciate the significant role of urban planning in potentially supporting or constraining the optimization of their water systems. This requires close coordination, early in the development stage, between planners and water professionals (Binney *et al*., 2010, Brown *et al*., 2008). Urban form and a clustered approach to urban development facilitate the development of decentralized systems, which foster the reuse of treated wastewater (Bieker *et al*., 2010). A survey of African water utilities revealed that the attitude among African water professionals about the integration of urban planning and sectoral perspectives is ahead of current practice (Jacobsen *et al*., 2012).

2.4.3. Water use ought to suit a specific purpose

Matching water quality to its intended use will change the requirements of water demand and reduce water abstraction. The application of this principle exposes alternative sources of water that can be safely used for different purposes and can help address the growing gap between water demand and supply caused by the competition for water sources by different users (Maheepala *et al*., 2010). Some examples of cascading and recycling include greywater reuse for toilet flushing or gardening and non-potable water for non-process industrial demand (Allen *et al*., 2010). A good example is the city of Harare and City of Bulawayo both in Zimbabwe where they use grey water to irrigate golf coasts, rather than using fresh or potable water for irrigation, which might end up creating competition between citizens and the golf costs for a scarce resource. Furthermore, through avoiding the need for the highest level of treatment for some applications, water can be reused, reducing gross water abstraction and water treatment costs (Muller, 2012, Foo, 2007).

2.4.4. Diverse sources provide better water security

Given the shrinking water supplies, rising demand and cost, and uncertainty about the future, it is necessary to explore diverse and flexible options for water sources. A broader range of water sources increases the reliability and security of the water supply (Gleick, 2009). Groundwater is the most obvious source to supplement surface water, but other options such as stormwater, greywater, and blackwater should also be considered. By combining the concepts of water fit for purpose and security through diversity, all potential water sources can be modeled to maximize end-use and system efficiency. This approach can reduce fresh water use and costs and may improve environmental outcomes (Araral and Wang, 2013).

2.4.5. Wastewater might be valuable

There is great potential in urban water systems for water, energy, and nutrient recovery. In particular, wastewater is often grossly undervalued as a potential resource. By employing innovative technologies, water, calorific energy, biogas, and nutrients can be reclaimed from different water and waste streams and reused locally (Cornel *et al*., 2011). The so-called water machine would also enable the reclamation of water of different qualities that are fit for different purposes.

A perspective to treatment is emerging that aims to maximize the benefits reaped from every drop of water as shown in figure 2.2 below. Recent advances have generated technologies for simple, low-cost solutions, allowing the water machine concept to be applied in developing countries. Wastewater treatment and reuse in agriculture can provide benefits to farmers in

conserving fresh water resources, improving soil integrity, and improving economic efficiency. In addition, wastewater has the potential to provide renewable energy and nutrients and will convert current liabilities (energy required for wastewater treatment) into assets (energy from wastewater treatment). Such a perspective raises the possibility of addressing the sanitation challenge in African cities as an opportunity rather than a burden (Howe *et al*., 2011).

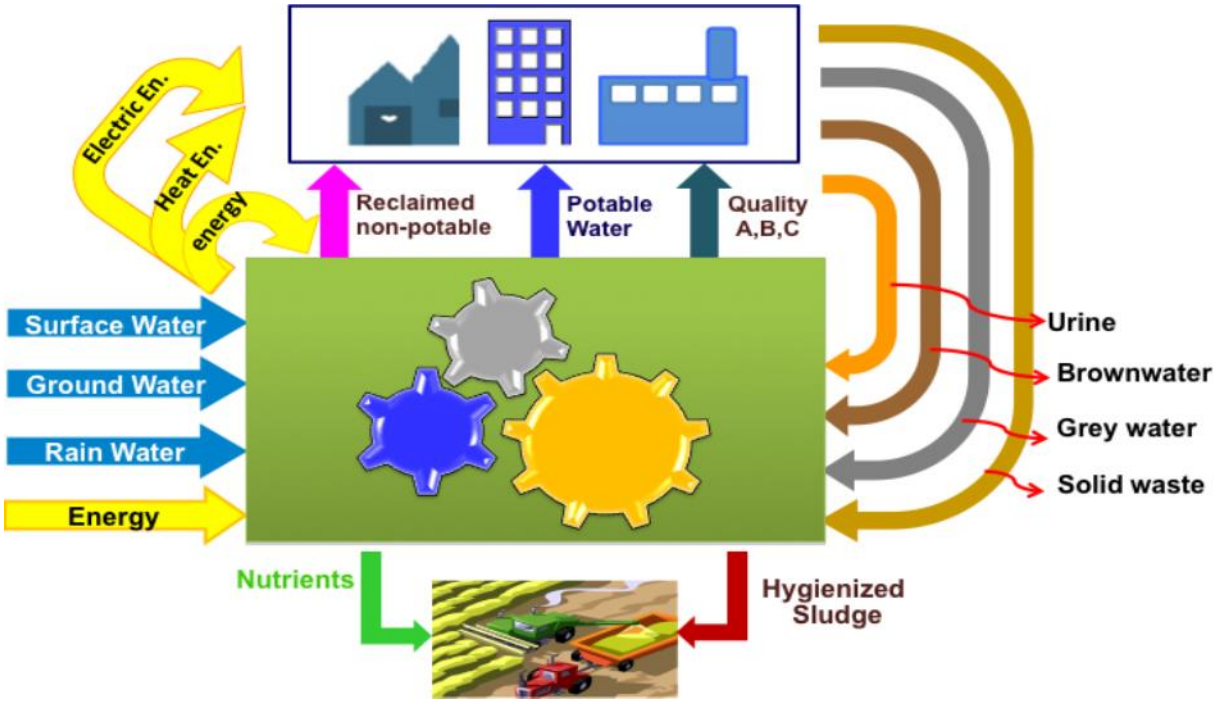

Figure 2.2. Showing resource recovery as described above. Source: (Jacobsen et al., 2012)

2.4.6. Innovative technologies can play a role

Technological innovations can help respond to the challenge of servicing more people with water and wastewater services under conditions of diminishing supply. Innovative treatment technologies might enhance recycling of wastewater and ensure that water can be used multiple times. Energy-efficient treatment options have been developed around natural systems (such as constructed wetlands and soil aquifer treatment), providing reliable treatment of multiple contaminants in a single system. Flexible technologies, such as small-scale decentralized storm water measures, can be optimized over time. Established technologies, such as membrane technologies, have recently undergone developments that drastically reduce their production costs, allowing small-scale applications to become cost-effective (Peter-Varbanets *et al*., 2009).

Treatment technologies have traditionally been viewed as linear systems, where water enters and leaves the system as a single stream of specific quality. A perspective to treatment based

on innovative technologies is emerging where waters of different qualities are received and produced within a single system (Otterpohl *et al*., 2004). In addition, recent advances have generated efficient treatment options, such as membrane bio-reactors, and relatively simple technologies such as soil aquifer treatment (Manda, 2015) and decentralized wastewater treatment systems (Gutterer *et al*., 2009). The low-cost and low-energy requirements of these technologies are well suited to conditions in developing countries, and open up opportunities for communities to consider reuse, recycling, and cascading use.

2.5. Theories

2.5.1. Introduction

In due course, the usefulness of any research programme is to be judged on its ability to explain an increase number of hitherto unexplained phenomena. A progressive research programme possesses an expanding empirical context. Theories within a progressive research programme are able to explain novel facts or regularities that were previously unexplained. On the contrary, a "regressive" research program is one whose theories require continuous ad hoc changes in order to shore up the fundamental axioms upon which they are based. The theories in a regressive research program continually confront empirical refutation, and they must be amended accordingly. In this section, neoclassical theory and neoliberal theory are going to form part of the theoretical framework on which this research is founded. These theories are going to apply in progressive research programme context. In this paper, these theories deal with the arguments with which they approached the problems of water scarcity, giving life to that branch of political economy that studies the problems related to the use of natural resources and environmental externalities.

2.5.2. Neoclassical theory

The neoclassical approach is based on the assumption that the capacity for self-regulation (Tietenberg *et al*., 2006) of free markets and not bound, and technological advances are able to ensure capacity of substitutions endless between the various forms of capital, mitigating so, the constraints arising from the possible scarcity of resources, allow sustainable growth, a level of consumption does not decreasing over time.

Neoclassical approach focuses on the behavior of the rational individual agent and treats macro states as outcomes of interaction between individual agents (Wong, 2006). The term 'neoclassical' in this context has been used broadly; it includes all the value-maximizing

agents. This term would embrace standard textbook theories of production and consumption; the property rights and transaction costs approach to industrial organization, law, history, and social institutions; public choice theories of politics and constitutional arrangements (ibid).

It is certainly true that the basis of neoclassical economics is methodological individualism. "The individual is modeled as an evaluating, choosing, and acting agent (Gleick, 2009). Aggregate social phenomena (of both the market and nonmarket variety) are then explained in terms of individual actions and their interrelations (Tan *et al*., 2009). Every observed social outcome is treated as an endogenous product of a process of individual choice and exchange, in the context of perceived constraints, which is water crisis in this context.

The assumption of "individual rationality" is really quite ordinary, in the sense that whether something is valued depends on whether individuals reveal by their behavior that they are willing to sacrifice some other object of utility in order to attain more of the "good" in question. This good might be commodified, like water, but it could also be a less-tangible form of satisfaction like charitable giving or the propagation of some ideological or religious belief. Adam Smith's belief is that self-interested individual behavior can have unintended, nevertheless beneficial, consequences for society. Unrestricted individual exchange will ensure that scarce resources flow to their highest valued uses (Khatri and Vairavamoorthy, 2007).

Within the broad heading of neoclassical theory there has developed the field of public choice, which provides an economic theory of politics based on the same methodological individualism that underpins other branches of neoclassical economics. Central to public choice theory is the recognition that optimal resource allocation does not always arise spontaneously out of individual optimizing. This theory makes it necessary to study the political processes through which individual preferences are translated into social structures behavior, because of various prisoner dilemma problems associated with the pursuit of collective outcomes (Patton, 1990).

2.5.2.1. Public choice

Some public choice models are voter oriented. According to this approach, political entrepreneurs (politicians) are interested only in gaining or retaining office. They adopt platforms and implement policies that they believe most closely accord with the preferences of the majority of voters. Government policy is viewed as an essentially passive reflection of the desires of the median voter. This applies to the way in which water-conserving policies are adopted by the government or political leader who are in the corridors of power to influence these policies. In such instances as advocated by the theory, the adoption and implementation

of policies may be skewed directly or indirectly to the political leaders' interest (Butterworth *et al*., 2011).

An alternative public choice approach comprises what Kuran calls "group-centered" theories. According to this perspective, politics can be viewed as a process of competition among several private interests who are perusing to influence government policy, with the state acting as an impartial broker of wealth transfers between suppliers and demanders (Bieker et al., 2010, Smith and Cartin, 2011, Rees, 1998). Although the resultant political outcomes seldom embody efficient resource allocations in the usual Pareto sense, they do maximize the influence weighted sum of utilities of the constituent interest groups. The weight attached to each group depends on its relative efficiency in exerting political influence, which in turn depends on its ability to overcome the incentive for its members to free ride on the pursuit of collectively sought outcomes. Olson (1965), in his classic work on collective action, shows that selective (or excludable) incentives are necessary to transform a coalition of rational individuals into a 'privileged' interest group.

In some variants of this model, politicians and bureaucrats are assumed to have their own goals, which need not coincide with those of their constituents. Politicians, for example, might desire certain public interest policies, which reflect a broad ideological conception of what is good for society as opposed to the special interests of the pressure groups whose lobbying and support brought the politicians into office. There is considerable debate among public choice theorists about whether legislators are constrained always to vote in accordance with what their constituents want, or whether there is scope for them to indulge their own ideological preferences.

However, neither the voter-oriented nor the group-oriented theory, in its simple formulations, represents the last word of neoclassical economics on political and institutional change. Recent work by some economists recognizes that collective action quite often occurs, not as a response of elected politicians to the preferences of the median voter, nor even as the result of organized interest group pressures. The free-rider problem notwithstanding, rational individuals are observed to make anonymous contributions to political causes and even to take to the streets in large crowds without evidence of explicit incitement by organized interests or the presence of selective incentives.

There is a growing consensus among neoclassical economists that social change is often ushered in by changes in prevailing beliefs, which are strong enough to overcome the usual

proclivity of the rational individual to avoid costly political participation. For (Jacobsen *et al*., 2012), ideology enables individuals to consume a feeling of solidarity or belonging with other, like-minded, individuals. People occupying different positions in the social division of labor will generally have different experiences of the world and, therefore, different ideologies. Individuals will find it privately advantageous to espouse an ideology publicly if they believe that the majority of their fellow citizens also believe it. Hence, interest groups will often attempt to portray their goals as popular in order to shape the ideological preferences of the majority in their favor. This can also influence implementation of water conserving polices, for example the issue around recycling of sewage water into potable where a certain group might see it as contradicting their religious and or cultural beliefs hence put challenges on that plan or policy supporting the plan.

2.5.2.2. Criticisms of the Neoclassical Theory

Modern critics of neoclassical theories of politics and institutions focus on two main lines of attack. Some have argued that the expansion of neoclassical economics into the domain of nonmarket behavior is limited by informational and cognitive constraints on individual decision-making capabilities. Nicolaides (1988), for example, states that the neoclassical rationality hypothesis cannot be applied uniformly to all areas of human choice, because individuals will separate their perceptions of the world into arbitrary segments to make information more manageable. Thus, individuals will use different decision rules for different circumstances.

More generally, the claim that neoclassical economics ignores the problem of information is unfounded indictment. Limitations of information and knowledge, far from being alien to neoclassical economists, are central to their analysis. Scarcity of information, like any other resource, is axiomatic to rational individual choice theory and is often incorporated in the formal structure of the models in the same way as other resource constraints.

Another line of attack against the extension of economics into the field of politics comes from institutionalists who object to methodological individualism because it ignores the impact of social structure on individual preferences. Dearlove (1989), accuses the neoclassical perspective of focusing on abstract individuals and their preferences and, therefore, of failing to get to grips with institutional behavior and the workings of concrete political systems. Although public choice theory attempts to explain what rational individuals will do given the

pattern of existing norms and institutions, there is no attempt to account for the character of the larger system within which actors behave.

2.5.3. Neoliberal theory

The term neoliberalism was first coined by the Freiberg School of German economists to denote a philosophy that was explicitly moderate in comparison to classical liberalism, both in its rejection of laissez-faire policies and its emphasis on humanistic values. However in the recent literature there has been a paradigm shift, and the foundations of this shift can be traced back to the classical liberalism advocated by Adam Smith, and to the specific conception of man and society on which he founds his economic theories (Saad-Filho, 2005). Neoliberalism is, under this view, thought of as an entirely new 'paradigm' for economic theory and policy-making – the ideology behind the most recent stage in the development of capitalist society – and at the same time a revival of the economic theories of Smith and his intellectual heirs in the nineteenth century (Betto, 2006).

The concept of neoliberalism suggests a particular account of the development of liberal thought. It suggests that liberalism was at one point in time an influential political ideology, but that it at some point lost some of its significance, only to revive itself in more recent times in a new form. Neoliberalism could therefore scarcely be understood as the recovery of a lost tradition of liberal, political thought (Thorsen and Lie, 2006).

2.5.3.1. Tenants of neo-liberalism

There is no ubiquitous or universal definition of the term neoliberalism that exist, thus many scholars agree that it epitomises fundamental values that support and maintain the status quo, encourages individualism, market fundamentalism, and privatization (Hasenfeld and Garrow, 2012). While neoliberalism provides stability and support to societal systems, it also promotes economic inequality, dependency, and individualistic values; all of which can be restricting to community well-being and social welfare (Choudry and Shragge, 2011).

To a certain extent the neo-liberal approach is rooted on the neoclassical vision of economic (Giva *et al*., 1990), which has as its stated goal, the maximization of welfare (Varian, 1993), identified with the willingness to offer to the widest number of people greater opportunities for consumption. Unlike a normative ideology, a neoliberal paradigm consists of positive assumptions about how markets operate; in this sense, it is often seen as closely related to neoclassical economic theory. Brohman (1995), for instance, argues that in the neoliberal approach, "the behaviour of individuals is predetermined by a set of universal rational rules

that are deductively speculated. Private producers and consumers are presupposed to be utility and profit maximisers who respond rationally and efficiently to correct market signals".

When speaking of a neoliberal ideology, scholars refer to normative ideas about the proper role of individuals versus collectivities and a particular conception of freedom as an overarching social value. Carruthers (2001), for example, argues, "Neoliberal ideology seeks to restrict the state to a minimum and to maximise the scope of individual freedom…. Political leaders should not impose any single utopia; rather, individuals should be free to pursue their own, mediated by exchange relationships in the marketplace." If a neoliberal development model is a specific plan for how a certain society will be organized, a neoliberal ideology is a more general statement about how society should be organized.

According to Harvey (2005), neoliberalism is in the first instance a theory of political economic practices that proposes that human well-being can best be advanced by liberating individual entrepreneurial freedoms and skills within an institutional framework characterized by strong private property rights, free markets and free trade. The role of the state is to create and preserve an institutional framework appropriate to such practices. Furthermore, if markets do not exist (in areas such as land, water, education, health care, social security, or environmental pollution) then they must be created, by state action if necessary. However, beyond these tasks the state should not venture. State interventions in markets (once created) must be kept to a bare minimum.

Critical theories of neoliberalism and neoliberalization provide a compelling moral narrative in which recent history is understood in terms of a motivated shift away from public and collective values towards private and individualistic values. Critical narratives of neoliberalism reinforce the image of there being a clear-cut divide between two sets of values – those of private, individualistic self-interest on the one hand, and those of public, collective interests on the other. There is a preconstructed normative framing of these theories around a set of conceptual and moral binaries: market versus state; public versus private; consumer versus citizen; liberty versus equality; individual utility versus collective solidarity; self-interested egoism versus other-regarding altruism.

2.5.3.2. Critics of neoliberalism

Although neoliberalism is often associated with U.S. economic and political values, its effects have been experienced and illustrated globally as well. One of the major flaws of neoliberalism is that it promotes dependency on government for support, while discouraging people from

challenging the unjust system (s) leading to their dependency (Mullaly, 2007). In the U.S. and Canada, large portions of the population receive some form of social welfare in order to survive. For example, people in the U.S. meeting the low income or poverty criteria receive government support for food, housing, healthcare, and other related needs. While individuals considered low-income receive some help, the support is only enough to sustain them at a bare minimum standard without allowing them to attain the education, training, or other resources necessary for true upward mobility in society (Piven and Cloward, 1977, Mullaly, 2007)

Theories of neoliberalism go hand in hand with a standard form of criticism that bemoans the decline of public life, active citizenly virtue, and values of egalitarianism and solidarity. These theories project ahead of themselves criteria of evaluation (Castree, 2008), for example neoliberalism reduces democracy, creates poverty and inequality, and is imposed either from the outside or by unaccountable elites. The conceptual analysis of neoliberalism is therefore always already critical, but at a cost. They are condemned to invoke their favoured positive values (e.g. the public realm, collective solidarity, equality, democracy, care, social justice) in a moralistic register without addressing normative problems of how practically to negotiate equally compelling values. In addition, as far as theories of neoliberalism dismiss considerations of rational action, motivation, and decentralised coordination as so much 'ideology', they remain chronically constricted in their capacity to reflect seriously on questions of institutional design, political organisation and economic coordination, which, one might suppose, remain an important task for any critical theory. It is argued that all markets, even the most 'free', are embedded in broader contexts.

