DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

REDUCING WATER CONSUMPTION IN LOW-COST HOUSING AREAS IN THE ETHEKWINI MUNICIPALITY

Submitted in fulfilment of the requirements of the

degree of **Doctor of Philosophy** in Public Administration - Peace Studies

in the

Faculty of Management Sciences

at the Durban University of Technology

ROOKMONEY THAKUR

OCTOBER 2021

Supervisor: _ Date: 15/11/2021

Co-Supervisor: _ Date: 15 November 2021

DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

Plagiarism declaration

1. I know and understand that plagiarism is using another person's work and pretending it is one's own is wrong.
2. This essay/report/project is my own work.
3. I have appropriately referenced the work of other people I have used.
4. I have not allowed and will not allow anyone to copy my work with the intention of passing it off as his or her own work.

ROOKMONEY THAKUR

_____

Signature

Student Number: 19251504

Declaration

I, **Rookmoney Thakur**, hereby declare that this dissertation represents my own work, and that all the references, to the best of my knowledge, are accurately reported. This work has not been submitted for any other qualification, and its only prior publication has been in the form of submissions as listed below.

JOURNAL PUBLICATION

Thakur, R., Harris, G., Thakur, S., Onwubu, S. 2019. Title: Factors contributing towards high water usage within poorer communities in Kwazulu-Natal, South Africa. Water and Society, WIT Transactions on Ecology and the Environment, Volume 239, WIT Press, 2019, ISSN 1743-3541.

BOOK CHAPTERS

Rane, A.V., Thakur, S. and **Thakur, R.,** 2019. Rubber Dam - an Introduction. In *Hydraulic Rubber Dam* (pp. 1-9). William Andrew Publishing.

Thakur, R., Rane, A.V., Harris, G. and Thakur, S., 2020. Government initiatives and policies for water conservation and wastewater treatment in South Africa and indigenous knowledge. In *Water Conservation and Wastewater Treatment in BRICS Nations* (pp. 285-293). Elsevier.

Thakur, R., Rane, A.V., Harris, G. and Thakur, S., 2020. Future prospective and possible management of water resources in respect to indigenous technical knowledge in South Africa. In *Water Conservation and Wastewater Treatment in BRICS Nations* (pp. 353-363). Elsevier.

ABSTRACTS AT CONFERENCES

Thakur, R., Harris, G. 2018. Title: A Review on water conservation development in the eThekwini municipality. 3rd Interdisciplinary Research and Innovation Conference, Durban University of Technology, Durban, South Africa, 18 – 20 September 2018.

Thakur, R., Harris, G., Thakur, S. 2019. Title: A review of global water supply and demand approaches in Singapore, Germany, Brazil, India and South Africa. 4th Interdisciplinary Research and Innovation Conference, Durban University of Technology, Durban, South Africa, 17 – 20 September 2019.

Thakur, R., Harris, G., Thakur, S., Onwubu, S. 2019. Title: Factors contributing towards high water usage within poorer communities in Kwazulu-Natal, South Africa. Water and Society 2019, Valencia, Spain, 2 – 4 October 2019.

_____ 14-11-2021

Signature **Date**

Acknowledgments

I am overwhelmed in all humbleness and gratefulness to acknowledge all those who have helped me put my ideas, well above the level of simplicity, and into something concrete.

Foremost, I express my sincere gratitude to my supervisor, Prof. Geoffrey Harris for his mentorship, patience and enthusiasm shown throughout my research.

I owe my deepest gratitude towards my spouse, Surendra Thakur, for his endless reassurance and understanding of my goals and aspirations. I am thankful to my children, Mikaela and Sachin, whose infallible love and patience will remain an inspiration throughout my life.

My special words of thanks to my parents, Mr. and Mrs. Roy and Rani Murugasen, for their endless words of encouragement and moral support during the duration of this research.

To Dr. Stanley Onwubu, an exceptional human being, I couldn't ask for a better friend. Thank you for your unwavering support, guidance, and insightful advice throughout my post-graduate studies.

I acknowledge the unfailing encouragement I received from my friends. Dr. Lavanya Madhura for your words of encouragement; Mrs. Pam Naidoo for your continuous support and friendship; and Dr. Ajay Rane for always boosting my confidence.

The financial assistance of the National Research Foundation (NRF) towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at, are those of the author and are not necessarily to be attributed to the NRF.

Abstract

South Africa is facing a water crisis and local municipalities are finding it difficult to mitigate the gap between supply and demand. Although the government's policy to allocate a basic supply of 9*kl* of free water per month to indigent communities is commendable, the rapid exhaustion of the free supply by low-income communities necessitating a tariff applied for additional water consumption, is concerning. Whilst this consumption-based tariff is used to encourage conservation, municipalities nevertheless face a revenue loss due to a non-payment culture.

This study argues that behavioural change is more beneficial than punitive economic measures and seeks to develop a strategic intervention to assist the eThekwini municipality to promote water conservation behaviour in one low-income community, called Waterloo. The Theory of reasoned action (TRA) is used to identify the beliefs, attitudes and subjective social norms towards water conservation and the Nudge Theory is used to incentivise water users towards behavioural change.

A mixed method exploratory sequential design method is adopted. The qualitative phase of the study consists of semi-structured interviews with eight key informants from government and the public sector; and four focus group discussions with 22 residents of the Waterloo community, to determine the factors that influence their water-use behaviour.

Participation in this study was voluntary with confidentiality maintained. The data was recorded and transcribed to ensure credibility. The results were interpreted and analysed against existing literature using thematic content analysis.

The quantitative phase of the study investigates the power of the TRA. Results from a survey comprising 304 residents indicate that low-income householders generally have very positive attitudes towards water conservation and saving practices, nonetheless these positive attitudes are not consistently translated into actual behaviour.

In synthesising the results, three recurring key issues are identified, namely (1) access to knowledge; (2) community engagement as part of the solution; and (3) allocation of incentives. The key finding of study indicated that awareness of the current water situation itself may not motivate good water use behaviour. While participants had knowledge of water conservation practices, there was, however, a high amount of water consumption and high unaccounted water losses in the area. Therefore, nudging the community may be an ideal approach towards behavioural change.

The thesis concludes by proposing a community-based behavioural framework, as a guideline for eThekwini to consider when designing conservation measures for low-income communities.