The concept of neoliberalization implies that neoliberalism is both *parasitic* on and *corrosive* of other social processes, but as already suggested, the source of this doubly destructive energy is never quite specified in these theories. The immediate objects of criticism are a range of substantive and observable social harms: rising levels of socio-economic inequality, authoritarianism, corrupt government, the concentration of wealth. Nevertheless, these immediate objects of criticism are seen as inevitable outcomes of a system, which has encouraged the disembedding of economic relations from broader structures of normative steering. It is the imputed content of neoliberalism as a narrowly individualistic, egoistic rationality that is the source of the status ascribed to it as a 'strong discourse', at once parasitic and corrosive. It is on these grounds that it neoliberalism is viewed as nothing short of "a programme of the methodical destruction of collectives" (Bourdieu, 1998).

The view that neoliberalism unleashes pathological human tendencies otherwise properly held in check by collective conventions is a distinctive updating of Polanyi's view of market capitalism as an unnatural formation. What is at work here is a theoretical imaginary in which the extension of accumulation by market exchange is understood to necessarily undermine forms of social integration previously knitted together through the state. Theories of neoliberalism display an intense ambivalence towards 'the state'. On the one hand, they follow a classical Marxist view in which the state is a territorial sovereign systematically involved in the reproduction of capital accumulation. On the other, they hark back almost nostalgically to a social democratic view in which the state stands opposed to the market as a counterweight, representing an opposing principle of social integration and political legitimacy (Barnett, 2010).

What is wrong with neoliberalism, for critics who have constructed it as a coherent object of analysis, is the unleashing of destructive pathologies through the combined withdrawal of the state and the unfettered growth of market exchange. 'Individual freedom' is presented as a medium of uninhibited hedonism, which if given too much free reign undermines the ascetic virtues of self-denial upon which struggles for 'social justice' are supposed to depend (Harvey, 2005).

Underwritten by simplistic moral denunciations of 'the market', these theories cover over a series of analytic, explanatory, and normative questions. In the case of both the Marxist narrative of neoliberalization, and the Foucauldian analysis of neoliberal governmentality, it remains unclear whether either tradition can provide adequate resources for thinking about the practical problems of democracy, rights and social justice. This is not through the systematic denigration in both lines of thought of 'liberalism', a catchall term used with little discrimination. There is a tendency to present neoliberalism as the natural end-point or rolling-out of a longer tradition of liberal thought – an argument only sustainable through the implicit invocation of some notion of a liberal 'episteme' covering all varieties and providing a core of meaning. One of the lessons drawn by diverse strands of radical political theory from the experience of twentieth-century history is that struggles for social justice can create new forms of domination and inequality. It is this that leads to a grudging appreciation of liberalism as a potential source for insight into the politics of pluralistic associational life (Barnett, 2010).

2.5.4. Relevance to study

The service provider use the neoclassical approach in the delivery of service to the citizens. eThekwini Water and Sanitation (EWS) department is in charge of distribution water and providing sanitation services to the communities within its jurisdiction, which its refer to as its 'customers'. Labeling the people it intend to serve as 'customers', the authority reflects its 'business oriented' approach to service provision, which is based neoliberalism. Though the municipality provide a certain quantity of water, free of charge, to the disadvantaged communities, the quality of service delivery is not as good as the one in well off communities, which pay for the service. In some cases, people in impoverished communities have to share a water tap. This interprets the municipality's neoliberal approach of prioritizing those who pay for the service better than those who are getting it free. The challenges with this comes when those who are not satisfied with the service delivery end up adding the problem of water scarcity through illegal connections which result in more leakages or water loses. On the other hand, the local government is caught up in a situation where they want to provide the service free of charge but the process involve money hence they will be left with no choice than to follow the neoliberal approach in service delivery. On a conceptual point of view, the principle of management of water across institution under IUWM help to address this issue if institution or all authorities put their maximum effort on their role. To optimize the potential of this principal in assisting, institutions need to be accountable and clear about their roles; the criteria for priorities should be made clear; and local governments, regulatory authorities, utilities, and so on, should receive (financial) resource allocations that correspond to the responsibilities conferred upon them by central authorities (Jacobsen *et al.*, 2012). For example the issue of illegal connections, is a case of law enforcement. The row of law enforcement agents in this matter should be clear, as their reluctance provides a loophole for failure.

The other challenge from free provision of water is that, people become reluctant and wasteful in their use of water since they are aware that any loss, which comes with wasteful use, will not directly affect them, especially financially. The neoclassical theory interpretation to this matter focuses on the behavior of the rational individual agent and treats macro states as outcomes of interaction between individual agents. In broader terms, neoclassical approach includes all the value-maximizing agents.

The neoclassical approach emphasizes methodological individualism. Unrestricted individual exchange will ensure that scarce resources flow to their highest valued uses. This may result in inequalities in resource allocation. In some instances sanitation provision in impoverished areas

is more challenging in these parts of the city as bulk sewerage infrastructure only extends to the edge of the urban core and water borne sanitation is dependent on increased water use, which comes with increased costs.

The neoclassical assumption of "individual rationality" is really quite ordinary, in the sense that whether something is valued depends on whether individuals reveal their behavior that they are willing to sacrifice some other object of utility in order to attain more of the "good" in question. This good might be commodified, like water, but it could also be a less-tangible form of satisfaction like charitable giving or the propagation of some ideological or religious belief. This is seen in cases where some water conservation initiative sometimes in contradiction with peoples belief systems or what they consider normal, for example wastewater reuse which is received with mixed feelings. Sometimes the technological initiatives like desalination contradict the government budget in place. Therefore it is in such cases where individual rationality plays a role in revealing people's behavior on how much they are willing to sacrifice or compromise to obtain the scarce good in question.

Within the broad heading of neoclassical theory there has developed the field of public choice, which provides an economic theory of politics based on the same methodological individualism that underpins other branches of neoclassical economics. According to the voter-oriented model of public choice approach, political entrepreneurs (politicians) are interested only in gaining or retaining office. They adopt platforms and implement policies that they believe most closely accord with the preferences of the majority of voters. An alternative public choice approach comprises what Kuran calls "group-centered" theories. This approach implies that politics can be viewed as a process of competition among several private interests who are perusing to influence government policy, with the state acting as an impartial broker of wealth transfers between suppliers and demanders (Smith and Cartin, 2011). This approach does not really precipitates in an efficient resource allocation. It turn to incline more on one group. The value attached to each group depends on its relative efficiency in exerting political influence. In both ways these approaches will have influence on how policies are being implemented

Chapter III: Study area and Research Method(s)

3.1 Introduction

Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically. In it, there are various steps that are generally adopted by a researcher in studying his research problem along with the logic behind them. It is necessary for the researcher to design his/her methodology for his/her problem as the same may differ from problem to problem (Berg and Lune, 2004).

In more details, in this chapter the author outlines the background of the study area, the research method, the research approach, the methods of data collection, the selection of the sample, the research process, the type of data analysis, the ethical considerations and the research limitations of the project.

3.2. Background of the study area

Durban, which has also current been known as *eThekwini*, is the largest city in the South African province of KwaZulu-Natal. Durban's metropolitan municipality ranks third after Johannesburg and Cape Town, which are the most populous urban areas in South Africa. It is also the second most important manufacturing hub in South Africa after Johannesburg (StatsSA, 2008), with its main industrial are located in the South Durban Basin (SDB). Durban forms part of the eThekwini Metropolitan Municipality and it is the biggest district in the metropolitan municipality concerning population density. The metropolitan land area of 2,292 square kilometres is comparatively larger than other South African cities, resulting in a somewhat lower population density of 1,513/km^2 .

Durban is renowned for being the busiest container port in South Africa, and as well as in Africa. The Durban Metropolitan Area (DMA) is the main economic driver in KwaZulu-Natal, contributing over half of the province's output, employment and income. In national terms, Durban is the second most important economic complex after Gauteng, accounting for 15% of national output, 14% of household income and 11% of national employment (ibid). Regional development corridors link Durban northwards to Richards Bay and Maputo, and westward to Pietermaritzburg and Johannesburg. Figure 3.1. below shows the map of the study area.

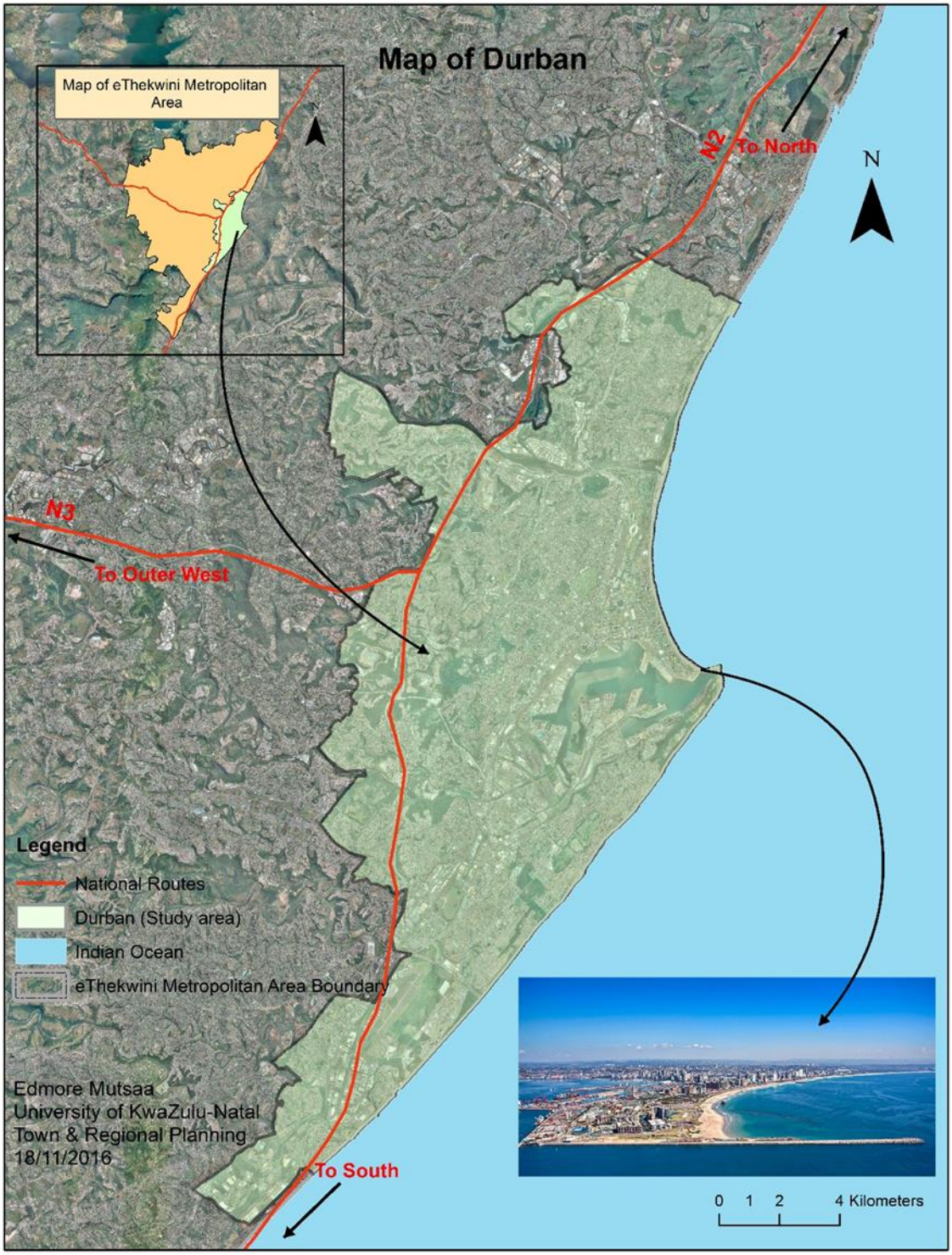

Figure 3.1. Map of Durban (Study area). Source: (Author, 2016)

It is also seen as one of the major centers of tourism because of the city's warm subtropical climate and extensive beaches. The eThekwini metropolitan municipality,

which includes neighbouring towns, has a population of almost 3.5 million, making the combined municipality one of the biggest cities on the Indian Ocean coast of the African continent (StatsSA, 2008).

Durban is ethnically diverse, with a cultural richness of mixed beliefs and traditions. Zulu people represent the largest single ethnic group. It has a large number of people of British descent and has the most Indians of any city in the world, outside India. The influence of Indians in Durban has been significant, bringing with them a variety of cuisine, culture and religion. One could say social cohesion in South Africa's third largest city is fairly strong despite a negative outlook in some cases (Mukherji, 2011). According to last national census, the population of the city of Durban and central suburbs such as Durban North, Durban South and the Berea is 595 061. The percentage of Black Africans is 51.1%, Indian or Asians is 24.0%, Whites is 15.3% and Coloureds (Mixed) is 8.59%. The city's demographics indicate that 68% of the population are of working age, and 38% of the people in Durban are under the age of 19 years (StatsSA, 2008).

3.3. The research technique

In order to satisfy the objectives of the dissertation, a qualitative approach was used. The main characteristic of qualitative research technique is that it is mostly appropriate for small samples, while its outcomes are not measurable and quantifiable. Its basic advantage, which also constitutes its basic difference with quantitative research, is that it offers a complete description and analysis of a research subject, without limiting the scope of the research and the nature of participant's responses (Collis & Hussey, 2003).

However, the effectiveness of this qualitative research is heavily based on the skills and abilities of researchers, while the outcomes may not be perceived as reliable, because they mostly came from researcher's personal judgments and interpretations. Because it is more appropriate for small samples, it is also risky for the results of qualitative research to be perceived as reflecting the opinions of a wider population (Bell, 2005).

3.4. Research Design

Burns & Grove (2001) define research design as the clearly defined structures within which the study is implemented. A qualitative, exploratory, descriptive and contextual design was followed using the phenomenological method to explore the issue of urban water management and planning in the inner city area of Durban. The richness and depth of the description gained from a qualitative approach, provides a unique appreciation of the reality of the experience

(Munhall 2001). Qualitative research emphasises the dynamic, holistic and individual aspects of the human experience, and attempts to capture those experiences in their entirety, within the context of those experiencing them (Polit & Beck 2004). The researcher chose to follow a qualitative research process to assess the usefulness of water conserving city planning in Durban. Through this approach, it was possible for the researcher to deeply engage and interact with top official key informants through phenomenological interviews, and rich data was generated on the experiences and issues around water security in Durban.

During the interviews the interviewer used bracketing (which refers to putting preconceived ideas aside) and intuiting (focusing on the experiences and knowledge of respondents). Field notes were taken by the interviewer based on the information provided during the interviews and observations made during fieldwork or field visits. Interviews were conducted until the data saturated through repeating themes and not by the amount of interviews conducted. The data was therefore analysed using thematic system.

3.5. Data Collection Methods and Tools

For the purposes of this research, in depth interviews were used. In depth interviews are personal and unstructured interviews, whose aim is to identify participant's emotions, feelings, and opinions regarding a particular research subject. These in depth interviews took the interview guide approach adopted from Patton's interview classifications (Frauendorfer and Liemberger, 2010). An interview guide approach is less structured than that taken in a standardised open-ended interview. Topic and issues covered were specified in advance in an outline form but the interviewer varied the wording of the questions and the sequence in which the questions were tackled. As a result, the interview had much greater freedom to explore specific avenues of enquiry; logical gaps within the data has been anticipated and closed. The interview took on a more conversational feel while ensuring that all the topics of interest were explored.

The main advantage of such personal interviews is that they involve personal and direct contact between interviewers and interviewees, as well as eliminate non-response rates, but interviewers need to have developed the necessary skills to successfully carry an interview (Fisher, 2005, Wilson, 2003). On a positive note, unstructured interviews offer flexibility in terms of the flow of the interview, thereby leaving room for the generation of conclusions that were not initially meant to be derived regarding a research subject. However, there is the risk

that the interview may deviate from the pre-specified research aims and objectives (Gill & Johnson, 2002).

The researcher conducted straight observations for the purpose of this research project. In this technique, the researcher was a visible and detached observer of a situation or issues under observation (Bloch, 2012). Observation entails the systematic noting and recording of events, behaviors, and artifacts in social setting (Chiplunkar et al., 2012). In this research project, issues under observation were mainly the use of infrastructure to conserve water, conservational ways in which people use water in business or domestic settings, the adaptive measures taken by people or the government to conserve water and so on. The researcher made no effort to undertake a particular role within the situation under observation. The researcher undertook straight observation by observing a situation without the observed community knowing or realizing the true purpose. In this research, the researcher remained firmly detached from any role in the observed situation and did not seek to engage the participants or event being observed in any way. In Robbin's term, such role is called marginal observation (Khoo, 2009). According to Gutterer et al. (2009), major advantage of observation as a technique is its directness. This directness provides a degree of validity as it concentrates upon the real situation on the ground. In other words it focuses on what people really do as opposed to what they say they will. Say something and doing it are different things.

Secondary and tertiary sources were used for the purpose of this research project. According to May (1993), secondary source refers material recorded after the event from second parties. The recorder therefore has no personal experience of the event itself. Tertiary source refers will enable the researcher to locate other sources and consists of indexes; bibliography, abstracts etc. in this case the researcher used a range of secondary sources from books, journal articles, government reports and documents, online documents, newspapers etc.

As far as data collection tools were concerned, the conduction of the research involved the use of interview guide questionnaire. Some certain questions were prepared, so as for the researcher to guide the interview towards the satisfaction of research objectives, but additional questions were made encountered during the interviews. Personal computer and internet also form part of the tools, which the researcher used during this project.

3.6. Sample selection

The method of purposive sampling was used to develop the sample of the research under discussion. According to this method, which belongs to the category of non-probability

sampling techniques, sample members are selected on the basis of their knowledge, relationships and expertise regarding a research subject (Freedman *et al*., 2007). In the current study, the sample members who were selected had special relationship with the phenomenon under investigation, sufficient and relevant work experience in the field of water conservation and management, active involvement in several water management initiatives and partnerships, as well as proven research background and understanding of raw data concerning the topic under discussion. Within this context, the participants of this study were executives of 4 (four) organisations operating within the study area. These organisations were selected from both private and public sectors, from which 2 (two) key informants were obtained from each (Senior governmental, non-governmental and parastatal officials).

The advantage of purposive sampling is that it allows the researcher to home in on people or events, which there are good grounds for believing will be critical for research. Instead of going for the typical instances, a cross-section or a balanced choice, the researcher concentrated on instances, which he assumed would display a wide variety-possibly even a focus on extreme cases – to illuminate the research question at hand. In this case it might not only have been economical but might also have been informative in a way that conventional probability sampling could not been (Ross, 2005).

3.7. Research process

Meetings were held from 12 to 19 September 2016 with the executives of the organisations mentioned above, to gain acceptance of their participation in the research. More specifically, the researcher came in touch with and asked them to participate in the research after explaining the nature and the scope of the study. The discussions took place at the offices of the executives and lasted approximately 20 to 25 minutes. During the interviews, the researcher mainly kept notes, which he then used to analyse the gathered data. During the interviews, respondents were free to express their views even in topics which were not included in the discussed areas. Generally, it suffice to note that the conversations flowed smoothly and pleasantly.

3.8. Data analysis

Thematic analysis was used to analyse the data which was gathered from personal interviews. According to Moore & McCabe (2005), this is the type of research whereby data gathered is categorized in themes and sub-themes, so as to be able to be comparable. This has minimally organised and described the data set in detail. Moreover, as frequently it went further than this, and interpreted various aspects of the research topic, hence gave the researcher, the ability to

structure the qualitative data collected in a way that satisfies the accomplishment of research objectives. However, according to Krippendorff & Bock (2008), human error is highly involved in thematic analysis, since there is the risk for researchers to misinterpret the data gathered, thereby generating false and unreliable conclusions.

3.9. Research Limitations

As it is for any research, this dissertation has faced some limitations. The first limitation of this research was to get hold of the key informants/participants in the expected time. All of the participants in this research hold high positions in the organizations/departments they are working in. This implies that most of them are usually busy at the appropriate time the interview meetings need to be conducted. In this regards, some meetings have to be reschedules and this dragged the progress of the research process.

Rendering to caliber of participants required for the research interview, the researcher was restrained from getting a much bigger number of participants, however managed to get a balanced sample of organizations/departments, which were required for the interviews. To counter for this misfit the researcher used some of the organization/departments' documented information for further interrogation of the situation. Some documents were actually recommended by the key informant to supplement and back up what they have given.

In some cases participants may be reluctant to give information which undermines or reflect a bad image on their organizations. However, the diversification of data sources from different organisation, participants and written or published research work tried to counter this effect.

Attributable to the free-form nature of the interview there is, nonetheless, the possibility that specific topics may have been inadvertently omitted. Furthermore, because of flexibility in sequencing and wording, the questions posed to interviewees may have varied, thus reducing the comparability of the responses. On this regard, the researcher or interviewer was conscious to keep the conversation based around specific topics, within a more informal interview style, and not let the conversation take off on wild tangents (ibid).

Though the researcher was well prepared, one of the limitations with this methodology was that the researcher was not an expert interviewer. This can lead to subjectivity in data collection and perhaps influence the results to a certain degree.

Chapter IV: Literature Review – Cities Going Thirst.

4.1. Introduction

The 21st century will go down in history as the first urban century. At the present time, approximately 3% of the earth's land surface is occupied by urban areas (Koester et al., 2010). Dating back from 2008, for the first time ever in the human history, a greater human population lives in cities than in rural area (Chiplunkar *et al.*, 2012). Generating tremendous competition for limited urban resources, population growth in urban areas is categorically putting strain on service delivery in cities throughout the globe. As the grain of human history is changing significantly on several fronts, the time has come for the world to meticulously read, understand and absorb the new perspective on several major global challenges (ibid).

Urban settlements in recent days come across several constraints in the delivery of services such as provision of power, water, sewage and waste management. Water remains a global challenge hitherto it being undoubtedly the lifeblood of the biosphere (Makwara and Tavuyanago, 2012). Access to this fugitive, finite, vital and yet vulnerable resource in its safe form is limited. With urban population burgeons at approximately 5% per year (Frühling, 1996) , the amount of water used by society escalates and consequently 'the thirst grows'. (Makwara and Tavuyanago, 2012).

Recently, droughts, water shortages and the threats generated by climate change have put water management directly at the top of the public agenda (Smith and Cartin, 2011). Water conservation is a prominent issue challenging communities throughout cities. Local governments are grappling with the design and development of water conservation plans and strategies that will permit continued economic development and social welfare in the face of limited and in some cases dwindling water resources (Alcamo *et al.*, 2008). It will take a resolute effort on the part of decision-makers across sectors and institutions in finding ways to provide sustainable water and sanitation services to city inhabitants (Jacobsen *et al*., 2012).

The United Nations proposed the Millennium Development Goals (MDGs), which are numerical time-bound goals for reducing human suffering. The MDGs, among others, involve various factors related to urban water management and one of their goals being to halve the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015 (Lai *et al.*, 2008). The provision of safe drinking water and basic sanitation also contributes to sustainable improvements in people's lives regarding their health, education and

economic situation, eradication of extreme hunger and the empowerment of women (UNICEF, 2010). To achieve the MDGs, it was agreed in Johannesburg in 2002 that countries should seek to develop Water Resources Plans. These plans involve developing the management of water resources in the countries (Parkinson *et al.*, 2010).

There is a need to cope with major global trends, which potentially unfold huge impact on urban areas, as there is an unavoidable need to handle a rising urban water crisis, to mitigate the negative impacts of climate change and adapt to changing climatic conditions. The pressure to rethink, reiterate and modify the standards and principles for urban development, concerning water security, is mainly generated by the global trends. To come closer to the vision of a water secure city and sustainable urban development, new approaches and starting points are urgently needed (Koester *et al.*, 2010). Therefore, this chapter is going to look at the general situation of the water security around the world, then do a thorough review of case studies from both a developed country - Singapore and a developing country – Namibia; both are regarded as success stories with regards to water security in urban areas. An Overview of South Africa's water security situation shall be looked at, as well as its water management system, National Water resource strategy and the Integrated Development Planning. Durban city's water situation, as a case study area, is going to be under microscope and finally.

4.2. General outlook of water security.

Today, there is a growing global water insecurity. Globally, the essence of water security is that, concern for water itself is combined with concern that services which exploit it for human survival and well-being, and for economic purposes, should be developed and managed in an equitable, efficient and integrated manner (Beddington, 2009). Most of the world's developing countries (i.e. South African, Namibia, Zimbabwe, etc.) remain relatively water insecure. Most developed (i.e. Singapore, UK, USA, etc.) countries invested heavily in water security, often starting early on their path to growth. These developed nations are now relatively water secure, but must continuously adapt and invest to maintain water security in the face of climate change, deteriorating infrastructure, economic development, demographic change, and rising environmental quality expectations. While demand for economic growth reaches boiling points and climate change intensify in both developing and developed nations, the priority and complexity of water security is likely to increase.

Population and economic growth are contradicting against a finite and increasingly water resource, and this is particularly evident in urban areas. In the year 2030, the urban population

is expected to reach 60%, while the current state of investments in public infrastructure is way below the required standards in both developing and developed countries (Guthrie, 2010). In developing world, population growth in megacities will continue to grow with an estimated increase of 60% - 70 % (ibid). Thus mounting pressure on water supplies in most of the developing countries. Although the extent and nature of this stress varies from country to country, city to city, many parts of the world will need to manage their water resources much more effectively to sustain their growth, and in some cases, prevent a major regression in water-derived welfare (World_Bank, 2015).

Issues associated with ageing and poorly functioning water infrastructure is a challenge for agricultural and urban water supply (UN, 2009). In urban areas water supply and sanitation networks are often insufficient and subject to failure (Molle and Berkoff, 2007) (with associated high levels of leakage) a problem which is compounded by uncontrolled expansion of urban areas (Unesco, 2003).

In trying to improve water security in urban areas around the world, technology and innovation play a role in developing new sources of water for different uses. The new sources of water include from desalination, recycling and reuse, and pricing among other initiatives. The Middle East and North Africa comprise almost half of the world's desalting capacity for municipal water supplies (Krishna, 2004).

The advantages of desalination are that it taps into a large resource of water (the oceans), increases supply rather than constraining demand, and can be widely implemented (Krishna, 2004). Desalination plants have been proposed not just in developed countries, but also in developing countries. The main disadvantage of desalination is the cost and concerns over energy security, putting it at the mercy of fluctuating energy prices (Schaefer, 2001).

Water has traditionally been regarded as a free resource. Any costs for water are usually associated with the cost of processing and delivering alone, rather than assigning any value to the resource (Unesco, 2003). Free or highly undervalued water gives limited incentive for water efficiency. There is growing interest internationally in the use of water pricing to reduce demand as well as to generate revenue to cover the cost of providing water supplies and maintaining infrastructure (Guthrie, 2010). The effectiveness of pricing in influencing demand varies between water users. For municipal water demand, pricing can be effective when combined with raising user awareness (ibid).

Water recycling, reuse and harvesting are also being considered around the globe in pursuit of securing urban water. Recycling water is the process of removing solids and certain impurities from wastewater and using it again rather than discharging into surface water or the ocean (Asano and Levine, 1996). The reuse and recycling of water in industrial and domestic settings has the potential significantly to reduce the consumption of water in these environments. Harvested rainwater and recycled water can be used for activities such as toilet flushing, reducing overall domestic water consumption (Guthrie, 2010).

Currently, recycled water is used for purposes such as irrigation, dust control, and fighting fires. There is skepticism around the health and environmental impacts of these uses; consumption of recycled water is still unwelcomed in many communities (Adewumi *et al.*, 2010). In some locations however, such as Singapore and Namibia, wastewater is given superior treatment and is used indirectly to supplement water sources that will eventually be used to supply potable water (Guthrine, 2010).

There can be no doubt that cities of the world can learn from each other, particularly from those that have assumes to have mastered the skills and plans to deal with the problems in regards to urban water security (Chiplunkar *et al*., 2012), be it in the context of developed or developing countries' cities. Since Asia is home to more than half of the world's population and is producing the biggest surge in urban populations, what Asia does in meeting this major global challenge of water should be of global interest. Particularly, the Singapore water miracle is a story that the world needs to understand better in order to gain significant new insights into urban water management. In the context of developing countries, Namibia's capital city, Windhoek is a case of interest concerning urban water management. In this instance, Singapore and Windhoek case are going to be analysed in details below.

4.3. Singapore

4.3.1. Background

Figure 4.1. Map of Singapore and its position on the world map. Source: (Google images)

Figure 4.1 above shows the map of Singapore and is geographical relation to the world map. Singapore is a city- island state with an area of 718 km square kilometers and an estimate of 5.5 million inhabitants (Connor, 2015), with an approximate water consumption per capita of 1531*l*/person/day and a total water consumption of 380Mgal/day in 2011 (Tortajada et al., 2013). Geographically, Singapore is located in the tropics where it receives abundant rainfall of about 2,400 mm annually, with rainy days accounting for about 50% of a calendar year (Chiplunkar *et al.*, 2012). However, because of the limited land for the collection and storage of rainwater (to collect and store rain water for domestic and industrial needs), the high evaporation rate and the lack of groundwater resources over high population density, Singapore is considered water scarce (Khoo, 2009).

After it attained independence in 1965, Singapore faced enormous challenge of water scarcity and vulnerability as its population grew rapidly (Frauendorfer and Liemberger, 2010). In counteract, the country implemented an integrated, innovative approach to water management, which, together with meticulous planning and diligence over above four decades, enabled it to implement sustainable, innovative, and cost effective water management solutions (Tan *et al*., 2009). Singapore has taken its water challenge as an opportunity to move from water scarcity to water sufficiency by 2061 through forward thinking and comprehensive planning (Gordon, 2014). The island state was once heavily reliant on water imported from neighbouring Malaysia under long-term agreements signed in 1961 and 1962, which expired in August 2011 and the current agreement will expire in 2061 (Connor, 2015). On contrary, the country has transformed to become an innovator and a model for successful water management. It has been able to deliver one of the best urban water records in the world with access to water and sanitation reaching the entire population in less than fifty years (Tortajada *et al*., 2013).

Representation based on integrated water resource management principles depicts that a range of factors are fundamental to Singapore's success. This among others comprises integrating water into development planning, building supportive institutional structures with the mandate to control, regulate and learn adaptability and managing both supply and demand (Xie, 2006). It has successfully diversified its water supply through expanding and building reservoirs, importing water, desalination and water reuse (Gordon, 2014). This has been combined with managing water demand through pricing, enforced water conservation measures and widespread public campaigning (Xie, 2006). The focus on a comprehensive, integrated water management approach provides a useful model for other urban areas around the globe to build systems based on their strengths and within their environmental constraints.

4.3.2. Factors behind Singapore's success story

Singapore's successful urban water management is based on the principals of Integrated Water Resource Management. According to Global Water Partnership's definition, cited in Rees (1998), Integrated Water Resource Management "a process, which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems". Integrated Water Resource Management involves the integration of various factors including development and water planning, water quality and quantity, different types of uses, demand and supply management and across time and governance scales (Biswas, 2004). Singapore made conscious effort to conform to the

principals of Integrated Water Resource management (Chen *et al*., 2011), and some of the features are as follows:

4.3.2.1. Integrated Land Use Planning

Integrating land use planning with water resource management is an important feature of Singapore's water management. Urban Redevelopment Authority (URA) plays an important role in urban development in Singapore (Yassin *et al*., 2009). Furthermore, the Singapore Land Authority Act (Cap.301) (2002) provides an inclusive legal base for land management and water resources issue which stipulates that land use planning must be conducted for the allocation and disposal of State land to any person or public authority, and for technical cooperation and exchange in the area of land survey and land resource administration and management with other persons and organizations. Moreover, cross-sectoral coordination from various departments namely Housing and Development Board (HDB), National Environmental Agency (NEA), Jurong Town Corporation (JTC) and Land Transport Authority (LTA) contributing to the successful of waterfront development and management in this island, although the Public Utility Board (PUB) takes overall responsibilities. (Xie, 2006).

Chen *et al*. (2011) states that some notable features of implemented sectoral coordinated planning and various measures includes: (a) judicious planning of land use to exclude polluting activities, principally industrial, from the storm water catchments; (b) redesign of HDB refuse bin collection centers and refuse chutes to minimize spillage; (c) strict enforcement of anti-pollution laws and regulations; and (d) incorporation of the main components of the collection system such as diversion structures and holding ponds into the main drainage network. Compliance with drainage requirements is necessary before planning approval is granted by URA (Xie, 2006).

4.3.2.2. Closing the Water loop and Supportive Institutions

The Public Utility Board (PUB) facilitates a comprehensive policymaking and implementation platform. This includes protecting and expanding water sources, storm water management, desalination, demand management, community programs, catchment management and managing the outsourcing to the private sector. It is also factually closing the water loop in the sense that PUB can reach its goal to capture every drop of rain, used water, and recycle all water more than once (PUB, 2012), to guarantee that no usable water is lost as illustrated in the diagram below. Water is being used, reused and retained within the system after being treated as shown in the diagram on figure 4.2 below.

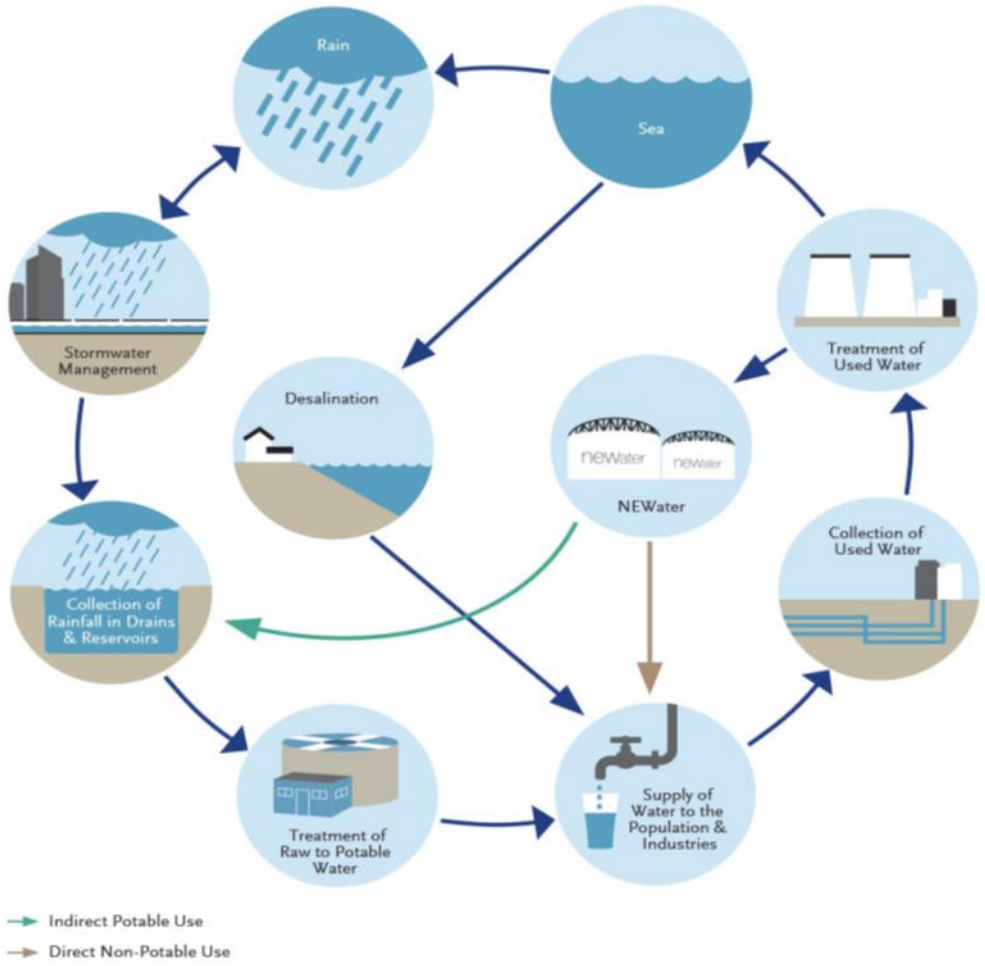

Figure 4.2. The water loop. Source: (NCCS, 2012)National Climate Change Secretariat (2012). (Source: http://app.nccs.gov.sg/nccs-2012/preparingsingapore-areas-of-work-in-progress.html)

The Water Master Plan adopted in 1972, outlined plans for a diversified water supply, including recycled and desalinated water, to meet future needs. PUB accordingly established a water recycling pilot plant in 1974, which was successful in showing that high quality drinking water could be produced by treating wastewater (Tan *et al*., 2009). It was demonstrated that because of its purity, recycled water, now being called NEWater would allow cost savings in manufacturing processes (such as wafer fabrication in the semi-conductor industry) by eliminating the need for pre-filtration of tap water. This convinced industrial water users to choose NEWater for their ultra-clean water requirement (PUB, 2014). NEWater is primarily

intended for industrial users with high standards required for their feed-water. Using it for this purpose frees up considerable amounts of potable water for domestic consumption and enhances Singapore's resilience against periods of low rainfall and drought. As of 2014, NEWater can meet up to 30% of Singapore's total water demand. The plan is to triple NEWater capacity to meet 55% of water demand by 2060. Furthermore, the process to produce NEWater is significantly more energy efficient than desalination (approximately 1 kWh per cubic meters versus 3.5 kWh per cubic meter) (Num, n.d.). By 2005 the first desalination plant was commissions to use reverse osmosis (RO) technology and with a capacity 136,380 cubic meters per day (30 mgd). This seawater plant was one of the first and largest of such facilities in the region.