Table of Contents

List of figures

List of Tables

Acronyms and Abbreviations

ANOVA	**:**	Analysis of Variance
CA	:	Choice Architecture
CBA	:	Cost-benefit Analysis
COAG	:	Council of Australian Government
DS	:	Department of Water and Sanitation
FBWP	:	Free Basic Water Policy
GDP	:	General Domestic Product
IUWM	:	Integrated Urban Water Management
IWRM	:	Integrated Water Reforms Management
LCH	:	Low-cost housing
MAE	:	Mean Annual Evaporation
MAP	:	Mean Annual Precipitation
MAR	:	Mean Annual Runoff
MDB	:	Murray-Darling Basin
NCWR	:	National Council on Water Resources
NEPA	:	National Environmental Policy Act
NGO	:	Non-governmental Organisation
NRW	:	Non-revenue Water
NSW	:	New South Wales
NT	:	Nudge Theory
NWA	:	National Water Act
NWRMS	:	National Water Resource Management System
NWRP	:	National Water Resources Policy
PPP	:	Public Private Partnership
PUB	:	Public Utilities Board
RDP	:	Reconstruction and Development Programme
RWH	:	Rainwater Harvesting
SA	:	South Africa
SEM	:	Structural Equation Model
SWRI	:	State Water Resource Management Institutions
TRA	:	Theory of Reasoned Action
UFW	:	Unaccounted for Water
UN	:	United Nations
UNDP	:	United Nations Development Fund

UNICEF	:	United Nations International Children's Fund
WEF	:	World Economic Forum
WHO	:	World Health Organisation
WM	:	Water Demand Management
WMA	:	Water Management Act
WMA	:	Water Management Area
WRA	:	Water Regulatory Authority
WSUD	:	Water Sensitive Urban Design

Chapter 1: Introduction

1.1 Background to the study

Water plays an integral role in every facet of life. It defies location, background and social standing thus making it vital in every living system from plants and animals to humans (Gibb 2016). The need for water can never be overemphasised as it sustains the functioning of schools, hospitals, industry and food production (Sobowale and Ortigara 2017). It is argued by Browne, Jack and Hitchings (2019) that it is only under conditions of scarcity when the needs of consumers are not fully satisfied, that the importance of water is felt. Gude (2016) highlights that when this resource is accessible in abundance, people are more likely to use it as if it were inexhaustible. Both the above-mentioned studies concur that it is most often the developing and under-developed nations that suffer the consequences of water scarcity as result of poor water management and conservation measures. Given that South Africa is a developing country, important steps need to be taken to develop sustainable water policies to necessitate its efficient use, particularly in regions reflecting an excess of demand over supply.

Water security has an impact on countries globally with the developing countries facing the biggest challenges from water-related risks. OECD (2016) cautioned that despite the fact that most developed countries have relatively good water availability, they must continue to adjust and invest in order to sustain it in the face of climate change, declining infrastructure, and economic growth, among other factors. Furthermore, preliminary studies since the turn of the century (Simonovic 2002; Ridoutt and Pfister 2010; Pahl-Wostl 2017) show that access to clean water is quickly becoming a global priority as freshwater resources become scarce in already *water stressed* regions. This is a consequence of increase in the population growth, urbanisation, and climate change and the United Nations Department of Economics and Social Affairs (2014) predicts that more than two thirds of the global population will live in water-stressed regions by 2025 (Ringler *et al*. 2016). Despite the advances in modern science and innovation, providing adequate and affordable clean portable water remains a challenge globally (Mauter *et al*. 2018).

Furthermore, Li *et al.* (2016) warn that the threat of climate change has drastically affected the spatial distribution of water supplies, particularly in semi-arid and arid regions of the world. As an example, Kostigen (2014) in his article published in the National Geographic noted that according to climatologists the mega drought experienced in California could last for 200 years. Jiang (2015) and Li and Qian (2018) report that China is facing increasing water stress due to global warming which is impacting its economic connection with the rest of the world. Also, in India, a satellite image of Chennai, home to nearly 9 million people, reveals the region in the throes of Day Zero as it had run out of fresh water (Palanichamy 2019). The aforementioned studies suggest that the water crisis is a potent global crisis with an estimated 700 million people in 43 countries afflicted with water scarcity.

In the context of South Africa, a number of factors such as climate change, pollution, and water use have a negative impact on the current water situation. This is further compounded by the lack of appropriate capabilities and skills at the municipal level to efficiently manage water resources (Hedden and Cilliers, 2014; Gumbi and Rangongo 2018). More so, the effective provision on the supply of water is further hindered by aged infrastructure, vandalism and illegal connections, among others. This poses a serious and immediate risk to the economy and social stability of citizens (ActionAid South Africa 2016).

A report by the Department of Water Affairs (2012) state that the country experiences low rainfall relative to the global average, high evaporation due to hot weather, and rising water pollution concerns. Hence, these factors restrict the amounts of water that can be used. Moreover, should climate change persist, and conservation measures prove inefficient, this will pose a serious concern when the allocated amount is no longer enough to meet future demands (ActionAid South Africa 2016). Despite these concerns, 40% of municipality-supplied water is lost through leaking or burst pipes and dripping taps resulting in an estimated economic loss of more than R7-billion annually (Mavundla 2016). Maphela (2015) highlights that such water losses are very high in many towns in South Africa as municipalities struggle to implement current water conservation strategies at a domestic level.

Water conservation studies (Feike and Henseler 2017; Tuncok and Eslamian 2017; Lede, Meleady and Seger 2019) argue that conservation measures are considered a viable tool for optimising existing supplies of water. They posit that conservation

measures are the cheapest, fastest, and most reliable way to stretch existing water supplies whilst still ensuring a high quality of life. However, an earlier study by Nkosi (2010) attributes the poor conservation practices to distrust in water authority bodies by the public. This is supported by Timm and Deal (2018) who note that the public may be more receptive to water conservation initiatives if they believed that water agencies were trustworthy.

Although different water conservation strategies, including quantifying and mapping of water scarcity areas (Brauman *et al*. (2016), codifying water practices for evaluating water use in life cycle (Boulay *et al*. 2015) and water pricing (Mamitimin, Feike and Doluschitz 2015), have been proposed in the literature, Bennett *et al*. (2017) has argued that these strategies are more centred on the benefits of conservation than on understanding the science of people's behaviour towards conservation. Furthermore, Reddy *et al*. (2017) argue that conservation strategies are only effective if there are fundamental and widespread changes in human behaviour. This is consistent with Timm and Deal (2018) who state that effective water demand management strategies require knowledge of how people use water and understanding of the relationship between psychological and behavioural aspects of water consumption. The authors suggest that by understanding psychological factors (attitude, beliefs, and social norms) affecting water consumption, water bodies can apply more effective and workable water conservation strategies.

The advice of the afore-mentioned authors is considered in this study through the application of the Theory of reasoned action (TRA) which views human behaviour as a result of rational thinking (Marandu, Moeti and Joseph 2010). TRA is considered by Haggar (2019) to be one of the most influential approaches to predicting and understanding intentional behaviour. It is thus inferred that understanding residential water conservation behaviour, will enable an effort to be made towards designing intervening measures that help individuals to develop more environmentally friendly water consumption behaviour.

Whilst municipalities have adopted monetary and other incentives to reduce water demand, little is known about how successful these initiatives were at convincing residents to save water. A study by Matikinca *et al*. (2020) found that there was no consensus in the literature about which types of measures are most effective for managing residential water demand and encouraging good consumer behaviour.