4.3.2.3. Adaptability

Pahl-Wostl (2008), attested that adaptability is a cornerstone to the success of integrated water resource management. Singapore is unique in that it has altered its policies and institutions to be able to respond the challenges as Singapore transitioned from a developing to a developed country. In its 1972 water plan, Singapore considered advanced technology which was not feasible at that time because they were too expensive and inefficient (PUB, 2012). PUB however resumed these ideas as the technologies improved and continued to monitor performance of these systems and to financially support research and development to inform future water technologies (Gordon, 2014).

4.3.2.4. Managing supply and demand

Many countries approach the water supply issues by means of managing supply alone (Gordon, 2014). The key to Singapore's success in urban water management is demand and supply management (Tortajada, 2006). Singapore has worked diligently to improve its water quality as well as its quantity over a long period, while also increasing its available water sources. Demand management plays a central role through promoting water conservation, which is through pricing mechanisms, public education and community mobilization (Gordon, 2014). Singapore has the highest water tariff in the region (Araral and Wang, 2013). Water pricing mechanism consists of the water tariff, water conservation tax and waterborne fee and sanitary appliance fee with different fee structures for households and non-domestic users (Khoo, 2009).

Other initiatives to promote water conservation include mandatory water efficiency taps and toilets. Water conservation initiatives have been supported through water saving campaigns.

This has included encouraging people to reduce their water use by 10 liters a day, water conservation week, learning centers for students and public engagement (Araral and Wang, 2013). The campaigns had been considered one of the best in the world for its public communication and education (PUB, 2013). Public engagement has been considerably successful due to a decline in daily per capita domestic water consumption from 165 liters in 2003 to 156 liters in 2008 (MNISI, 2011). PUB plans to continue its water conservation focus and aims to decrease domestic water consumption to 140 liters per person per day by 2030 (ibid).

4.3.3. Challenges

Despite the fact that Singapore has managed to flaunt as a success story, about water conservation, it is uncertain whether its pace can continue and accelerate to address rising energy prices, climate risks and changing demographics and needs.

4.3.3.1. Energy

Rygaard *et al*. (2011), argues that energy is one of the main challenges of water self-sufficiency around the globe. Singapore is not exceptional to the energy challenges. It needs a substantial amount of energy to pump water, treat raw water and sewage effluent to produce NEWater and desalination. In particular, desalination and NEWater are heavily reliant on energy owing to their high pressures requirement in forcing water through membranes and to remove salt. NEWater (recycled water) consumes approximately 1 kWh per cubic meter whereas desalination takes 3.5 kWh per cubic meter (Num, n.d.). The price and availability of energy is a key cost for these water systems and global energy costs are expected to continue to rise. This leaves Singapore with a significant trade off because as it becomes more water independent, it becomes more dependent on imported energy.

4.3.3.2. Climate Change

The Singapore's government research indicates that, climate change might challenge water management system (Gordon, 2014). There is concern that droughts could affect the reliability of Singapore's water supply and that intense rainfall could lead to flash flooding. There has been increased evidence that climate change will require more flexible water management systems (Huntjens *et al*., 2012). Given the extensive hard infrastructure, it is likely that there will have to be changes to address emerging risks. At the same time, some technical aspects are being addressed, for example, NEWater and desalination are not rainfall dependent and could fill reservoirs when rainfall is low.

4.3.3.3. Urbanization, Population Growth and Increased Demand

Singapore has gone through dramatic development changes as the population has grown from 1.8 million in 1965 to 5.5 million people currently and per capital GDP has exploded from $1,580 in 1965 to $63,050 in 2011 (Tortajada *et al*., 2013). Water consumption continues to increase Water managers expect that in 2060, water needs will double from 2011 to 3,460,00 m3/day (PUB, 2013). The population is expected to reach around 6 million by 2020 and between 6.5 and 6.9 million by 2030 (Gordon, 2014). This will bring enormous challenges for water systems to address increasing demands that follow increasing population and economic growth.

Concisely, Singapore is on its way toward becoming water sufficient by 2061. Singapore has become an innovator and model in urban water management. This success is due to a range of factors including integrating water into development planning, building supportive institutional structures with the mandate to control, regulate and learn adaptability and managing both supply and demand. It has successfully diversified its water supply through expanding and building reservoirs, importing water, desalination and water reuse. This has been combined with managing water demand through pricing, enforced water conservation measures and widespread public campaigning. As the world shifts to become more urbanized, the lessons from Singapore have large implications in moving toward a more sustainable approach to water management.

4.4. Windhoek, Namibia

4.4.1. Background

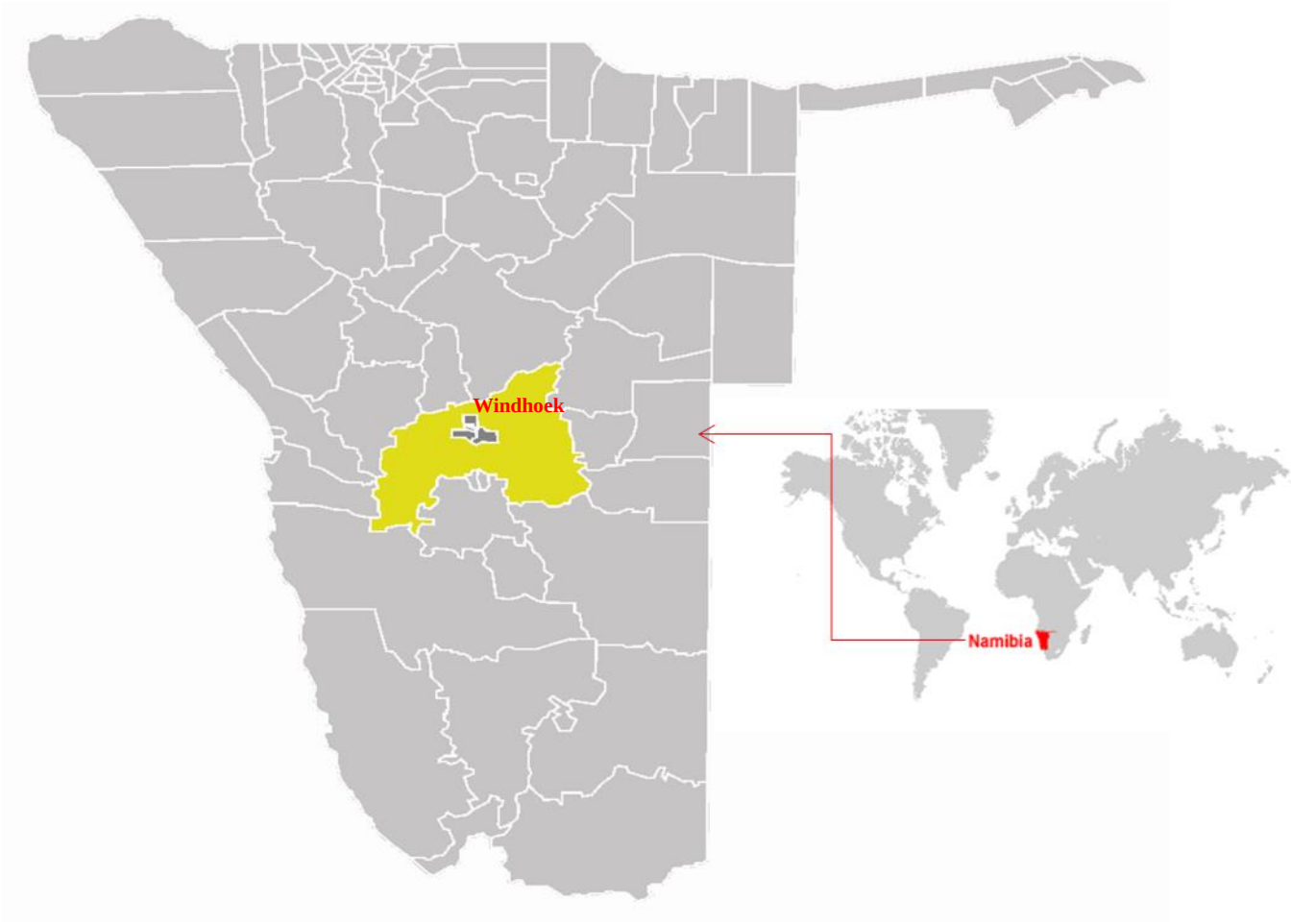

Figure 4.3. Map showing the orientation of Windhoek in Namibia as well as orientation of Namibia on the world map. Source (Google images).

Figure 4.3 above shows the map of Namibia and the location of the city of Windhoek within it. Namibia is one of the most arid countries in the world and Southern Africa's most arid country (Biggs and Williams, 2001), flanked by the Namib Desert in the west and Kalahari Desert in the east. More than 80% of the country consists of desert or semi-desert. Windhoek, the capital, is located in the Central Highlands with an altitude of about 1,540m. According to the Department of Water Affairs, cited in Lahnsteiner and Lempert (2007), the annual rainfall in Windhoek is approximately 370 mm/a, while the potential surface evaporation rate is in the range of 3,200–3,400 mm/a. Boucher *et al*. (2011) also states that 83 % annual rainfall water evaporates instantly after precipitation. An additional 14 % is taken by vegetation, and 1 % feeds the ground water in the region, hence leaving merely 2 % for surface use. To worsen

Windhoek's water situation, the distance from the city to the closest perennial river, the Okavango River, is 750 km and roughly 300 km to the Pacific Ocean (Menge et al., 2009). The population of Windhoek is at least 281,300 (Boucher *et al.*, 2011) with an estimated growth rate of 5% per year (natural population growth 1.5%, migration from rural areas 3.5%) (Van der Merwe, 2000). Economically, politically, culturally and socially it is the most important city in Namibia. The country's parliament is located there and it is the capital for trade, industry, commerce, culture and education (Biggs and Williams, 2001).

The Windhoek's water supply is based on the use of surface and groundwater. All potable water resources within a radius of 500 km have been fully exploited. The rainfall is uncertain and long spells of severe droughts are frequently encountered. Accordingly, it is uncertain to rely on the central Namibian reservoirs and wells for water supplies in the near future (Lahnsteiner and Lempert, 2007). Forced by this prediction, the city council of Windhoek approved an integrated water demand management programme in 1994 that included policy matters, legislation, education, technical and financial measures (Van der Merwe, 1994).

At the beginning of the 1980s, average water consumption was 600-700litres/person/day (l/p/d) in the affluent areas of Windhoek. IWRM was introduced in the early 1990s as a concerted effort to both reduce the level of consumption and increase the safe yield of Windhoek's water resources to meet increased demand. Considerable progress has been made to date, the current average water consumption having reduced to 180l/p/d, although this is still above average for African cities.

4.4.2. Integrated Water Resource Management (IWRM)

Integrated water resource management is crucial in meeting and managing the increasing water demand in Namibia. Studies have shown that both water demand management measures and non-conventional water supply reinforcement schemes are considerably cheaper than developing more traditional pipeline schemes in Namibia. The city of Windhoek (municipality) together with NamWater and the Department of Water Affairs in the Government (Bulk water suppliers), adopted to integrate traditional supply systems, Water Demand Management and non-conventional supply initiatives to manage and meet the city's demand. The case study gives an index of what is achievable and what are and practically feasible interventions. Lessons from Windhoek can be learnt in some areas throughout Namibia and abroad.

4.4.2.1. Water Demand Management (WDM)

As illustrated in the diagram below, the total annual water consumption for the city is approximately 21 million cubic meters per year; 26% is from the water reclamation plant (NGWRP), 66% is from dam water and 8% is from ground water. This breaks down to 60,000 cubic meters per day, however owing to the uncertainty of rainfall, and the reality of long, severe droughts, daily demand can range from 60,000 to 100,000 cubic meters per day (Flod and Landquist, 2010). There are three main sources of water as illustrated by the diagram below viz. surface water (66%), ground water (8%) and reclaimed water (26%). From the 21 million cubic meters per year; Non-Revenue Water (NRW) – water uncountable for, amounts to 10%, 45% of the water goes to domestic wastewater, 38% goes to consumptive use and 7% is absorbed by industrial wastewater. The industrial wastewater will therefore go through sewage treatment and end up being used for irrigation of plants. Like industrial wastewater, domestic wastewater also go through sewage treatment, however a bigger proportion of this water is reclaimed back into the system to form the 26% of the 21 million cubic meter per year to the consumers, a 6% of it is used for irrigation of parks, golf courses, sports fields and cemeteries, and the other proportion is discharged into the river system. Figure 4.4 below shows an illustrative diagram for the water sources and water supply to Windhoek.

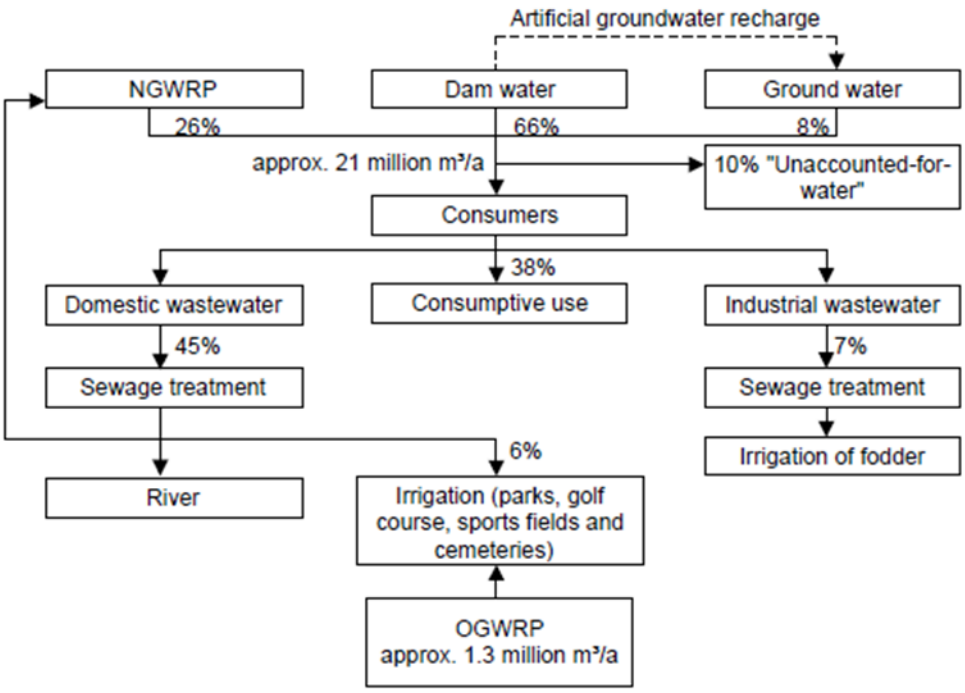

Figure 4.4. Water sources and water supply to Windhoek. Source: Flod and Landquist (2010)

In years of average to good rainfall, surface water runoff from the catchment areas will be sufficient to satisfy the potable water demand for Windhoek. In the course of successive years of drought 4 million cubic meters potable water could be abstracted from the municipal boreholes over a period of four consecutive years. New Goreangab Water Reclamation Plant (NGWRP) supplies almost a quarter of the total water demand. Water from the Old Goreangab Water Reclamation Plant (OGWRP) is not suitable for human consumption and they used it mainly to irrigate sport fields and golf course. Industrial wastewater primarily discharged from a small food and beverage industry is treated and reused for irrigation of pastures. Borehole water, especially after a drought, needs to be artificially improved and one of the proposals is to recharge the groundwater aquifer. Treated surface water will be injected into the boreholes. Facilities to recharge groundwater have already been installed around the city and will be used in times of good rains and low water demand. Underground, as opposed to surface water storage, will be very beneficial as the evaporation of millions of cubic metres from the surface reservoirs can be avoided resulting in higher water availability. Furthermore, the recovery period of an aquifer is substantially shortened by artificial recharge and this provides a higher security of water supply. This is especially important after severe droughts when too much water has to be abstracted from the aquifer.

The major policies related to the integrated water demand management programme emphasise maximum wastewater reuse and saving of water. Windhoek city introduced measures through municipal bylaws for water saving and they are rigorously enforced during periods dry spells as shown in table 4.1 below.

Table 4.1. Requirements of the water supply regulations and method of implementation. Source: Flod and Landquist (2010)

Regulation requirement	Method of implementation
Prevention of undue water consumption on private properties	Wastage of water on a private property can be addressed immediately. Windhoek is the only city in Southern Africa with a water control officer
Water efficient equipment	As from 16 December 1996, the following is compulsory in new developments in the city: Metering taps must be used in hostels. Taps outside non-residential buildings must be self-closing or lockable. Only low flow showers are allowed. Toilet cisterns must be 6/3 L dual flush units. Automatic flushing devices without activation by the user are prohibited. Retrofitting of existing inefficient water devices is compulsory within 3 years.
Groundwater	Groundwater abstraction from private boreholes and groundwater levels is controlled.
Gardens	Watering may not be done during high evaporation times, i.e. between the hours of 10:00 and 16:00.
Swimming pools	Swimming pools must be covered when not in use.
Prevention of water pollution	Regular testing of groundwater fuel tanks is mandatory. All tanks were registered.

Consumption-related, progressive water pricing also played an important role towards achieving ambitiously set water-saving targets. Per capita consumption has already been reduced to a minimum by technical improvements and exemplary public relation activities. Technical measures implemented are mainly with regard to leakage control (lowering of "unaccounted-for-water") and proper watering of gardens. In order to reduce water losses both leakage detection and water audits are being done on a continuous basis. Additionally, repairs as well as systematic pipe replacement programmes have been implemented and a proper management of water meters is done. Due to these measures, water losses in Windhoek are only 10%, which represents the lowest comparable value in Southern Africa. Even for cities in highly developed regions such as Western Europe, this represents a very low figure.

(i) Public awareness of water saving and acceptance of direct potable reuse

To increase both the level of awareness of water savings and the acceptance of direct potable reuse, the city of Windhoek has arranged adequate education programmes in schools, radio and television, as well as in the printed media. Evaluation of these programmes showed that the biggest benefit would be accomplished if water awareness forms part of the normal curriculum in schools. Reclaiming drinking water from municipal secondary effluent is not generally

acceptable to the public and psychological barriers have to be broken down first. However, with persistent and good marketing this perception can be changed.

4.4.2.2. Water supply management

The infrastructure that supplies the city of Windhoek with water consists of a number of different facilities owned and operated by NamWater and the City of Windhoek. NamWater is the major bulk water supplier in Namibia and is a parastatal company with the Namibian government as its only stakeholder (Flod and Landquist, 2010). The amount of water supplied per day ranges from 60,000 to 100,000 cubic metres depending on the season (Theron, 2010). There are three sources supplying Windhoek with water, which are groundwater, surface water and reclaimed water (Menge *et al*., 2009).