Whilst the attempt of changing human behaviour has been premised on the TRA in previous studies (Hurlimann and Dolnicar 2010; Marandu *et al.* 2010; Ramsey, Berglund and Goyal 2017), to the researcher's knowledge, there is no research on using Nudge theory to promote water conservation behaviour in a low-cost housing (LCH) setting within South Africa in which the provision and allocation of water is free. According to Reddy *et al*. (2017), the nudging approach of changing human behaviour is centred on using intuition to influence a change in human behaviour. More so, Ryan (2017) found that one of the most prominent ways in which behavioural sciences have shaped public policy has been through the principles of Nudge theory. According to the afore-mentioned author, to nudge someone is to purposely intercede in a given environment, without the need to offer financial incentives. Furthermore, Nudge theory is considered a progressive deviation from conventional approaches such as direct training or instruction towards creating change in an individual's behaviour. According to John (2018), it is based on the principle of indirect encouragement as it eludes direct enforcement. For example, instructing a child to clean his room is an enforced change, whereas, playing a 'room tidying game' with the child is a nudge technique.

Nudges have been claimed to steer people in undesirable directions (goals) and even been criticized for insufficiently respecting people's rational decision-making capacities (Hausman and Welch 2010; Engelen, 2019). However rather than coercing, incentivizing or merely informing or persuading people, nudges steer people's behavior by tapping into irrational psychological mechanisms such as salience, loss aversion, conformism and status quo bias. Further even if a problem is presented in a particular way, "*one must weigh what matters most – generating desirable outcomes* "(Engelen, 2019:206).

Although the TRA and nudge theory appear to be contradictory, the researcher hopes that by combining the two paradigms, it will help strengthen the water conservation behaviour in the low-income communities. While the TRA will aid in understanding the influence of subject norms and attitudes in water conservation behaviour, the nudge, by contrast, will gently encourage and or reshape existing choices of water conservation methods available to the people by the government. As such, the purpose of this study is thus to propose a strategic intervention in the form of a community behavioural model that is premised on the TRA and the nudging approach

towards behaviour change, in order to assist the eThekwini municipality in its efforts to encourage water usage within the free water allocation limits.

1.2 Statement of the problem

South Africa currently has a low economic growth economy and in the short term it is predicted that the number of indigent households will increase (Department of Water and Sanitation 2018). Furthermore, the demand for water supply and sanitation services is significantly affected by high urbanisation. Significantly, water wastage and pollution of rivers and groundwater are increasing as a result of aging, low quality, and poorly maintained infrastructure.

At a global level, the provision of safe drinking water is threatened by rapid population growth, lack of infrastructure to support the increase in demand, and climate change that has caused droughts and flooding in many countries (Lindsay, Dean and Supski 2017). Given the said concern, it becomes imperative that attention be paid towards water conservation as a way of managing the current water supply. Several studies (Feike and Henseler 2017; Tuncok and Eslamian 2017; Lede, Meleady and Seger, 2019) identify water conservation as one of the most cost-effective measures in ensuring a reliable supply of water particularly for water-scarce regions. However, water authorities remain fundamentally focused on increasing water supply as opposed to reducing water demand.

As a water scarce nation, South Africa is plagued by a slew of issues, either natural like droughts and flooding or man-made such as deforestations and industrialisation that continue to deplete the country's water supply (Gumbi and Rangongo 2018). By 2025, it is expected that the country's water supply will have decreased by about 1.7 percent (Von Bormann and Gulati 2014). As a result, it is critical to implement attentive and comprehensive strategies to expand and sustain the adequate supply of water in the communities. In addition, this increase in water demand has created more challenges particularly to impoverished communities who are impacted by lack of or aged water infrastructure. Adeyeye, Gibberd and Chakwizira (2019) found that limited resources, both human and capital, further constrain the possibility towards sustainability in vulnerable communities.

Other studies (Griffin 2016; Shiva 2016; Loucks and van Beek 2017), however, observe that within poorer areas, the efficient use of water resources remains a subject of major concern for water utilities. A report by eThekwini Water and Sanitation (eThekwini municipality 2015) reveals that the economic loss of treated water, as a result of leaks, vandalism, and wastage, is estimated to cost the city of Durban an estimated R600 million a year. In South Africa, water is billed on a sliding scale (Njiraini, Thiam and Coggan 2017) with the first 6 kilolitres provided free as part of the Free Basic Water Policy. However, amounts used above this level is priced and the more you use the higher the rate per kilolitre you will pay. That said, in the eThekwini municipality, for example, indigent households receive a stipulated amount of 9*kl* of free water per month for a household of eight people as per the government's Free Basic Water Policy (FBWP). This limit is reduced to 6*kl* during periods of drought. The amount of water used above the deemed limits is priced. The tariff system is further discussed in Ch 3 section 3.91. Whilst access to water is acknowledged as a basic human right to address the inequalities of the past, as reported by Hazelton (2019), recovering the full cost for the excess water used over and above the 9kl is problematic and has contributed further to the financial crisis plaguing many municipalities throughout the country.

Butler (2017) blames a *culture of non-payment* for the loss in revenue, particularly in areas receiving free basic services such as water and electricity. Moreover, according to Sheik (2017) punitive measures to curb overuse beyond the 9*kl* monthly limit of water is futile because many municipalities face technical challenges with their billing system. Significantly, discussions with eThekwini municipality water officials suggest that the FBWP model has been a challenge when it comes to the cost recovery for the usage of water above the FBWP limits of water. When interviewed on 12 July 2018, Gounden (Strategic executive of eThekwini water and sanitation) expressed concern that large amounts of water were also lost due to unreported leaks. Studies (Feike and Henseler 2017; Katz, Kronrod, Grinstein and Nisan 2018; Tortajada *et al*. 2019; Lu, Deller and Hviid 2019) show that water pricing as an incentive to conserve water in order to reduce production and consumption costs, has provided relief to the water supply system in countries like China, Australia, Germany and Spain. For the reasons noted above however, in South Africa it has become a challenge to promote water conservation.

This study takes cognisance of the challenges related to water usage in LCH areas. There is clearly a need for innovation of new concepts and strategies to instil a water-saving culture and behavioural change. This research proposes a community-based framework to assist the eThekwini municipality to promote effective water conservation behaviour. The study will focus on household attitudes, knowledge and subjective norms in an effort to reduce water consumption.

Bearing in mind that the provision of water to domestic consumers in the eThekwini municipality is based on a stepped tariff, which is the higher the consumption, the more you pay (eThekwini Municipality, Environmental Planning and Climate Protection Departments 2010), this study will also apply the Nudge theory to incentivise recipients towards behavioural change.

1.3 Aim and objectives

The overall aim of this study is to develop a strategic intervention in the form of a behavioural model to assist the eThekwini municipality in its efforts to encourage water usage within the free water allocation limits.

The specific objectives of the study are:

1. To compare the South African water resource management strategy with Brazil, Singapore, Australia and India.
2. To determine the factors that influence water-use behaviour in one low-cost housing area by:
    - Examining the resident's levels of knowledge and
    - Determining the resident's attitude towards water conservation.
3. To propose a community-based model towards water conservation and preservation in low-cost housing areas by applying Nudge theory and the Theory of reasoned action.

1.4 Research questions

The study asks the following questions:

1. Is the eThekwini water management system for low-cost housing areas sustainable and affordable?
2. What are the prevalent water consumption behaviour in the Waterloo community and what effective strategies can be designed to target behaviours that have the greatest potential to save the most water?

3. What is the residents' awareness of water conservation issues in the Waterloo community?

1.5 Causes of water scarcity

The eThekwini Municipality, Environmental Planning and Climate Protection Departments (2010) report acknowledge that South Africa is a water scare country. The report, therefore, cautioned that should the current rate of water usage continues, demand may exceed the supply, which could result in water cuts. Moreover, and as highlighted in the report, should South Africa experience another extended drought period, water shortages will become acute and could result in the introduction of extreme measures including water rationing.

The above reports reflect the dire water situation in South Africa and the need to implement water conservation to avoid water supply interruption and its subsequent impacts in the quality of life of many South Africans. Hence, it becomes highly important to unpack the causes of water scarcity in order to develop measures for effective mitigation and conservation strategy. Pedro-Monzonís *et al*. (2015) define water scarcity as a state where a short supply of water resources is available to satisfy long-term average requirements. Similarly, Armenia *et al*. (2018) describes water scarcity as the overexploitation of water resources when demand for water is higher than water availability.

Singh and Sharma (2019) refer to water scarcity as the gap between the demand for and supply of freshwater resources, given a predetermined time horizon and spatial scale. In general terms, water scarcity covers all aspects related to restricted water availability. Water scarcity may be categorised into economic water scarcity and physical water scarcity as depicted in Figure 1-1.

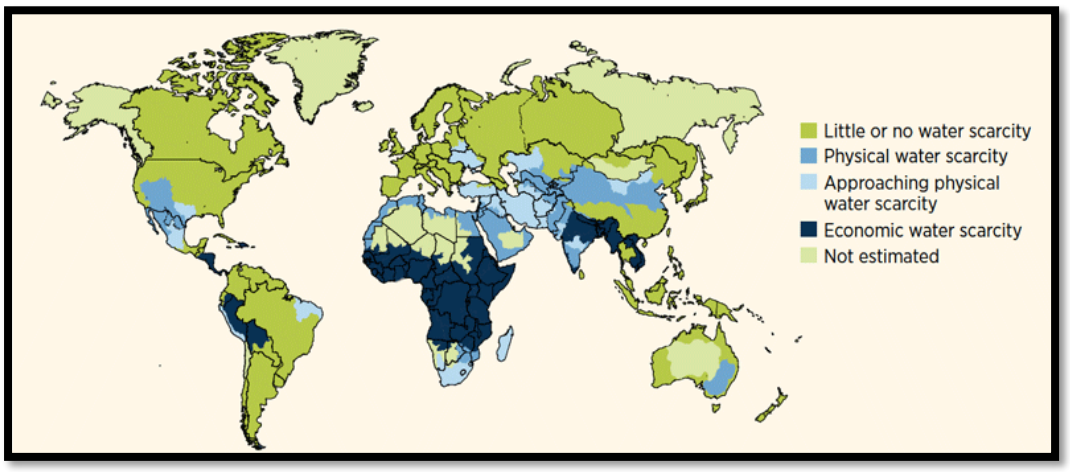


Figure 1-1: Different types of water scarcity around the world (adopted from World Water Assessment Programme 2012)

According to Gupta (2018), water scarcity occurs because water resources are poorly managed, there is a lack of good governance, there is a lack of investment in sustainable water infrastructure, or there is a lack of human capacity to satisfy water demand, particularly in areas where there are sufficient resources. This typically occurs in African countries and parts of the Indian subcontinent where there is an unequitable distribution of water and a lack of investment in water infrastructure development. Physical scarcity of water arises in countries that are not able to meet all water demands (Holland *et al.* 2015). This often occurs in arid and semi-arid regions because of low rainfall and dearth of natural water resources. Around 700 million people in 43 countries suffered from water scarcity in 2019. It was noted by Yazdanpanah *et al*. (2015) that by 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity.

Balooni and Venkatachalam (2016) indicate that water scarcity is a paramount concern that affects economic growth and sustainable development. In turn, as shown by Pekel *et al*. (2016), water scarcity parallels the climate change effect in terms of space and scale. This aligns with Lonergan (2018) who attributes water scarcity to population growth and climate change. All the aforementioned authors concur that both these intertwined concerns are a challenge to food security and may well lead to cross-boundary conflicts between nations.

Consequently, it should be noted that many poor countries experience scarcity due to climate change and lack of proper infrastructure, whilst industrialised nations experience conflicts in terms of water-quality degradation and droughts (Maggioni 2015). The literature, as noted, suggests that due to natural and man-made threats to the availability of water, industrialised and developing countries are now compelled to explore new management techniques and policy makers world-wide are now compelled to review existing policies on water management (Cosgrove and Loucks 2015).

According to Liu, Liu and Yang (2016), water scarcity can be a result of two mechanisms, namely, natural causes and human causes. This aligns with Loucks and Van Beek (2017) who established that physical water scarcity (natural) is a result of inadequate natural resources to supply a region's demand; whilst economic water scarcity (human) is a result of poor management of the sufficient available water resources. The causes are noted in Table 1-1.

Table 1-1: Natural and human causes of water scarcity

Natural Causes	Human Causes
(a) Drought (b) Climate Change	(c) Urbanisation and Population Growth (d) Poor and aging infrastructure

Natural causes of water scarcity can be a result of drought, climate change and earthquakes whilst human causes are ascribed to urbanisation and population growth, disparity in water supply, and aged or poor infrastructure. These causes are discussed below:

(a) Drought

A drought, as described by Otkin *et al*. (2016), occurs when an area or region experiences a lengthy period of atypical dry weather. This is usually due to reduced levels of rainfall which results in low water levels in aquifers and reservoirs, consequently resulting in water shortages at a household level. A drought is therefore an area that doesn't get enough rainfall to sustain the life that resides there. Some countries such as Ethiopia, Sudan, Afghanistan, India, Pakistan and China are in perpetual drought (Barlow and Clark 2017).

As noted by Carrao, Naumann and Barbosa (2016), parts of the world that suffer erratic periods of drought include the United States, Australia and South Africa, amongst many others. Accordingly, many countries where large portions of the population are affected by drought and severe water restrictions, have identified sustainable management of water as a key national priority.