(a) The groundwater source

The groundwater is abstracted from the Windhoek aquifer by 60 production boreholes. The water from the boreholes is not treated separately and is only chlorinated before it is placed in the storage reservoir (Menge *et al.,* 2009). The total amount water generated from the boreholes per year ranges between 0.5 and 5.5 million cubic metres (Christelis, 2010).

(b) The surface water source

Surface water source for drinking in Windhoek comes from three dams that are feed by ephemeral rivers. The dams are the Von Bach Dam, the Swakoppoort Dam and the Omatako Dam (Menge et al., 2009). The total quantity of water produced from the three dams per year is approximately 20 million cubic meters but 15 million cubic meters will be available for use (Christelis, 2010). The surface water is treated by NamWater, before it reaches the water distribution system and the consumers (Flod and Landquist, 2010).

(c) The reclaimed water source

The Goreangab water reclamation plant treats domestic wastewater (Menge et al., 2009). The Goreangab water reclamation plant is owned by the City of Windhoek, but operated by Windhoek Goreangab Operating Company (WINGOC) with the shareholders Berlinwasser International, WABAG/ VATECH and Veolia Water (NGWRP, 2010).

The experience of Windhoek stipulates that careful water management is required to meet the water supply and demand of the city. With proper process design and quality management, water meeting stringent standards can be produced by reclamation and direct potable reuse can be practised. The public will accept such schemes if properly informed, despite initial health

and aesthetic concerns. The Windhoek Water Management policy is exemplary and should be considered as a model for other arid regions and cities facing water crisis or water scarcity threats.

4.5. Lessons learned and drawn from Singapore and Windhoek, Namibia

The high rate of urbanisation in developing countries exerts an enormous pressure on the natural availability and the sustainable provision of this service. This is especially true for African cities where authorities struggle to cope with this and other problems associated with high rates of urbanisation. The provision and delivery of potable water is made even more difficult by the deteriorating quality and quantity of the resource. Many African cities are losing huge amounts of treated water due to leakages, wastage and illegal connections, which in turn results in a significant loss in revenue. African cities therefore find themselves in a predicament as far as water provision is concerned and the effective management of the resource is highly relevant in most of these cities. What complicates the task of managing water supplies is the fact that most of the fastest growing urban areas in Africa are situated in water stressed or water scarce areas.

Windhoek as one of such African cities, which does not have the luxury of permanent fresh water bodies in close proximity of the city. This is the most important reason why water authorities in Windhoek have gone to such extremes to provide water for its residents. As is the case in many African cities, water authorities are not only occupied with finding alternatives to boost supplies, but are also faced with the challenge to meet a rapidly increasing demand. By using the concept of integrated water resource management, the City of Windhoek is doing an excellent job attending to this problem.

The City Council of Windhoek recognizes the vulnerability and scarcity of the resource and is constantly occupied with planning and management strategies to ensure the sustainable use of the resource. The strategies used by the city renders it unique in terms of water supply to its residents. Windhoek is the only city in the world that use reclaimed water for domestic use and has gone to great lengths to implement Water Demand Management principles in order to cope with the limited supply. The city of Windhoek still has a lot to learn with vast scope for improvement, but at the same time presents a noteworthy solution in many respects for other cities finding themselves in a similar predicament.

Singapore has become an innovator and model in urban water management. This success is due to a range of factors including integrating water into development planning, building

supportive institutional structures with the mandate to control, regulate and learn, adaptability and managing both supply and demand. It has successfully diversified its water supply through expanding and building reservoirs, importing water, desalination and water reuse. This has been combined with managing water demand through pricing, enforced water conservation measures and widespread public campaigning. The focus on a comprehensive, integrated water management approach has provided the active test bed for new ideas and the ability to implement them effectively.

While part of Singapore's ability to implement effective water policy is due to its unique governance structure as a city-state. There are various institutional, technical and innovative factors, which are applicable to other urban areas. It is essential for cities to manage their water as a finite resource that is integral to their overall development planning. As the world shifts to become more urbanized, the lessons from Singapore have large implications is moving toward a more sustainable approach to water management.

4.5. South African

4.5.1. Overview of South Africa's water status

South Africa is a water-scarce country with extreme climate and rainfall fluctuations. It has an average annual rainfall of 500mm, (NCDC and NOAA, 2012, Hedden and Cilliers, 2014), whereas the world average is 1 033 mm, making it the 30th driest country in the world. Only a narrow region along the southeastern coastline receives good rainfall, while the greater part of the interior and western part of the country is arid or semi-arid. Evaporation losses are often three times more than rainfall. Furthermore, the meagre rainfall is unevenly distributed, with some regions receiving less than 200mm per year (Mukheibir and Sparks, 2003). The National Development Plan 2030 clearly states that food, fuel and water are interconnected, particularly in the context of climate change and their impact on one another. Low and unpredictable supply, coupled with high (and growing) demand and poor use of existing water resources, make South Africa a water-constrained country. South Africa is currently ranked the 30th driest country in the world (DWA, 2013a). Figure 4.5 below shows the map of South Africa in relation to the map of Africa.

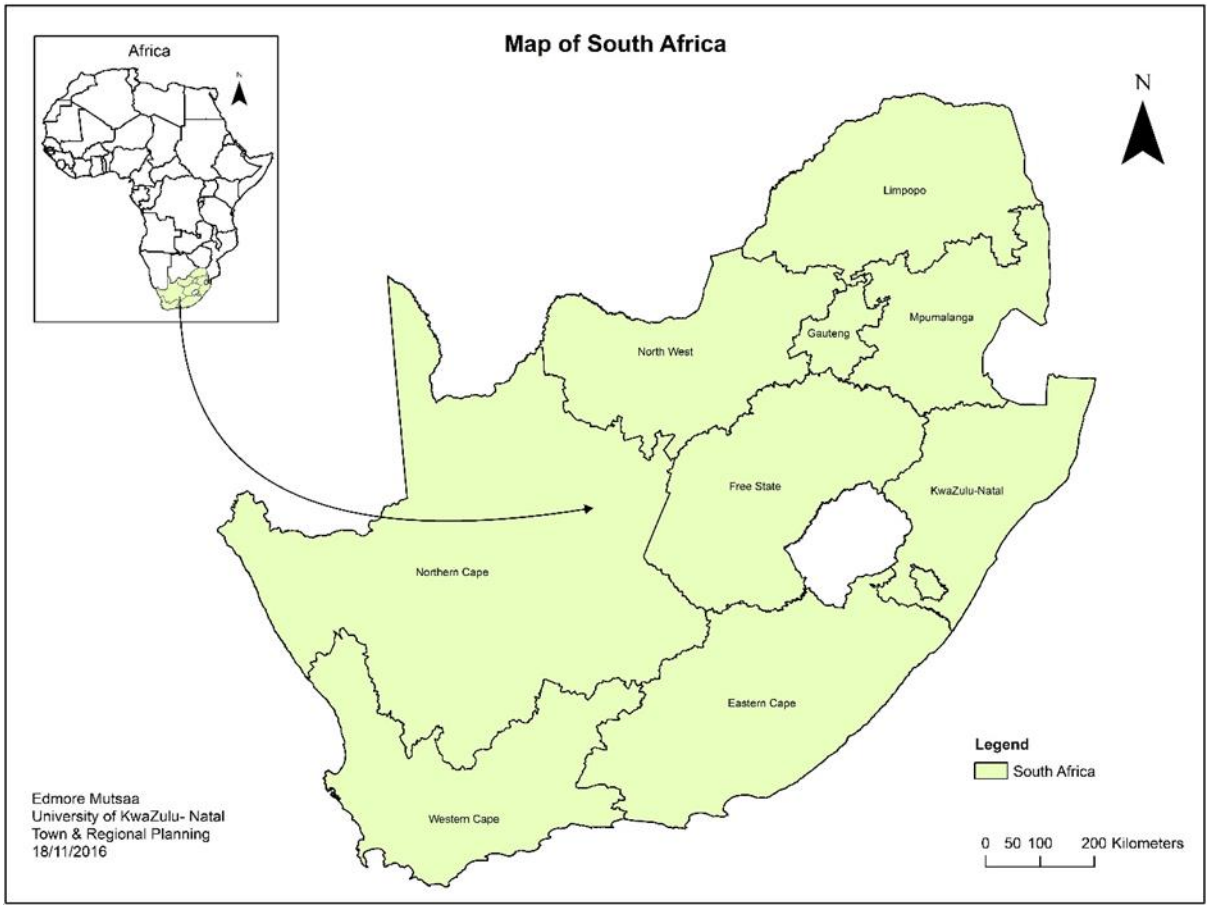

Figure 4.5. Map of South Africa. Source: (Author, 2016).

South Africa is over-exploiting its freshwater resources and water could be a large constraint on the implementation of the National Development Plan. During a media briefing, the former minister of Water and Environmental Affairs, Edna Molewa, was succinct in her summary: 'The situation currently in South Africa is that we have 98% of the water in the country being considered "fully allocated". This means that the future generation has 2% of water for use going into the future (Hedden and Cilliers, 2014).

According to experts, South Africa's two major river systems; the Vaal and the Umgeni are already in deficit. These two river systems supply water to regions that generate two-thirds of the country's gross national product. They collectively drain two thirds of the land area. It is estimated that, based on current usage trends, water demand will exceed availability of economically usable fresh water resources by 2025. The continuing trend in industrialization and urbanization of the population is expected to place further pressure on the country's sources of water supply unless appropriate corrective action is taken.

4.5.2. Water Management in South Africa

South Africa is over exploiting its water sources, meaning the country uses more water than is reliably available from both surface and groundwater sources. While water quality is not monitored as systematically as its quantity, the deterioration in water quality is a significant indicator of the degree of stress being placed on South Africa's water resources. It should be noted that having water that is too polluted to use is nearly as bad as having no water at all. A number of approaches to reconciliation are subsequently discussed.

The prime objective of Water Resource Management (WRM) is to reconcile the supply of water of satisfactory quality and demand. In the past, this inevitably meant increasing supply by developing new infrastructure. As the water resource is increasingly utilised, more attention needs to be given to the other side of the equation and demand needs to be managed.

4.5.2.1. Supply management

Mayer et al. (2011) States that, there are numerous ways to increase water supply, as indicated below.

Storage: Storage can be increased by building new dams to store water from the rainy season for use during the dry season, and to use water from wet years in dry years. There is a limit to this approach, however, as it is only useful to build dams if there is likely to be sufficient rainfall to fill them. South Africa's storage capacity is already relatively well developed, with a dam capacity of over 32 billion m^3. This is equivalent to about two-thirds of the average annual flow in all its rivers.

Water transfer: Water transfer, both within river basins and from other river basins, is another possibility as local supplies become fully developed. This is already being done extensively in South Africa. The best-known example is the Vaal River, which is supplemented with water brought from the Orange River via the Lesotho Highlands Water Scheme. Regions such as Gauteng, the Nelson Mandela Metropole in the Eastern Cape and significant parts of the North West and Limpopo provinces depend on such transfers.

Desalination and reuse of wastewater: These are further supply options. South Africa's coastal population is unlikely ever to face total water shortage, as desalination will increasingly become an affordable alternative for high-value uses. Inland, the recycling of polluted wastewater is already being practiced extensively. Desalination of water in the Vaal River from the mines is becoming increasingly attractive as a solution to water quality problems, as

substantial volumes of "clean" water are currently used to keep salinity levels down. Transfer of reused water to other catchments also helps to reduce salinity loads on the Vaal River.

Natural environments are a final source of additional water. In terms of legislation, enough water must be left in rivers to sustain an acceptable natural environment, prior to any allocation for economic purposes. While there are sound policy reasons for protecting the environment as an objective in itself, the maintenance of "environmental flows" is also important with a view to safeguarding environmental attractions, such as the country's national parks and other sources of livelihoods. Nonetheless, environmental flows (and the levels of their protection) are socially and administratively determined. In periods of shortage, water reserved for the environment might be taken illegally for economic or social uses unless there is strict management oversight at the local level, supported by national priorities.

When these supply options are taken into account, the situation is not as serious as it appears at first. Although a number of WMAs depend on transfers to meet their needs, in only three (Limpopo, Olifants and Komati) will the volume of water required up to 2025 not be met by developing additional storage infrastructure. Table 4.2 below shows the water requirements reconciliation and availability for 2025.

Table. 4.2. Reconciliation of water requirements and availability for 2025, base scenario (million m^3 p.a.) Source: (Mayer et al., 2011)

Water management area		Local yield	Transfers in	Local requirements	Transfers out	Balance	Potential for development
1	Limpopo	281	18	347	0	(48)	8
2	Luvuvhu/Letaba	403	0	349	13	41	102
3	Crocodile West and Marico	805	901	1 594	10	102	0
4	Olifants	630	210	1 075	8	(243)	239
5	Inkomati	1 073	0	1 088	148	(163)	114
6	Usutu to Mhlathuze	1 011	32	700	114	229	110
7	Thukela	742	0	347	497	(102)	598
8	Upper Vaal	1 818	1 743	1 440	2 042	79	50
9	Middle Vaal	205	775	400	580	0	0
10	Lower Vaal	48	648	645	0	51	0
11	Mvoti to Umzimkulu	555	34	1 012	0	(423)	1 018
12	Mzimvubu to Keiskamma	872	0	413	0	459	1500
13	Upper Orange	4 799	2	1 022	3 496	283	900
14	Lower Orange	(1 001)	1 931	883	54	(7)	150
15	Fish to Tsitsikamma	452	595	979	0	68	85
16	Gouritz	278	0	353	1	(76)	110
17	Olifants/Doring	335	3	371	0	(33)	185
18	Breede	869	1	639	203	28	197
19	Berg	506	203	829	0	(120)	210
Total for Country		**14 681**	**0**	**14 486**	**124**	**68**	**5 576**

However, while such infrastructural development may be technically feasible, it is not necessarily economically justifiable, affordable, or environmentally or socially desirable. Dams and water transport infrastructure are expensive. In most cases, the cheaper schemes have already been developed and the marginal cost of the next scheme can be as much as ten times that of the previous one. For example, while the current tariff to pay for the Lesotho Highlands Water Scheme is less than R2/m ^{3}, that of the Olifants augmentation at De Hoop is estimated at over R10/m^3. To pay for increased supplies, users must be able to fund the capital and operating costs of new developments, or make a convincing case for public investment (Muller *et al*., 2009).

4.5.2.2. Demand Management

Once the cheaper supply options have been developed, the alternative approach to reconciliation, namely management of demand, becomes increasingly attractive. In each of the main user sectors, a range of options is available for controlling demand (Mayer *et al*., 2011).

Household level: Effective measures at the household level include tariff increases that discourage consumption (but these can affect poorer households disproportionately); changes in settlement patterns, such as smaller plot sizes; and leakage control in the extensive municipal distribution networks that serve households. The latter approach can be particularly effective

in large networks. Many more demand management activities can be undertaken, ranging from maintenance of household water fittings to regulating the water use efficiency of domestic appliances, such as washing machines.

Industrial level: Water consumption at the industrial level is often sensitive to controls on the disposal of wastewater. To achieve these targets, consumption has to be reduced. The availability of water and reliability of supply, rather than prices, are usually the main drivers for existing industry. For large new industries, however, the policy that the industry should cover the full costs of making water available has helped decision makers to focus on water efficiency options and alternative locations where water constraints are less pronounced. It has also resulted in many cooperative arrangements where industries treat and reuse municipal wastewater in their processes.

Trading of water allocations: This mechanism is often suggested to promote greater water use efficiency through pricing. This can be done within a single sector and region (e.g. among farmers in the same area), between sectors, and/or between areas that are subject to physical constraints. While trading within a particular sector in a region is relatively common, intra-sectoral and intra- regional trading is regulated in order to manage externalities that would result if a sector or region were to lose an important factor of production.

On the basis of developing new supplies of water through a programme of infrastructure investments, together with the application of management measures, the National Water Resource Strategy (NWRS), concluded that the demands projected for 2025 could be met (Muller et al., 2009).

4.5.3. National Water Resource Strategy 2013 and National Development Plan 2030

The National Water Resource Strategy ensures the provision of water services, which are safe drinking water and sanitation to all people, particularly the poor and previously disadvantaged (Peter-Varbanets et al., 2009). The first National Water Resource Strategy (NWRS1) was released in 2004 as a blueprint for water-resource management and as one of the requirements of the 1998 National Water Act (Hedden and Cilliers, 2014). The NWRS1 provided quantitative information about the present and future availability of and requirements for water in each of the then water-management areas until 2025 (McKenzie, 2012). The NWRS2 provides hard targets for increasing water supply for each of the recently promulgated nine water-management areas. NWRS2 is a new version of NWRS1.

Cilliers (2014), highlights that the Human Rights Commission, Among its many goals, the National Development Plan set the following interrelated target: all South Africans should have access to clean running water in their homes by 2030 (the current proportion is estimated at 92%). The National Development Plan proposes the better use of existing water resources and a 33 percent increase in the area of land currently under irrigation and the development of new water schemes (Hedden and Cilliers, 2014). It advocates for investments in infrastructure for water, and proposes achieving an average reduction in water demand of 15% below baseline levels in urban areas by 2030 (ibid).

According to Peter-Varbanets *et al*. (2009), the South Africa: Millennium Development Goals (MDGs) Country Report indicates that South Africa is well on track to meet these goals and targets, with the proportion of households having access to clean water increasing from 60% in 1995 to 85% in 2003. Between 1994 and 2004, 10 million people gained access to basic clean water supply. Access to sanitation increased from 49% of households in 1994 to 63% in 2003. The MDGs were set to be met by the year 2015. The reality of water situation in the post 2015 reflects that the country is still in a problem and much need to be done.

4.5.4. Integrated Development Plan (IDP)

The Municipal Systems Act in the South African constitution, prescribes the drafting and adoption of integrated development plans that bind municipalities in exercising their executive functions (Glazewski, 2000). A legal review of such a plan may reveal whether the municipality has drafted and developed the plan according to its mandate and whether the plan adequately addresses the functions of the municipality. A court can compel a municipality to redraft the plan to fulfil the mandate of the municipality to provide municipal services i.e. Water and Sanitation service. Municipal planning, in terms of the Municipal Systems Act, must provide the right to water as provided for in Section 27 of the Constitution (Kidd, 2008).

Municipalities are obliged to draft and adopt integrated development plans, but unless these are carefully and consistently monitored by all interested and affected parties – provincial and national government in particular – the plans may prove to be ineffective as a means to deliver water services in compliance with national policy and constitutional obligations (Otterpohl et al., 2004). There are no specific sanctions for failure to comply with or failure to draft and adopt such plans. The legislator here relies on the principle of cooperative governance and the MEC for local government to take necessary steps to ensure that such plans are rated and adopted. Cooperative governance has, as is demonstrated forthwith, its own limitations and

cannot be relied upon as the sole instrument to solve issues around failed service delivery. The lack of sanctions makes it difficult for civil society to put pressure on water services authorities to comply with statutory requirements (Peter-Varbanets *et al*., 2009).