(b) Climate Change

Gosling and Arnell (2016) describe climate change as any change to weather patterns over a period of time, whether caused by natural or human activity. Climate change presents potential risks related to the availability of water supply at a sustainable quality and quantity. It can lead to a significant variation in the patterns of weather related to temperature, rainfall, or wind. DeNicola *et al.* (2015) observe that the average global temperatures and precipitation levels are expected to increase at varying degrees around the globe as a result of climate change. Silanikove and Koluman (2015) caution that this will severely affect the availability and quality of water unless water-scarce nations are able to adapt. Stigter *et al*. (2017) agree that not only will the effects of climate change exert pressure on water demand and existing water resources, but due to extreme weather patterns it will also transmit pathogens and other pollutants into waterways via runoff and flooding. Thus, water quality becomes a matter of concern as it will be the poor and developing nations who will suffer the most from climate change and water-related health issues. Loucks and Van Beek (2017) warn that because many of these nations lack adequate water infrastructure, many communities will switch to unsustainable adaptation methods, such as overexploiting groundwater or resort to using untreated wastewater.

(c) Population growth and urbanisation

Mukherjee (2018) reports that the rapid rise in population, urbanisation, change in societal water use, and changing lifestyles are some of the factors which contribute to an acute shortage of usable water. Consequently, this will have an effect on the current drinking water resources, leading to the need to identify new and alternative sources of production of drinking water. The consensus, as stated by Béné *et al*. (2015) is that there will be more or less the same aggregate available water resources in 2050 as there was in 2007.

Figure 1-2 shows that although the world population is projected to increase by 9.3 billion by 2050, access to available fresh water remains the same.

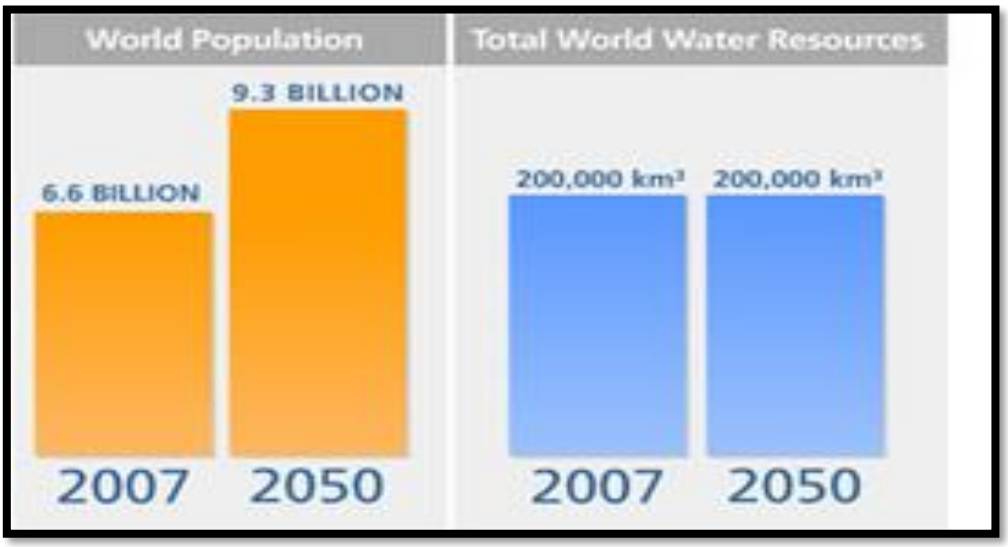


Figure 1-2: Projected water resources in 2007 and 2050 (Sourced from www.fewresources.org/water-scarcity-issues-were-running-out-of-water.html)

A report by WHO (2017) postulates that the world population is anticipated to rise by 33 percent from 7.2 billion to 9.3 billion between 2014 and 2050. During this era, urban populations are expected to expand by 61% from 3.9 billion to 6.3 billion, with the greatest growth anticipated in Asia and Africa. Grafton *et al*. (2016) establish that globally, governments face critical water risks in relation to water availability on the one hand, and increasing water demand on the other hand. Lonergan (2018) reports noticeable tensions between water for food production and other purposes.

(d) Pollution

Pollution has become one of the primary threats to water supply and reuse caused by human activity.

Water pollution has environmental effects that render water unsuitable for human consumption or use. According to Lu *et al*. (2015), pollution can be caused by sewage and pesticides, or excessive salt, nutrients, or suspended solids that make water unsuitable for drinking, or industrial and agricultural use. This suggests that the available water resources are being diminished as a result. Furthermore, according to Huddart *et al*. (2016), unclean water can be a severe threat to human health and

the ecosystem. As such, the degradation of water quality can become a cause of controversy between those causing it and those impacted by it.

In addition, water quality concerns can lead to public demonstrations if it has an impact on living conditions and the environment.

(e) Conflict

In 1985, the then United Nations Secretary-General, Boutros Boutros-Ghali, warned that "*the wars in the future are likely to be fought over wate*r" (Jones 2017:2). For centuries warfare and conflict have been interrelated with the protection of water resources (Shiva 2016). Like oil and other natural finite resources, it follows that the availability of fresh water is every bit as crucial to human progress as energy security. However, unlike oil, water has no known substitutes (Cosgrove and Loucks 2015). Significantly, Francis (2015) points out that this scarcity has already triggered desperation in countries which already have little access to water. One of the main reasons, according to Barlow and Clark (2017), is competing claims for limited quantity water. When water is limited, its provision to users becomes highly contested. Many countries in the Middle East, Africa, Central and South Asia, such as Afghanistan, Iraq, Turkey, Somalia, Egypt, and India, are already feeling the direct consequences of the water scarcity as shown in Table 1-2 below.

Table 1-2: Examples of water-related disputes in selected countries

Location	Main Issue	Observation
1. Yemen	Mismanagement of water resources	As one of the most water-scarce nations in the world, Yemen's water availability is severely declining as a result of unequal distribution, corruption and nepotism. This has resulted in civil unrest and poverty (Warf 2016).
2. Turkey, Syria and Iraq	Transboundary	The sharing of the Euphrates-Tigris Basin has led to strained relations between these three countries. In addition, unilateral irrigation plans to alter the flow of the river have given rise to political tensions (Glass 2017).
3. Afghanistan and Iran	Transboundary	Tensions between the two countries surfaced when Afghanistan initiated dam construction activities along the Helmand River. The river supplies the agricultural needs for both Afghan and Iranian farmers. Iran perceives these developments as a threat to its water security (Thomas, Azizi and Behzad 2016).
4. Cauvery River in India	Quantity of water	The long-standing conflict over water from the Cauvery River between the Indian states Karnataka and Tamil Nadu has recently resurfaced in the context of drier climate conditions. The implications are not only legal battles, but also violent protests following decisions to alter water distribution between the two states (Bhave *et al*. 2018).
5. Somalia	Drought	Plagued by recurrent drought, Somalian herders are forced to sell more of their livestock resulting in a plummet of livestock prices. This has led to widespread poverty which has seen many in recent years turn to illicit activities such as extreme militancy (Warsame 2018).
6. Egypt	High water consumption	Growing water scarcity as a consequence of rapid population growth, rising temperatures and increasing water consumption has put severe strains on Egypt's economy, making the country more vulnerable to renewed internal strife and increasing pressure on diplomatic relations with other states along the Nile (Ghazouani *et al*. 2015).

Weitz *et al*. (2017) believe it is poor governance and management of water resources that led to conflict rather than the lack of water.

This resonates with work conducted by Kerzner (2017) who maintains that in order to regulate water use, countries who experience water scarcity, need to develop and implement stronger water management policies towards sustainable management. The advice of the afore-mentioned studies will be considered towards more effective water conservation strategies for low-income households in South Africa.

A report commissioned by the United Nations on World Water Development (Connor 2015) cautions that inadequate access to safe freshwater will lead to a spate of critical health problems such as waterborne disease and malnutrition. It will also exacerbate challenges such as poverty, economic and political instability. Water insecurity threatens peace not only by accelerating existing conflicts, but also by creating the risk of new conflicts (Balooni and Venkatachalam 2016). In addition, as reported by Jain (2018), the effects of water scarcity can be grouped into six areas, namely lack of access to drinking water, hunger, and lack of education, poverty, sanitation and diseases. This is illustrated in Figure 1-3.

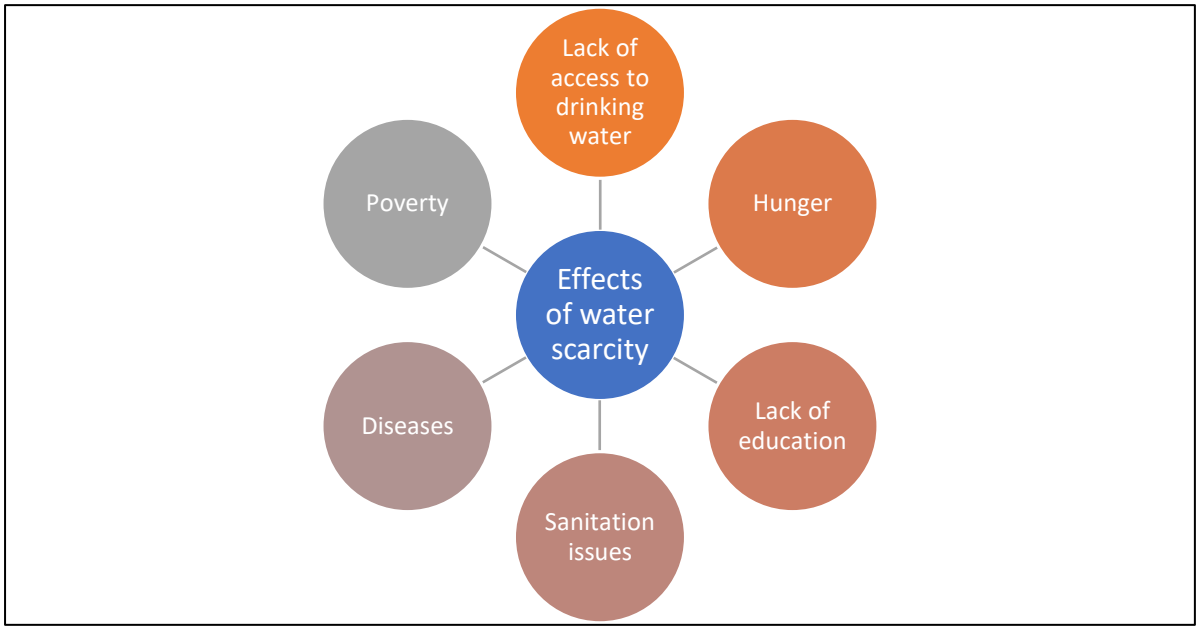


Figure 1-3: Effects of water scarcity (adapted from Jain 2018)

1.6 Significance of the study

Whilst technological devices, in the form of water saving initiatives, are readily accepted by domestic users, Gianfrate *et al*. (2017) found that the savings from these are minimal compared to those that can be achieved by behavioural changes.

Water conservation through the reduction of demand is considered a key aspect of water management. Studies (Ashoori, Dzambuk and Small 2016; Salih and Abdo 2017; Stavenhagen, Buurman and Tortajada 2018) show water conservation is one of the most cost-effective measures in ensuring a reliable supply of water for water-scarce regions. The afore-mentioned studies have urged water utilities to consider water conservation behaviour by consumers as part of their long-term management strategy. If attitudes can be managed more efficiently and if technical solutions are designed to promote more effective use of water, water can contribute to wider sustainability objectives by creating a feeling of social accountability (Wells *et al*. 2016) and a sense of agency in self-managing reduced water habits.

Martin *et al.* (2015) further assert that water utilities can gain bigger benefits when they consider water conservation as part of their long-term water management strategies. Rasul and Sharma (2016) concur that water conservation measures have the ability to reduce water demands in their service areas. It is against this background that this study is undertaken.

1.7 Overview of research methodology and research design

This study has been stimulated by inductive reasoning. Using scientific reports, research and development publications, scholarly articles, standard requirements and legislative guidelines, the study investigates the adequacy of current strategies. The study develops a strategic intervention in the form of a behavioural model to assist the eThekwini municipality in its efforts to encourage water conservation practices in low-cost housing areas. The strategy that is adopted is both theoretical and empirical. A mixed method exploratory sequential design research approach is used for the study. This approach is a two-stage design that starts with qualitative data collection and analysis and followed by quantitative data collection and analysis (Babbie and Mouton 2001).

In addition to the consultation of literature sources, semi-structured interviews and surveys are conducted with experts. Data collection involves purposeful sampling of literature, interviewing of researchers, focus group discussions and a questionnaire administered to water users in a low-income area. The information gathered is analysed and utilised fully, in order to achieve the research, aim and objectives. The validity of the study is based on credibility, dependability, trustworthiness and transferability (Lincoln and Guba 1985).

1.8 Ethics

Ethics clearance for this study was granted by the Durban University of Technology (Appendix 1). Participation in the study is voluntary and all information about the respondents is confidential. Raw and personal data will be stored securely for five years and thereafter will be destroyed. A gatekeeper's letter to conduct the study in the Waterloo community was granted by the eThekwini municipality (Appendix 2).

1.9 Structure of the study

The study comprises nine chapters which are organised as follows:

Chapter 1: Introduction

This chapter has presented an overview of the study covering aspects such as background, problem statement, causes of water scarcity, aim and objectives, justification, research methodology and research design, ethics and the structure of the study.

Chapter 2: Review of Literature – Water resource management in the global south

This chapter reviews related literature from journals, periodicals, books, and conference proceedings. It highlights the water management approaches employed by countries in the global south such as Brazil, Singapore, Australia and India. The theoretical framework underpinning this study is presented.

Chapter 3: Review of Literature – Water resource management in South Africa

This chapter reviews literature on the governance of water in South Africa. The review presents an overall view of the state of water in relation to policies, institutional framework and conservation measures. It concludes with a comparative analysis with water resource management in countries in the global south.