4.5.4.1. Water Services Development Plans

The primary municipal planning instrument in the Water Services Sector is the Water Services Development Plan (WSDP). All Water Service Authorities (WSAs) must develop a 5-year WSDP that must be updated on an ongoing basis. The WSDP indicates how the WSA plans to provide universal access to water services, including the eradication of historical backlogs within its area of jurisdiction. The WSDP integrates technical, social, institutional, financial and environmental planning and feeds into the Integrated Development Planning (IDP) process. The WSA must report annually against the WSDP. Municipalities to develop and update their WSDPs can utilize a WSDP Guideline document, developed by the DWA.

Although implementation of these plans has faced several drawbacks, significant progress has been made in some basic areas. “Perhaps the most important among these is that resource planning, built on foundations laid in the 1970s, has enabled South Africa to map a water-secure future for its main urban and economic centres” (Muller, 2012). Post 1994, planning priority were given to ensure water availability in all urban and industrial (including mining) hubs because of their relatively rapid growth and contribution to the economy.

The major hubs of Johannesburg, Durban, Cape Town, Port Elizabeth metropolis and other surrounding metropolitan areas should not face water-supply constraints in the medium term (up to 2035) if only the measures identified as necessary to maintain the balance between supply and demand are implemented in in the right time (Howe *et al*., 2011). For each of the demand hubs, an indicative programme of investment and management has been proposed. They include extensive programmes of re-use, which is already an important component of supply options in inland areas as well as quantified conservation targets, designed to reduce the rate of demand growth. In addition, in coastal areas, desalination has been identified as a possible option, although wastewater re-use is usually the preferred option because of cost and locational advantages (Muller, 2012).

Throughout the South African municipalities, this constrained resource supports a population of over 50 million people and one of the major economies in Africa in a state that approaches water security hitches (Muller, 2012). Officials in the Western Cape, Free State, Limpopo and the Northern Cape are currently considering applying to be declared drought areas. KwaZulu-

Natal was officially given drought status late 2014 (Savides, 2015). Not even a single dam in KwaZulu-Natal currently has as much water as it did in 2014, just a year ago (ibid) and this direct predicts a water crisis in the city of Durban, which is in KwaZulu-Natal province. Figure 4.6 below shows the position of metropolitan cities across the map of South Africa.

Figure 4.6. Orientation of Metropolitans within provinces in South Africa. Source: (DWA, 2013b)

In South Africa, the National government is responsible for and has authority over the country's water resources but local governments or Municipalities, which act as Water Services Authorities, are responsible for water and sanitation service provision. In general, water supply to major cities has kept pace with demand and there have not been restrictions due to water resource constraints. However, in the cases of eThekwini region covering the main port city of Durban, this owed to a much favourable weather than timely planning and implementation. eThekwini had sought to delay the need for implementation of supply augmentations by promoting demand-management interventions but these did not yield the savings projected

(Muller, 2012). It may be left with a water crisis in the next 10 years unless the city takes drastic action, even pursuing the 'toilet to tap' (Pillay, 2014).

4.6. Durban, South Africa

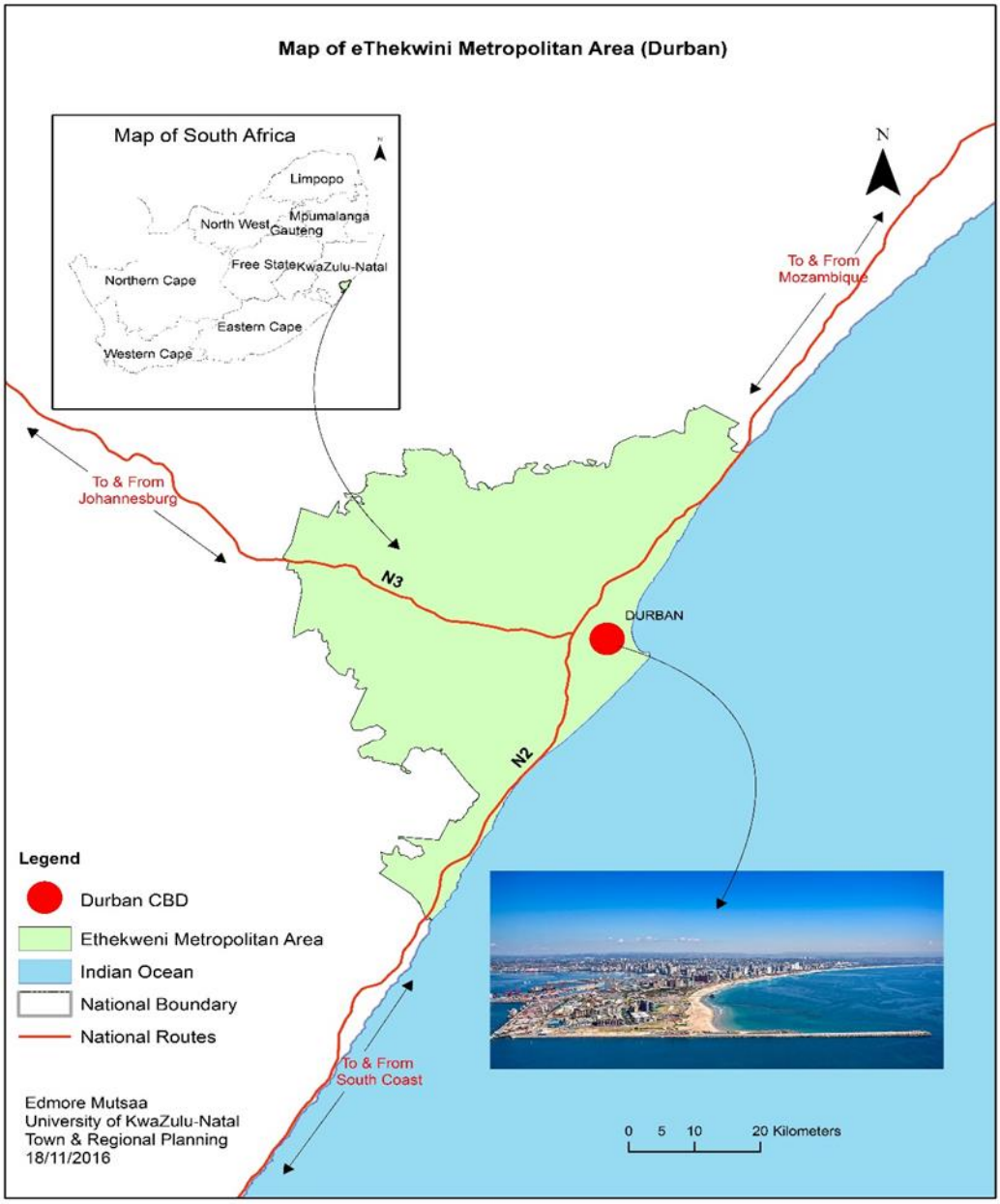

Figure 4.7. Map showing the position of Durban in the eThekwini Metropolitan Area (Municipality). Source: (Author, 2016).

4.6.1. Introduction

According to the eThekwini Spatial Development Framework (SDF), the whole Metropolitan Area of eThekwini is experiencing serious hitches water wise (eThekwini_Municipality, 2015a). The difficulties might are alluded to have been caused poor long term infrastructure planning and decline in investment in bulk infrastructure over the last 20 years as well as above average rainfall over the last few years that had led to a false sense of security regarding the water supply situation, in other words it had caused foot-dragging in giving attention to the matter as it seemingly to be under control and to be not an immediate threat (ibid).

In November 2013, The Spring Grove Dam was commissioned and if failed to withstanding the additional capacity that was available after its completion, therefore eThekwini continues to suffer from a water supply shortage. A below average rainfall period will push the government to introduce water restrictions which are accompanied by impacts on the local society and economy. Upon the approval, water recycling may come to place in 2016 though more efficient utilisation of the existing resource is a priority (eThekwini Municipality, 2015). From the point of view of current water supply, there is insufficient supply to deal with any further development as envisaged in the SDF and SDPs. The situation is sufficiently severe that water restrictions are inevitable even when rainfall returns to normal.

Within eThekwini Metropolitan Area, 91 percent of households have water available within 200m of their dwelling and this is only in the area of current water delivery. To cater for the impoverished, the Municipality as part of its welfare package provides a basket of free basic services, which include water, sanitation, and electricity in accordance with a defined level of service. Those consumers living in formal properties having a maximum property value of R120 000 are considered to fall in the indigent (poverty-stricken) category and therefore benefit from free service delivery.

As water experts have warned that South Africa may be facing sharp price increases and interrupted supplies of water in the next 10 years - similar to the current electricity crisis, Michael Singh (Deputy Director of the Department of Water and Sanitation in KwaZulu-Natal) told a gathering of Durban industry representatives that water conservation is a more cost-effective way of dealing with the problem than building new dams and desalinating sea water (SABC, 2015). However, the water conservation initiatives are faced with a number of challenges in the city of Durban.

4.6.2. General background of Durban

The city of Durban is located on the far-east side of South Africa's east coast, about 600 km from Johannesburg and widely recognized as the country's most competent metropolitan-level local authority (Robbins, 2005). It is the largest city of the KwaZulu-Natal Province, and one of the country's main seaside resort cities with excellent beaches and a distinctive tropical climate. The city is well equipped for the needs of tourists and has for years been the prime holiday venue for locals.

The city of Durban is administered by the eThekwini Municipality, has a population of approximately 3.6 million people, which is one third of the population of the province of KwaZulu-Natal and the population is anticipated to increase to 4 million people by 2020 (eThekwini_Municipality, 2002a). The city has a very young population with the majority being comprised of the 15-34-year age group. It has a prominently African population (71%), followed by the Indian (19%), white (8%) and coloured communities (2%) (eThekwini_Municipality, 2002a). The majority of Durban residents live in the central urban core (36% of the population) and the north region (32% of population). The city has high levels of poverty, with 41.8% of the population subject to conditions associated with poverty, and low economic diversity therefore faces significant socio-economic challenges (eThekwini_Municipality, 2002a).

Durban is one of the fastest-growing urban areas in the world. It has undergone rapid industrialisation owing to its availabity of water supply and labour resources in recent times. Its harbour is the busiest in South Africa, and it is rated as one of the 10 largest in the world. The port of Durban handles more than 30 million tons of cargo with a value of more than R100 billion every year. Despite the rapid industrialization in Durban being relatively owed to the availability of water, the resource is increasingly becoming scarce and it will (if not already) compromising the extent to which the needs of major users should be met (Sutherland *et al.*, 2013).

The water supply systems in Durban are under considerable stress as a result of periods of droughts, more intense rainfall events due to climate change, deterioration of water quality and catchments, lack of adequate bulk infrastructure and rapid urban growth (eThekwini_Municipality, 2012a). Although the eThekwini Municipality is a water scarce Municipality, the city experiences periods of higher rainfall that creates the public perception that water supply is not a major issue in the city. Climate change predictions suggest that the Municipality will experience wetter summers and winters, with a higher frequency of storm

events (Sutherland *et al.*, 2013). However, this does not translate into a stable supply of water for the city due to the increasing demand for water and the lack of bulk infrastructure to manage and distribute water. Poor long-term infrastructure planning over the past twenty years has influenced the future supply of water in the Municipality. The Umgeni Water system can only provide a level of assurance of water supply at 95%, which has dropped from 99%, which will lead to water restrictions once rainfall returns to normal from the wet cycle the city has currently been experiencing (eThekwini_Municipality, 2002a)

Water quality in the rivers of Durban is another challenge faced by EWS and other sectors of the Municipality. This issue is the responsibility of a number of different departments and units in the Municipality and is dependent on an integrated planning approach in order to mitigate the impacts of un-serviced settlements and industry on river quality. The eThekwini Municipality is presently considering the development of a direct re-use system, however, this has met strong public resistance as a result of social, cultural and technical concerns about recycling sewage water in the city (Sutherland *et al.*, 2013)

Water loss through leaks is also a major issue in the Municipality. The Municipality does not obtain enough funding through the National Municipal Infrastructure Grant for service provision and maintenance. One of the most significant impacts of this lack of funding is that infrastructure for water and sanitation services are not adequately maintained. This leads to a significant amount of water being lost through leaks, which has implications for water demand management.

The provision of an acceptable level of basic services is a major focus of both the national and eThekwini Municipality developmental agenda. However, this pro-poor effort is tempered by the neo-liberal pro-growth approach that is dominant in the development agenda of South Africa. Water and sanitation in the eThekwini Municipality therefore has both a cost-recovery and pro-poor focus. Both national and local policy states that the Municipality has to ensure regional efficiency in water provision, be cost effective and socially responsive, ensuring that all residents have access to a basic level of affordable water, and achieve the benefits of scale (Republic_of_South_Africa, 1998).

4.6.3. Water and Sanitation Vulnerabilities in Durban

Considerable progress has been made in Durban in water and sanitation service delivery post 1994. The eThekwini Municipality has reduced its water backlog to 15% of what it was in 1996 and the sewerage backlog stands at approximately 50% of the 1996 figure (Sutherland *et al.*,

2013). In terms of water delivery, 91% of households have water available within 200 m of their home. EWS has been the lead agency in securing free basic water for citizens in South Africa. The Municipality provides free basic water of 9 000 litres per month to households whose value is below R250 000 (*ibid*). The city offers three systems of water provision based on tariffs: the full pressure system, the semi-pressure system where flow restrictors are applied when households cannot manage the costs of water on a full pressure system and ground tanks or yard tanks that are supplied with 300 litres per day to the poor who qualify for free basic water (9 000 litres per month). Residents of informal settlements, who are the most vulnerable in the city, obtain free water through communal tap points that are provided within the settlement. Empirical research reveals that poor residents are generally satisfied with water provision in the Municipality (Lewis *et al*., 2013).

EWS has adopted a pro-active and socially responsive position in terms of the provision of free basic water. The Municipality was the first to provide free basic water in South Africa and the lessons learnt in the city led to the development of the free basic water policy at National level. Initially the poor were provided with 6 000 litres of free basic water per household per month (Sutherland *et al.,* 2015). However, as a result of EWS"s concerns about the impact of illegal connections on water supply in the city, and the social learning that occurred through water forums and surveys with customers in the Municipality around the amount of water households required to meet their basic needs, particularly with ill household residents, EWS raised the amount of free basic water supplied to poor households to 9 000 litres per month. EWS had hoped that by providing an additional amount of free basic water household would be more willing to participate in the formal administrative system of water provision, rather than obtaining it from illegal connections (Sutherland *et al*., 2015).

There are concerns from a number of different actors both within the Municipality and outside of it that the provision of free basic water undermines the social and economic value of water (Meyer, 2013). These actors believe that the Municipality has to generate revenue to support sustainable water and sanitation services and that by attaching an economic value to water, the social value of water and its value as a limited resource, is raised within communities.

4.6.4. Water Governance in Durban

The Constitution of South Africa Act 108 (1996) provides everyone with the right of access to sufficient water (Section 27, (1b)) and compels the state to "take reasonable legislative and other measures, within its available resources, to achieve the progressive realisation" of

everyone's right of access to sufficient water (Section 27 (2)). The Constitution states that water and sanitation services are a local government responsibility. Human dignity (Section 10) and the promotion of equality (Section 9) are also core values of the Constitution (Section 10) which should underpin water and sanitation service provision (Government_of_South_Africa, 1996).

National Water Act 36 of 1998 is the overarching framework for water governance and management in South Africa. The management of water resources is therefore a national government responsibility. The Water Services Act 108 of 1997 governs the provision of water and sanitation services to households and other water users that is the responsibility of local government. Although water service provision is a local government responsibility all spheres of government are required to support water and sanitation provision where possible. In eThekwini Municipality EWS, which is located within the Engineering Services Cluster, is responsible for water and sanitation provision. Municipalities are best positioned to identify, react and respond to what is happening in reality on the ground and they can be much more responsive than national government and hence they are well suited to the responsibility of providing and managing water and sanitation services (Meyer, 2013)

The legislation and policy that was developed for water and sanitation services post 1994 identifies public participation as central to water governance. Public participation around water and sanitation services was initiated in 1997. EWS was facing a number of critical challenges such as the blockage of pipes, misuse and wastage of water, vandalism, high levels of non-revenue water, difficulty in accessing remote areas and the presence of water borne diseases such as cholera. According to (Gounden, 2006), these issues arose post 1994 from a lack of awareness and education, especially in those areas that had not previously had access to water or sanitation services, while others consumers had never had a voice with regard to any services.

4.6.5. Water legislation and policies

In almost all countries, water legislation draws on old standing traditions, local customs and rules of conduct. Water legislation is not an end in itself but it is one of the various instruments of giving effect to the water policies which it should reflect (Gordon, 2014). Accordingly, legislation which is not preceded by, or does not explicitly involve the adoption of certain policies, is unlikely to be effective and non-functional (Marshall and Rossman, 2014). The policies may be adopted before the legislation and may even originate with another

governmental body. In all countries, water legislation has been reviewed based on certain hazards, community conflicts or specific uses, and the South African water legislation is not divorced to that. A good example is the *free basic water police of 2001*.

The Policy for Free Basic Water promotes sustainable access to a basic water supply by subsidising the ongoing operating and maintenance costs of a basic water supply service. It is envisaged that the minimum quantity of free basic water of 25 litres per person per day should over time be increased to 50 litres per person per day. Free Basic Water is financed from the Local Government Equitable Share and through cross-subsidisation (Peter-Varbanets *et al*., 2009).

Durban was the first South African city to introduce a policy of free basic water in 1998. After the 2000 cholera outbreak, the African Nation Congress (ANC) under the Governance of President Thabo Mbeki promised free basic water during a municipal election campaign in December 2000. In July 2001 free basic water became a national policy through a revised tariff structure that included at least 6 "kiloliters" (cubic meters) of free water per month (40 liters/capita/day for a family of five or 25 liters/capita/day for a family of eight). The policy was being implemented gradually within the means of each municipality (Galvin 2012).

4.6.6. Public Participation

EWS has focused on public participation through the 'Raising the Citizen's Voice' programme and the Water Dialogues, which was a national project that drew in a wide range of actors to deliberate and share knowledge on water and sanitation provision in the country (Galvin, 2013) EWS has established a number of platforms through which it can engage with citizens, all of which represent the invited spaces of the state to ensure higher levels of participatory local governance (Piper and Nadvi, 2010). Public responsiveness is a cornerstone of EWS's Water and Sanitation Services Charter and forms a core focus of the business of the Unit. EWS engaged with the public though Focus Groups and User Forums, which were established due to the 'Raising the Citizen's Voice' Project.

As a result of its intent of increasing public participation, EWS has developed the User Platforms so that ordinary citizens can communicate their concerns to the state. According to officials from EWS, the Unit commits itself to reflecting on its behaviour and practices because of the feedback obtained from communities, hence ensuring greater accountability. EWS also uses the media, including the radio and the newspaper to communicate with its customers and to inform the public of responses to water and sanitation issues. The widely available Customer

Services Charter and the Service Level Standards provide a clear indication of the vision and practices of EWS. All of these processes therefore encourage an on-going dialogue between EWS and the community. It also enables EWS to understand its customers and their needs better (Malakoana, 2012).