Chapter 4: Theoretical framework

The theoretical framework underpinning this study is presented. This study applies the Theory of reasoned action to identify the beliefs, attitudes and subjective social norms towards water conservation and the Nudge Theory to incentivise water users towards behavioural change.

Chapter 5: Research design and methodology

This chapter explains the design of the research and the rationale adopted for this study. The research methodology is presented, and the research paradigm is justified. The pilot study conducted is reviewed and the main study is introduced.

Chapter 6: Results and discussion (Qualitative phase)

This chapter presents the outcomes of the data gathering process for the qualitative part (phase one) of the study. It analyses the results obtained from semi-structured interviews conducted with water stakeholders from the community, the eThekwini municipality and academics and focus group discussions with residents of the Waterloo community. This phase forms part of the preliminary data and served as a point of departure for the study and informs the questionnaire in the quantitative phase of the research.

Chapter 7: Results (Quantitative phase)

This chapter presents data obtained through a questionnaire administered to over 300 residents the Waterloo community, with reference to their knowledge, awareness, and attitude towards water conservation. Results are presented in the form of graphs and tables.

Chapter 8: Discussion

The synthesis of results is discussed in this chapter. The results are used to develop the proposed community-based framework. It provides a guideline for the eThekwini municipality to promote water conservation behaviour in low-income communities.

Chapter 9: Conclusions and recommendations

The chapter discusses the conclusions that are drawn from this study. The main points and findings are summarised, and recommendations are provided for future research.

Chapter 2: Water resource management in the global south (Brazil, Singapore, India, and Australia)

This chapter reviews literature related to water scarcity and water management in the global south. The review is structured into four sections and examines the state of water affairs in Brazil, Singapore, India and Australia in the context of water governance including water policies, institutional frameworks and conservation measures employed by each country respectively. The countries examined in this study form part of the global south and have a unique history of inequality, poverty, and scarcity of water distribution. The intent is to consider whether South Africa can adopt or translocate ideas and strategies in order to adjust, improve or develop its existing methods and practices.

2.1 Introduction

Water is an important commodity and without it life would be impossible. Shiva (2016) describes water as an indispensable resource towards the well-being of mankind that is vital for the manufacturing and sustainability of food, energy, industrial, and household needs. Loucks and Van Beek (2017) further emphasise that water is vital for maintaining all life, ensuring food security and sustainable development. More so, according to Mamathashree, Pavithra and Shilpha (2017), water is impossible to reproduce, it is a challenge to de-pollute, and it is costly to transport. Bharathi *et al*. (2016) further assert that water is a precious gift from nature to humanity. Despite the importance of water in sustaining the ecosystem, the amount of available clean water is relatively scarce.

It is now widely acknowledged that water has become one of the most contentious resources of the future, and that it is becoming increasingly scarce, necessitating more prudent and better usage in the future (El-Nwsany, Maarouf and Abd el-Aal, 2019). Maintaining a long-term approach to water management should help achieve the goals of sustainable development, which are defined as: satisfying present demands while not jeopardizing the capacity of future generations to meet their own requirements (El-Nwsany *et al*., 2019).

Mekonnen and Hoekstra (2016) reviewed the 2016 annual report of the World Economic Forum (WEF) which lists the water crisis as the largest global risk in terms of potential impact. The report identifies the main factors behind the global water crisis as rapid population growth, urbanisation and the changing water consumption patterns as well as the concomitant growth of irrigated agriculture. Varady *et al*. (2016) observe that policy makers and industry stakeholders worldwide are exploring new water management stragegies to ensure the water security within their regions.

They define water security as *"the reliable availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies" (*Varady *et al.* 2016: 71).

Several studies highlight the importance of freshwater and its significance to the sustenance of life. The United Nations General Assembly (2010) asserts that water is a human right. Lu *et al*. (2016) and Agarwal and Goyal (2017) argue that water is an inherent component of the natural environment and a vital part to all social and economic activities. Significantly, Bhaduri *et al*. (2016) emphasise that water sustainability is dependent on managing both supply and demand efficiently.

Concern over water not being able to meet societal needs has been amplified as a result of climate change which is expected to future reduce water resource availability in already arid areas. According to Cosgrove and Loucks (2015), this has deepened competition for water among the different sectors of society such agriculture, ecosystems, local communities, businesses, and energy producing institutions. The result is a threat to regional water supply, energy, and food security, which introduces further challenges related to the distribution and efficiency of water governance (Cosgrove and Loucks 2015). Hence, there is a gap in research on water policy towards economic development, social growth and for environmental sustainability.

2.2 Global context of water

Barlow and Clark (2017) indicate that global concerns over water availability have increased over the last few decades. Fukuyama (2017) agrees that there has been growing concern about the likelihood of a water crisis and further warns that such a crisis would most likely impact a big proportion of the world's population by inhibiting access to services which are essential to the realisation of fundamental human rights.

This view is supported by Schwab (2017) who states that the impact will be felt by the most vulnerable members of the global population, mostly those who do not already have appropriate access to basic public services. According to Gosling and Arnell (2016), the global dependence on water is high with 7, 5 billion people depending on water for general use every day. Concerns are particularly severe in the developing countries where climate change and growing population are expected to be especially challenging.

Fan *et al*. (2014) report that nearly one fifth of the population of the world live in regions where water is considered scarce, and a quarter live with severe water shortages. Figure 2-1 below illustrates the top 10 countries where people live without access to clean water.

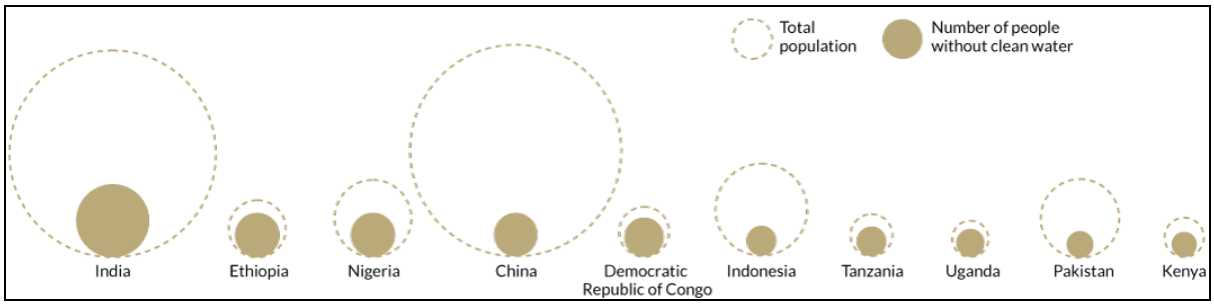


Figure 2-1: Top 10 countries where people live without access to clean water (adopted from Travelhumanity 2018)

International organisations such as World Health Organisation (WHO) and United Nations International Children's Emergency Fund (UNICEF) undertake efforts to resolve these problems in order to ensure safe domestic water sources throughout the world. This has led to an increase in access to improved water supply globally from 76% in 1990 to more than 89% in 2010. According to UNICEF (2017) this means that at least 90% or more of the populations of Latin America, Northern Africa, and large parts of Asia, as well as 61% of the population of sub-Saharan Africa have access to fresh water.