In Durban, the state has developed a strong and well-defended spatial discourse, which has provided justification for inequalities in service delivery using historical, technical, environmental and economic explanations. This discourse explains the difficulty of expanding the infrastructural network to the harder-to-reach areas beyond the urban edge. By rendering the spatial inequalities scientific and technical, through the use of the UDL, the 'politics' has been taken out of the process of service delivery, enabling the state to navigate around the social and political processes which reinforce the inequalities. However, the research reveals both a state and citizens that are attempting to move toward greater resilience through engagement with water as a social good, water as an economic good and the spatial reality within which these discourses are situated.

4.6.7. Projections and Planning for future water availability

Although implementation has faced several drawbacks, significant progress has been made in some basic areas. "Perhaps the most important among these is that resource planning, built on foundations laid in the 1970s, has enabled South Africa to map a water-secure future for its main urban and economic centres" (Muller, 2012). Post 1994, planning priority were given to ensure water availability in all urban and industrial (including mining) hubs because of their relatively rapid growth and contribution to the economy.

Post-1994 planning has demonstrated that the major hubs of Johannesburg, Durban, Cape Town, Port Elizabeth metropolis and other surrounding metropolitan areas should not face water-supply constraints in the medium term (up to 2035) if only the measures identified as necessary to maintain the balance between supply and demand are implemented in in the right time (Howe *et al*., 2011).

For each of the demand hubs, an indicative programme of investment and management has been proposed. These reflect the 1998 policy changes and are no longer limited to infrastructure investments to expand supplies. They include extensive programmes of re-use, which is already an important component of supply options in inland areas as well as quantified conservation targets, designed to reduce the rate of demand growth. In addition, in coastal areas, desalination

has been identified as a possible option, although wastewater re-use is usually the preferred option because of cost and locational advantages (Muller, 2012).

Both climate change and environmental flows have been explicitly considered. There are common messages of consensus around precipitation; a wetter escarpment in the east, a shorter winter season in the southwest, a slight increase in intensity of precipitation, and drying in the far west of southern Africa. 'For temperature, the country as a whole is projected to experience an increase in temperature, with the maximum increase in the interior' (Tortajada *et al*., 2013). These projections clearly indicate that there will be serious water scarcity in the near future, if immediate action has not been taken now, with regards to legislation, polices, infrastructure, people behaviour to mention a few among other measures.

Chapter V: Data Presentation and Analysis

5.1. Introduction

The fact is water demand in Durban is in its inexorable rise over the years, and the projection of continuing growth in the coming decades. The gest of this chapter is to analyse data collected from interviews and observation, using qualitative data analysis. In this chapter, responses to the interview guide questions will be reduced to key statements that can be categorised into themes across all interviews recorded in order to identify similar areas of response. In other words, this can be done by determination of basic themes by examining clusters of comments made by respondents and memos made by the researchers. Ely (1991), define a theme as "a statement of meaning that runs through all or most of the pertinent data, or one in the minority that carries heavy emotional or factual impact".

When carrying out research interviews, it is extremely unlikely to get a 100% turnout or respondent rate. Within the analysis stage, it is then important to identify the rate of non-return, since it is widely acknowledged that the views of non-respondents are often different to those of respondents. This means that a note of caution is required when drawing conclusions from incomplete data sets, particularly where a random sampling strategy is assumed.

5.2. Presentation

5.2.1. Current Water Conservation Challenges in *Durban*

Twenty five percent of the respondents advanced that leakages are a big challenge against efforts to conserve water. He went on to state that, though the provision of free water to economically deprived communities is a noble idea, there are cases of high water wastage due to negligence to conserve water since people do not incur an extra or direct cost related to negligent water wastages. Furthermore, these leakages are mainly caused by illegal connection, normally in low cost housing areas. Individual households' leakages amount to a huge amount of water when combined, yet seen as little or nothing at all when looking at a household level. On the other hand, the other challenge to the water conservation is that the municipality does not respond urgently to the leakages hence continue to loose water for a very long time.

According to twenty five percent of the respondents, an increase in migration to the city of Durban is increasing the demand of water and on the other side is putting strain on the already

dwindling water supply in the city. By 2025, the consumption of water is expected to double in the city of Durban. Unpredictability of future development is also another challenge to plan for water conservation basing on ceiling demand.

Twenty five percent of the respondents assert that, there is a challenge on public participation as people do not turn up for the public participation meetings to deliberate on issues pertaining efficient service delivery of water and sanitation. A skewed representation of the public in these meetings will subsequently affect the inclusivity of the decisions, which will be made in tackling the current problem of water at hand.

5.2.2. Efficiency of fresh water supply

According to eThekwini Water and Sanitation (EWS) (2014), Durban fresh water supply efficiency stood at 35.30% in October 2014, a reduction from 35.70% in July 2014. Msweli (2014), states that the long-term goal of the Municipality is to obtain non-revenue water to 25 percent by June 2019 through various programmes and initiatives.

5.2.3. Water Conserving Policies framework

A policy framework guides water conservation from a National level to local government level. According to a large number of respondents, the country as a whole has a very good policy framework, on water conservation. The country has enough policies to support water conservation. For example, the policies on water conservation stress the control or removal of invasive plants, which use a more water from the rivers and dams, hence contributing to the water scarcity since they take a sizable capacity of water from these sources, which can be put to good use, for the benefit of the community or the economy.

A few respondents, also supported the fact that there is nothing wrong with the policies, ‘its working’’, he said. He gave an example of Water Service Act 108 of 1997, which guide the distribution of water: “To provide for the rights of access to basic water supply and basic sanitation; to provide for the setting of national standards and of norms and standards for tariffs; to provide for water services development plans; to provide a regulatory framework for water services institutions and water services intermediaries; to provide for the establishment and disestablishment of water boards and water services committees and their powers and duties; to provide for the monitoring of water services and intervention by the Minister or by the relevant Province; to provide for financial assistance to water services institutions; to provide for certain general powers of the Minister; to provide for the gathering of information in a

national information system and the distribution of that information; to repeal certain laws; and to provide for matters connected therewith." (Republic_of_South_Africa, 1996).

In terms of the Water Services Act, Act 108 of 1997, clause 12 (1) every water services authority must prepare and submit both a draft water services development plan (WSDP) and a summary of that plan.

According to some respondents, many communities are benefiting from such policies, which encourage equitable and efficient distribution of water, though not everyone is covered sufficiently.

On average, the respondent stated that; though the policies are sound, the implementation of these policies by the government of South Africa could be improved. They also stressed the need for improvement on the implementation of the policies. Furthermore, they highlighted the fact that sometimes politics get in the way of policy implementation. For instance, sometimes politicians give promise to the public, yet some of the promises are difficult to implement in time of timeframe they need to be implemented or these promises may go in some cases go in contrary with the actual policies.

5.2.4. Urban land use and infrastructure uses to conserve water

According to the respondents from the planning department, there is water harvesting in some parts of the city as a way in which infrastructure is being used to conserve water i.e. the use of jojo tanks. The potential of water harvesting is not fully capitalised. They also postulate the use of boreholes and windmills to supplement the current water supply in the city.

From observations made in the inner city by the researcher, there is no mechanism to collect storm water from the city water cycle for use. Cities generate a substantial amount of accelerated stormwater run-off because of large areas of impervious surfaces, such as rooftops and roads. This is channelled into the city's stormwater drainage system; from which it is discharged into rivers or the ocean. This stormwater merely flows down the drain without any effort to collect it for usage i.e. collect it, store it in a reservoir, and then use it for irrigation purposes in parks, playgrounds, gardens and other non-domestic use if it is not treated fully for human consumption. The lack of mechanism to recollect storm water may in some cases poses a risk of flooding and possible destruction of property and loss of life.

As observed by the researcher in Durban's inner city, the use of green roof infrastructure to conserve water is on the loom in the city; however, it is still on a very small scale, which does

not make much recognisable impact or difference, hence, there is need for improvement. One of the identifies green roof infrastructure is shown in plate 5.1 below.

Plate 5.1. Showing green roof at City Engineer Buildings (Source: Author, 2016)

5.2.5. Water Specifically suitable for certain purpose

Respondents from city's Water and Sanitation and Planning department pointed out that, the principle of using water to suit a specific purpose is already underway in the Durban South Basin (DSB). The application of this principle exposes alternative sources of water that can be safely used for different purposes and can help address the growing gap between water demand and supply caused by the competition for water sources by different users (Maheepala et al., 2010). Jacobsen et al. (2012), attests that the concept of water fit for purpose has been implemented in the city of Durban, South Africa, to respond to a conflict between water demand for domestic use and economic development under conditions of water scarcity. Figure 5.1 below shows the diagram of how fresh water is being used, wastewater reclamation, and reuse of recycles water and use of fresh water for a specific purpose.

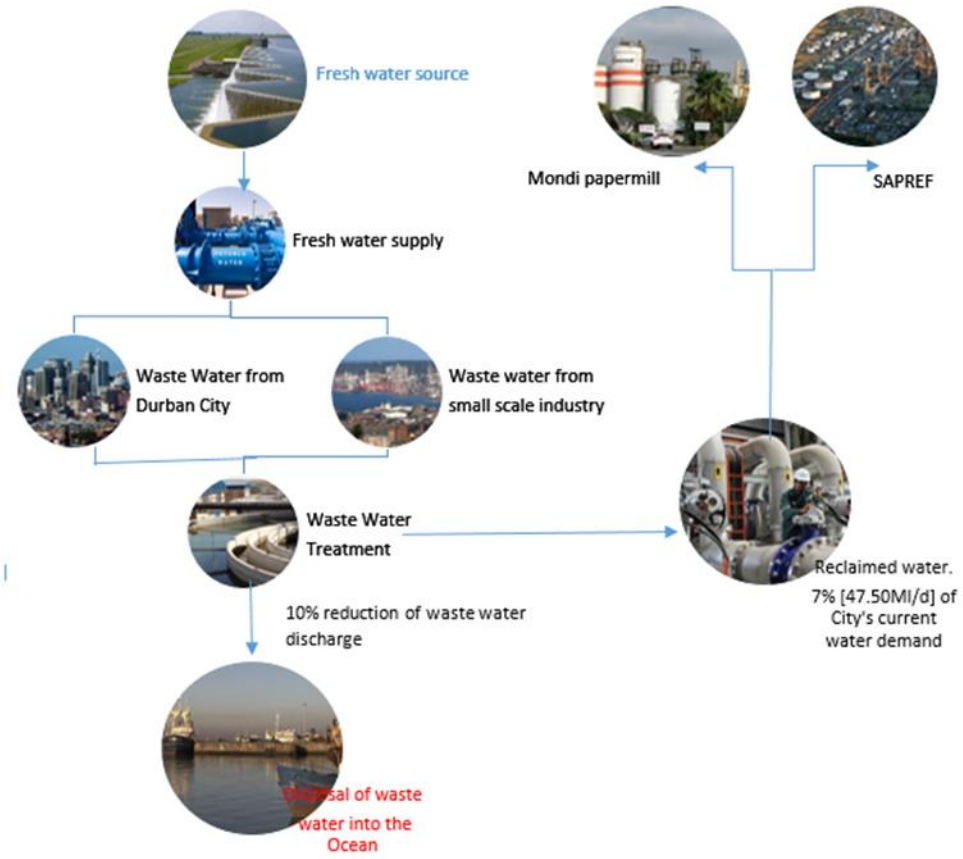

Figure 5.1. Water fit for a specific purpose. Source: (IWA-Water-Wiki, 2011)

The eThekwini Water Services developed a strategy to recycle wastewater as an additional water source. A wastewater treatment plant and a recycling plant provide reclaimed water that meets the water quality requirements of the primary clients (a paper mill and a refinery). At operational capacity, the reclamation plant meets 7 percent of Durban's water demand and reduces the wastewater discharge by 10 percent as shown in figure 5.1 above. As a co-benefit, the industry customers reduce their costs by purchasing reclaimed water rather than high-quality potable water (IWA Water Wiki, 2011).

On a different perspective some of the respondents, put forward that the principle of using water to suit a specific purpose sort of segregate customers, especially the industries as customers for the municipality and yet these are valuable customers with the regards to the money they pay for the service. Proper consideration should be taken into account in the way in which these customers are separated, since infrastructure maintenance and other operation

services depend on the funds paid by these customers. The respondent added that for the principle to work across all boards of customers there is need for thorough workshops to educated people that there is nothing wrong with recycled water for domestic use.

5.2.6. Proposed intervention plans.

The solutions are grouped into two categories; short-term interventions and long-term intervention plans. The short term intervention, are those plans which need to be put in place immediately to cope up with the current water stress in the city of Durban. The long-term interventions are the plans designed to water conservation in the long run and to prevent water scarcity in the long run.

5.2.6.1. Short term interventions

Most of the respondents stated that for the interim time the water authorities must intervene through Water Demand Management (WDM). Water Demand Management**,** is the adaptation and implementation of a strategy by a water institution or consumer to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency, social development, social equity, environmental protection, sustainability of water supply and services and political acceptability.

In addition, pinpointed that in the meantime; water restriction policies must be implemented and enforced in order to achieve the water conservation goal of the city. Public awareness plays a very crucial role in educating the public about water conservation or water saving. Individual households can be addressed and advised on the sustainable or recommended use of water for things like irrigating their gardens or lawn, the use of swimming pools. They also added that the car wash business need to be advised or educated on the methods of washing cars, which saves water.

According to direct observation survey in the inner city, it seems some car wash already understand water conserving methods in doing their business. For example, the use of buckets instead of horse pipes to wash cars is being witnessed throughout the study area. Whether they chose that method due to the awareness of water scarcity problem at hand or they chose it to minimize water costs, which come wasteful use of water. One of the identified car washes in the inner city is shown in plate 5.2 below.

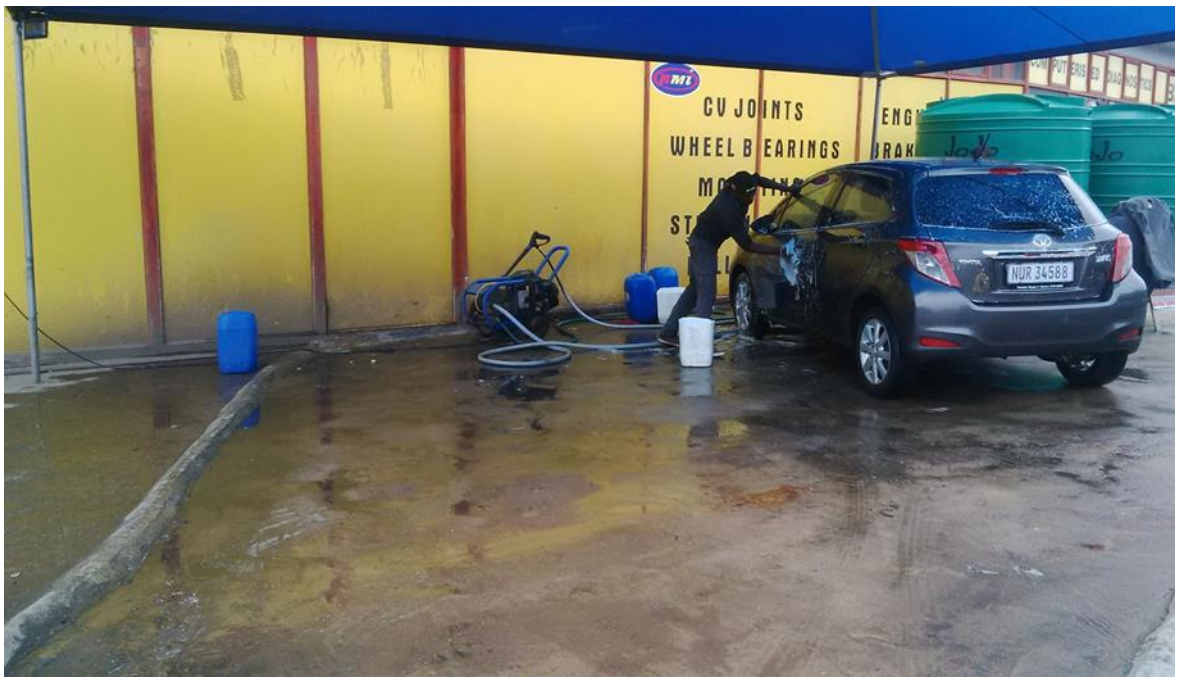

Plate 5.2. Showing a car wash business at 57 Pine Street, Durban using buckets to wash cars. (Source: Author, 2016)

Respondents from a contracted water governing board and water and sanitation department indicated that as short term intervention potable water can be diverted from different water treatment plants where water is sufficient to supply other areas in the city where with insufficient water or which are severely affected by water scarcity. Butler and Memon (2006), put emphasise on the same idea of water transfers, though the emphasis was on setting up of interregional transfer schemes to help the severely affected areas.

5.2.6.2. Long term interventions

A majority of the respondents agreed that there is need to increase the water storage infrastructure, as the ones in place this far seems not to be enough. They suggested the construction of new water treatment plants for example at Umkhomasi. The respondents stated that there is need for proper planning and added the idea of constructing water resource schemes to meet future demands, well in advance. They went on the state that, it is very important to note that these goas are not always possible to meet in targeted time; however, they are part of the plan.

Some of the respondents stressed the idea of protecting river, streams and dams eliminating or controlling alien plants, which are spreading along and around these water bodies. Some

invasive or alien plants use a lot of water from rivers or dams, and this impact greatly to the capacity of water which could be put to beneficial use, if not wasted by these plants. Eliminating them or control their spread will ensure an increase in the capacity of water in these water bodies, hence more water available for use in the long run.

On average, the respondents highlighted that the use of grey water, especially wastewater reuse is a part of the long-term intervention measure toward a water secure city. On water reuse, there are two options involves which are; direct and indirect waste water reuse. Direct wastewater reuse means wastewater is being treated at a wastewater treatment plant, and then distributed from there direct to consumer, when it is suitable for consumption. Indirect wastewater reuse means wastewater is treated at the wastewater treatment plant, instead of being distributed direct to consumers, it is returned to a river system, dams or other potable water storage facilities. Then from there it will therefore be redistributed to consumers when it is ready for consumption. On the same topic, they put forward the idea of investing in the decentralisation of water works to achieve a long-term goal of a water secure city.

Desalination is part of the options on the long term plans to meet the demand of water in the city. According to fifty percent of the respondent, there is already a plan to establish a desalination plant at Umdloti. They also added to the plan to establish a desalination plant to meet the future water demand of Durban, despite the cost of establishing that plant.

A number of the respondents heralded the importance of long-term interventions as they are envisaged in the National Development Plan-2030. Water supply and sanitation services, which depend on adequate management, are a priority for most South African communities. Their effective and sustainable management is essential for community health, development and cohesion, and continued economic activity. By 2030, it is envisaged that effective management of water and the services derived from it will support a strong economy and a healthy environment. All main urban and industrial centres will have a reliable water supply to meet their needs.

Before 2030, all South Africans will have affordable, reliable access to sufficient safe water and hygienic sanitation. Service provision arrangements will vary in different parts of the country, with different approaches adopted for densely built-up urban areas and scattered rural settlements. Local governments will retain responsibility for ensuring service provision in their areas and, in many cases, will continue to manage the services directly (ibid).

According to secondary data source, there is considerable pressure from general public, regulatory agencies, and the government to minimise the impact of new supply projects (i.e. Building new resources or inter-regional transfer schemes), which implies that emphasise should be shifted towards managing water demand by best utilising the water that is already available. As transcribed in the National Development Plan (NDP)-2030, reducing growth in water demand is just as important as increasing its supply. Current planning assumes it will be possible to achieve an average reduction in water demand of 15 percent below baseline levels in urban areas by 2030. Detailed targets have been set for different areas (National_Planning_Commission, 2012).

Achieving demand reductions on the scale of 15 percent below baseline level in urban areas by 2030 as envisaged in the NDP will require programmes to reduce water leakage in distribution networks and improve efficient domestic and commercial water use. The Commission proposes running a national programme to support local and sectoral initiatives to reduce water demand and improve water-use efficiency. Demand-management projects with merit should be given priority and regarded as being on par with water-supply expansion projects in terms of importance (National Development Plan, 2012).

5.3. Data Analysis

As more people move to the city, they are demanding better services, including clean water and basic sanitation services. These demands are putting pressure on local and regional water supplies. Moreover, inadequate water and sanitation supplies leave communities vulnerable to a broad range of risks and significantly affect the economic progress in most the countries. To this effect, the data presented above regarding water security in Durban shall be analysed as follows;

5.3.1. Water conservation and management challenges

Objective to the data presentation above, Butler and Memon (2006) also embraces same position that, the chief influencing factors are population and migration, together with changes in lifestyle, demographic structure and the possible effects of climate change. The detailed implication of climate change in the data are not yet clear, but must at least increase uncertainty in security of supply. This is compounded by rapid urban development, rapid urbanisation and in some places of the city, rising standards of living which precipitate into an increased water usage and demand.

Meeting this increasing demand from the existing resources is obviously an uphill for the city of Durban, which needs execution at any cost possible. The issue of leakages caused through illegal connection poses serious concerns about the ability of the current water administration to cope with emerging challenges. Administrative failures and the absence of enforcement indicate a deterioration of the management quality and erosion of institutional memory.

Rendering to the presented data, there are usually two potential responses, either 'supply-side', meeting demand with new resource or 'demand-side', managing consumptive demand itself to postpone or avoid the need to develop new resources. The 'supply-side' response advocate for investing in the water infrastructure, which will technically increase the supply of water for consumption. For example, the building of new dams, waste water recycling and water treatment plants, construction of desalinisation plant, and proper maintenance of the infrastructure to avoid leakages. The 'demand-side' approach advances the idea of water restrictions, educating the public on water saving methods through national wide campaigns though different Medias for the current and long run benefit.

5.3.2. Efficiency of fresh water supply

One indicator to measure the technical efficiency of water utilities is the level of non-water revenue. Non-revenue water (NRW) is water that has been produced and is "lost" before it reaches the customer. In a well-managed utility, that level should be below about 25% (EWS, 2014). From the secondary data presented above, the city is making a substantial effort to improve the efficiency of fresh water supply, through which its 2019 target is to reach the 25% standard measure for an efficient system. However, according to Msweli (2014) contrary to the goal, South Africans use 235liters per person per day which is far more water than the global average of 173liters per person per day. This indicates that much need to done on the demand management side as well in order to improve efficiency; because the reasons for such high water usage can be complex, i.e. the number can be worsened by household leakages.

5.3.3. Police framework

In the spheres of policy guide to improve management, use and conservation of water resource, there seem to be nothing wrong with the current policy except implementation and enforcement of those polices, according to the survey data. In other word, the data presented show that, good polices alone, are not sufficient to achieve a required standard of water security in the city However, this also seem to be a caricature of the reality. The National Development Plan-2030 states that investments to support economic uses of water, including urban consumption, should

normally be funded by users through appropriate pricing measures, which must include arrangements to ensure that all people can afford access to basic water services. The challenges, nonetheless, of sustaining service provision in poor communities must be recognised and addressed. This will also address the issue to illegal water connection due to failure to pay the charged costs, hence resulting in more leakages. Policies aligned to these challenges could be drafted to guide such investments in order to achieve a balance between financial (economic) costs and social benefits.

5.3.4. Urban land use and infrastructure uses

Alluding to the data presented above, less has been done in capitalising the urban land use and infrastructure as far as issues of water conservation as concerned. However, there is hope in the emerging use of green roof infrastructure to conserve water. Instead of channelling it down the drain, rainwater will now be used to grow plants and vegetable on rooftops, which positively contribute to reduction of climate change impacts, however the advantages of this land use/ infrastructural use can be said, to be not yet fully exploited.

The city of Durban receive a considerably better amount of rainfall than other South African cities. Failure to capitalise on this comparative advantage through collection of storm water is a setback in itself, as far as the quest to achieve a water secure urban environment.

Concerning the water treatment infrastructure to provide additional water sources, the city developed a wastewater treatment plant and a recycling plant, which provide reclaimed water that, meets the water quality requirements of the primary clients (a paper mill and a refinery). As much as this strategy is a big step in the right direction, it is not enough without meeting the water quality requirement of all client, and leave them with choices to make when it comes to controversies behind the use of reclaimed wastewater for human consumption and other domestic uses.

5.3.5. Intervention Plans

From the data presentation point of view, considerable effort is now being concentrated on addressing the future water needs, and demand management is seen as a key element in the government's sustainable development policy, in which concentrate on managing demand for water by controlling leakages and maximising its efficient use. From the presented data, the need to develop, investigate and implement environmentally sustainable, technically feasible, economically viable and socially acceptable option has never been more urgent.

The outcomes of the data presented above indicates that the supply management is also a cornerstone to the achieving a water secure future. With that being said, at national level there is already extensive indirect reuse of water in inland areas, where municipal and industrial wastewater is reintroduced into rivers after treatment. In Durban, water reuse is still limited to the industrial area of the South Durban Basin. Henceforward, there is considerable need to further the scope of water reuse. Many municipalities lack the technical capacity to build and manage their wastewater treatment systems. As a result, a regional approach to wastewater management may be required in certain areas (National Planning Commission, 2012). Durban is not exceptional to this challenge. Therefore, this implies that, water infrastructure investment should include projects to treat and reuse water. Research into water reuse and desalination and the skills to operate such technology should be developed, perhaps under the assistance of a national water-resource infrastructure agency.

Water availability and demand varies widely. This limits the usefulness of pricing as an instrument of allocation and control and increases the complexity of price setting. At present, water price setting aims to recover the cost of making water available, while administrative allocation methods seek to balance economic, social and environmental benefits where markets frequently fail. For water services, price setting is regulated by municipal procedures. In this context, the need for an independent economic regulator for water, its specific functions and the potential costs and benefits in relation to the current arrangements should be carefully assessed. This assessment could take place within the proposed cross-sectoral review of infrastructure regulators.

5.4. Conclusion

Water demand in Durban is on a rise, yet the supply of the resource is constrained. The main contributing causes to this rise are population growth and migration, together with changes in lifestyle, demographic structure and the possible effects of climate change. Meeting the rising demand is undoubtedly an uphill task. However, there are usually two potential responses, either ‘supply-side’, meeting demand with new resource or ‘demand-side’, managing consumptive demand itself to postpone or avoid the need to develop new resources. The intervention pressure is geared towards minimise the impact of new supply projects, which implies that emphasise should be shifted towards managing water demand by best utilising the water that is already available, as a short term intervention as well as long term intervention. In the long run, the municipality has considered expanding and improving the supply

management by introducing water-reuse and desalinisation to increase the water supply of the city and of cause, guided by the National Development Plan.

Chapter VI: Summary of findings, recommendations and conclusion

6.1. Introduction

Basing on the information gather, presented and analysed in the previous chapters of this research, this chapter strives to present the finding in relation to the objectives of the research. Grounded on these outcomes or findings, recommendations are going to be made for where is necessary, however leaving a room for further research. Concluding remarks will therefore, be made for the whole research.

6.2. Findings

The chief influencing factors to water insecurity in the city are population growth and migration, together with changes in lifestyle, demographic structure and the possible effects of climate change. Among other, the above are, putting strain on the already dwindling water supply in the city.

Rendering to the responses gathered during this research, leakages are a big challenge against efforts to conserve water. In some instances, the provision of free water to economically deprived communities are allegedly contributing to water wastage due to negligence of the community member grounded on the fact that they don't seem to feel the direct economic pinch which comes with water leakages. Furthermore, illegal connection are also contributing to leakages, normally in low cost housing areas. There is an issue of skewed representation of public opinions since the people normally do not turn up for public participation meetings.

The outcomes of the research shows the South Africa has good policies around water management and conservation; however, a meaningful implementation of these policies is the challenge. This highlights the fact that good polices alone, are not sufficient to achieve a required standard of water security in the city or even for the entire country.

The advantages of urban infrastructure are not being fully exploited to their maximum potential. For example, there is no system to collect and integrated storm water into the main water system, where it can therefore be treated and used for industrial and domestic uses. However, efforts are being made in the right direction, such as the green roof infrastructure pilot project. The interventions are divided into two categories; long term and short term. The long-term intervention measures focus of the supply-side of water management while the short-term intervention measures focus on the demand-side of water management. On the same note,

the fact that the government see the need to expand the waste storage infrastructure indicate the shortage of this infrastructure.

6.3. Recommendation

The recommendation on water conservation in the city of Durban for this research are mainly based on the Integrated Water Resource Management. Integrated Water Resource Management is most commonly defined as "a process, which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (Global_Water_Partnership, 2000). The success of water management is due to a range of factors including integrating water into development planning, building supportive institutional structures with the mandate to control, regulate and learn adaptability and managing both supply and demand.

Water management and conservation efforts in Durban should be grounded in a strong comprehensive planning regime. Urban development requires uniting water, land, infrastructure and environmental policies and a commitment to sustainable development. Water must be integrated into wider development planning and take into account urban, commercial and industrial growth patterns. Planning has to take a long-term perspective in giving a strong vision and the means to attain it. The plan and subsequent efforts should combine urban land use, environment and water in order to unite the work of various agencies within the water planning agenda. This structure provided a means to address the issue with an understanding of both current and future water struggles.

The Department of Water and Sanitation show oversee all components of water management to facilitate the development of comprehensive policymaking and implementation. This includes protecting and expanding water sources, storm water management, desalination, demand management, community programs, catchment management and managing the outsourcing to the private sector. The department should invest more in trying to capture every drop of rain, used water, and recycle all water more than once, in order to ensure that no usable water is wasted or lost. Additionally, the combination of effective legislative frameworks and the strong regulatory enforcement should be key to the success of utilizing urban catchments through ensuring physical infrastructure is maintained and connected to the main sewers, all wastewater is discharged into the appropriate sewage facilities and that there no water pollution due to improper discharge of trade effluent or hazardous waste.

There is also need strong institutional coordination across agencies to support the Department of Water and Sanitation efforts. For example, coordination between agencies responsible for land use planning, housing, environment, trade, industry and transportation.

Pahl-Wostl (2008) has argued that adaptability is key to the success of integrated water resource management. This requires learning within policies and practices over time. A good and unique example in this case could be Singapore in that it has altered its policies and institutions to be able to respond the challenges as Singapore transitioned from a developing to a developed country. It also wrote the 1972 Water Plan with the outlook of considering advanced technologies that were not feasible at the time. In the 1970s following the plan, PUB began to study the use of desalination and water reuse technologies and found them to be too expensive and inefficient (Gordon, 2014). PUB however returned to these ideas as the technologies improved. It was through allowing for room for experimentation that it decided to apply these technologies later, rather than continuing with the status quo. New technologies were also tested through a small demonstration plant before scaling up innovations (Tortajada et al., 2013). PUB has also continued to monitor performance of these systems and to financially support research and development to inform future water technologies. With Singapore's story being considered a case to emulate in this regards, it will be wise that the institutions and policies also adapt to dynamics of water security over time as we have witness in the past decades.

It is necessary to diversify its water supply through expanding and building reservoirs, importing water, desalination and water reuse. This will be combined with managing water demand through pricing, enforced water conservation measures and widespread public campaigning. The focus on a comprehensive, integrated water management approach provides the active test grounds for new ideas and the ability to implement them effectively.

Efficient supply and use of water is necessary to meet future demand. The city's aging water infrastructure is in need of repair as precious water resources are lost. Aging, leaking pipe contributes greatly to the issue of non-revenue water (NRW), or water that is pumped and then lost or unaccounted for. An advanced metering infrastructure (AMI) system can be a fundamental component of any NRW detection program.

It is essential for cities to manage their water as a finite resource that is integral to their overall development planning. As the world shifts to become more urbanized, the lessons from Singapore and Windhoek, Namibia have large implications in moving toward a more

sustainable approach to water management. These examples are characterized by a comprehensive approach in which institutions were further restructured, legislation continued being updated, the public was further engaged into water resources conservation activities and implementation of plans is effective. Not limited to these recommendation, Further research is required to establish the validity of the claim that but in their realization is a better promise of sustainable water security.

6.4. Conclusion

Generates greater competition for limited urban resources, climate change, economic activities and population growth in urban areas will unquestionably put strain on water supply and sanitation in cities worldwide. With South Africa rated the 30th driest country in the world, its cities are grappling with regards to water security for its citizens. In this regards, Durban continues to lose hundreds of millions of litres of water every day, despite the city and province being in the grip of the fiercest drought in 30 years.

Most of the losses were attributed to unmetered connections, connections not on the Coins billing system or not monitored; inadequate capacity (human and financial resources) and vandalism of infrastructure. This also contribute to the current low efficiency of the water supply system. Unpredictability of future development is also another challenge to plan for water conservation basing on ceiling demand. By 2025, the consumption of water is expected to double in the city of Durban.

Meeting this increasing demand from the existing resources is obviously a big giant to kill for the city of Durban, yet it has to be done anyway. There are serious concerns about the ability of the current water administration to cope with emerging challenges. Administrative failures and the absence of enforcement indicate that management quality is deteriorating and institutional memory is being eroded. Water conservation is guided by a policy framework from a National level to local government level and the country as a whole has a very good policy framework, with regards to water conservation. However, Good polices alone, are not sufficient to achieve a required standard of water security in the city.

There are usually two potential responses, either ‘supply-side’, meeting demand with new resource or ‘demand-side’, managing consumptive demand itself to postpone or avoid the need to develop new resources. The ‘supply-side’ response advocate for investing in the water infrastructure, which will technically increase the supply of water for consumption. For example, the ‘supply-side’ building of new dams, waste water recycling and water treatment

plants, construction of desalinisation plant, and proper maintenance of the infrastructure to avoid leakages. The ‘demand-side’ approach advances the idea of water restrictions, educating the public on water saving methods through national wide campaigns though different Medias for the current and long run benefit.

Basing on the principles of Integrated Water Resource Management, the success of water management is due to a range of factors including integrating water into development planning, building supportive institutional structures with the mandate to control, regulate and learn, adaptability and managing both supply and demand. Lesson can be drawn from case studies that are considered as success stories from developed and developing countries, such as Singapore and Windhoek, Namibia respectively. More research need to be conducted in order to advance the intervention towards water secure cities.

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Appendices

UNIVERSITY OF KWAZULU-NATAL
SCHOOL OF BUILT ENVIRONMENTS AND DEVELOPMENT STUDIES

Researcher: Mr. Edmore Mutsaa (+27710526148)
Supervisor: Dr. H. Magidimisha (031 260 1353)
Research Office: Mr. P. Mohun (031 260 4557)

Dear Respondent,

I, **Edmore Mutsaa (211543942),** a Master of Town and Regional Planning student, in the **School of Built Environments & Development Studies**, of the University of KwaZulu Natal invite you to participate in a research project entitled "Assessing the usefulness of Water Conserving City Planning: A Case of Inner city Durban, South Africa**"**. The aim of this study is to find ways to optimize the use urban landscape in conserving water and maximize the use of available water supplier before attempting to explore and expand new supplies at higher costs.

Through your participation I hope to address the following typical questions:

a. Can we safely and certainly say we have a water crisis in the city of Durban?
b. How useful do you think are the existing water conservation plan, considering the continuation of the water crisis?
c. Are the water conserving policies failing to address the issue of water scarcity, starting from the National, provincial to local governmental level, if so what the what are the challenges?
d. In which way you perceive the infrastructure being used to conserve water in inner city Durban, for example storm water, blue roofs on buildings, etc.?
e. What is your take on the feasibility of supplying water specifically suitable for its use in a specific area for the whole city of Durban as a way of conserving water, for example fresh water to residential areas and grey water or recycled water to industrial precincts/areas?
f. In general, what are the perceived challenges to the water conserving initiative in Durban?
g. In your efforts to conserve water, you might have experienced challenges; can you describe the various difficulties experienced or currently being experienced?
h. Looking at the current water threats in the city of Durban, what would you propose as recommendation to conserve or save water?
    I. Can you think any short-term solutions to the current water problem in the city of Durban?
    II. What do you think might be long-term solution to the water problem in the city of Durban?

The results of this research study are intended to contribute to eThekwini Municipal area with the purpose of enhancing a water secure city and its practices particularly in Durban inner city.

Your participation in this project is voluntary. You may refuse to participate or withdraw from the project at any time with no negative consequence. There will be no monetary gain from participating in this survey. Confidentiality and anonymity of records identifying you as a participant will be maintained by the School of Built Environments and Development Studies, UKZN. The final dissertation is going to be available in the School library and upon request the findings of the research will be given to you.

If you have any questions or concerns about participating in this study, you may contact me or my supervisor on the numbers listed above.

The interview should take you about **15-20** minutes to complete.

Sincerely

Researcher's Signature_____ Date_____

CONSENT

I …… (Full names & surname of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project.

I understand that I am at liberty to withdraw from the project at any time, should I so desire.

I hereby consent to allowing this interview to be tape recorded Yes ☐ No ☐

Signature of Participant…..…… Date……..

(i) Can we safely and certainly say we have a water crisis in the city of Durban?

(ii) How useful do you think are the existing water conservation plan, considering the continuation of the water crisis?

(iii) Are the water conserving policies failing to address the issue of water scarcity, starting from the National, provincial to local governmental level, if so what the what are the challenges?

(iv) In which way you perceive the infrastructure being used to conserve water in inner city Durban, for example storm water, blue roofs on buildings, etc.?

(v) What is your take on the feasibility of supplying water specifically suitable for its use in a specific area for the whole city of Durban as a way of conserving water, for example fresh water to residential areas and grey water or recycled water to industrial precincts/areas?

(vi) In general, what are the perceived challenges to the water conserving initiative in Durban?

(vii) In your efforts to conserve water, you might have experienced challenges; can you describe the various difficulties experienced or currently being experienced?

(viii) Looking at the current water threats in the city of Durban, what would you propose as recommendation to conserve or save water?

-Can you think any short-term solutions to the current water problem in the city of Durban?

-What would you suggest to be long-term solution to the water problem in the city of Durban?