Whilst the above figures are commendable, there are still billions of people worldwide who lack access to water and sanitation. A UN report (Water *et al*. 2018:13) notes that world leaders are not on track to achieve Sustainable Development Goal 6 (SDG 6) on water and sanitation by the year 2030. SDG 6 is part of 17 SDGs designed by

the UN to balance the social, economic and environmental dimensions of sustainable development, as illustrated in Figure 2-2 below.

Figure 2-2: Sustainable Development Goals to be achieved by 2030 (sourced from www.un.org/en/development/desa/population/theme/sdg/index.asp**)**

In some parts of the world, the main factors contributing to the water crisis are not the result of lack of water but rather the effects of flooding - which causes water contamination, as well as countries having poor infrastructure development and investment in water management (Nobre *et al*. 2016). These factors have emerged as a major point of concern. Mabhaudhi *et al*. (2016) believe it is critical that water demand management (WDM) be considered an important matter in the development processes of these regions to ensure access to safe and sufficient water availability. A study by Wanjiru, Zhang and Xia (2016) indicate that WDM is receiving far less attention than supply management. They submit WDM requires further consideration so as to garner more awareness of water resource management and water conservation, particularly in vulnerable communities. This view is supported by Kusena *et al* (2016) who highlight a lack of effort on the part of some government officials in tackling this critical issue. It is evident there is a gap in research on WDM as water is considered a driving force towards sustainable development in any country

in the world. This research, which aims to establish a behavioral paradigm that can be applied to indigent households in South Africa, is aligned with the work of the above authors.

Table 2-1 highlights literature on some of the countries affected not by a physical lack of water but by the effects of climate change and poor water infrastructure.

Table 1-1: Some countries affected by climate change or poor water infrastructure

Country	**Cause of water scarcity**	**% Of Population without access to safe water**	**References**
Papua New Guinea	Rising sea levels caused by extreme weather conditions have tainted groundwater reserves. Even though the country receives above average rainfalls, most of the weather is unsafe to drink.	63 %	Pascoe, Brincat and Croucher (2019)
Sierra Leone	The Ebola outbreak was aided by a lack of clean water as a result of poor infrastructure as health centres and communities struggled to maintain the high hygiene standards needed to halt the spread of the virus.	42 %	Mallow *et al*. (2018)
Liberia	Infrastructure damaged as a result of civil war	33 %	Damkjaer and Taylor (2017).
Myanmar	Depletion of groundwater resources as a result of low rainfall	33 %	Khaing (2016)
Madagascar	Severe drought and flooding	50 %	Desbureaux and Damania (2018)

2.3 Water governance

Water is an inherent component of the natural environment and vital to all social and economic activity (Lu *et al*. 2016) and Agarwal and Goyal 2017) and its sustainability

is dependent on managing both supply and demand efficiently. Woodhouse and Muller (2017) maintain that whilst water is crucial to supporting life, increasing economic development, social growth and environmental sustainability, the myriad of conditions in which water is recognised and used makes it very hard to identify a specific and consistent governance strategy.

Brears (2016), in fact, notes that scholars and policymakers have concentrated on major water users such as agriculture and industries, whilst very little consideration has been given to the management of the urban water cycle in cities.

Baumgartner and Pahl-Wostl (2013:2) define water governance as: *"the range of political, social, economic and administrative systems that are in place to regulate development and management of water resources and provisions of water services at different levels of society".* In addition, the Global Water Partnership's frequently cited definition of water governance reads as follows: "*Water governance refers to the range of political, social, economic and administrative systems that are in place to regulate development and management of water*". Studies (Pahl-Wostl 2017; Bhat *et. al*. 2017) observe that the idea of water management attempts to capture the complexity of procedures controlling the provision of water-related services for societal demands and providing the context in which water management operates. Significantly, research on water governance has gained prominence in the field of scholarly expertise over the last 15 years. Pahl-Wostl (2017) found that the number of publications has risen from about 20 in 2000 to over 600 in 2016.

Wada *et al*. (2016) maintain that water governance reforms in developing nations, are being introduced as a means to support the use of water for fiscal reasons. This suggests that irrespective of whether sustaining extensive commercial agriculture or generating energy, water reforms often come in tandem with the centralisation of power which recognises the government as the owner of water resources and the guardian of water as a public good. According to Marques, Pinto and Miranda (2016) there is a lack of clarity on the roles and responsibilities amongst leaders, policy makers and regulators in relation to methods of allocating resources, as well as poor financial management and lack of accountability. This lack of ability to provide a stable atmosphere for private-sector involvement threatens the provision of water and wastewater services. For that reason, it can be deduced that a lot of water related difficulties can be ascribed to governance failure at multiple levels rather than to the

resource base itself. Consequently, Glavan *et al*. (2019) advise that it is essential to tackle both technical and governance problems in order to ensure sustainable development in the water sector.

Bhat *et al*. (2017) report that there is increasing recognition that better governance and accountable behaviour by all stakeholders are vital towards sustainable development. In other words, present methods seem outdated and no longer sufficient to address the complexity of the water industry, particularly the human dimension. Consequently, Glavan *et al*. (2019) calls for a radical change to integrated water leadership. Their study suggests that the main challenge in moving towards more viable water governance and management lies in transforming the governing of water governance. Wada *et al.* (2016) caution though that water reforms are often greeted with resistance from local community groups whose traditional practices and atitudes are premised on water being a common resource meant to be provided sparingly and not restricted. For example, in Thailand, plans by the government to introduce charges on irrigation water encountered extensive resistance from non-governmental organizations (NGOs) and communities that viewed such an approach as a tax on the poor (Cookey, Darnsawasdi and Ratanachai 2016). In this study, cognisance will be taken of people's attitudes and behaviour towards water conservation in indigent communities in South Africa that are provided with a stipulated amount of free water.

Addressing challenges of water supply and demand, and sustainable development, is a multifarious issue as it is different from one country to another. According to Biggs *et al*. (2015), it presents both a technical and political challenge for society in general. For example, in many regions, funding for upgrading and expansion of water infrastructure is neither sufficient, nor sustainable. Liu and Speed (2009) note that the balance between economic development and protection of water resources is pertinent in preventing a gap between availability and demand. Therefore, in order to safeguard the long-term sustainability of water use, water bodies need to capitalize on the value of current supplies.

As an example, in a study by Loucks and Beek (2017), it was found that countries that embarked on infrastructure development by means of significant investments have improved their water resources management and operations. On the other hand, Porter and Kramer (2019) argue that even if poorer countries invested in management of their water resources, it may not yield significant returns as their infrastructure

stocks are so low. This suggests that without the suitable infrastructure to store and distribute water and manage flows, water establishments in poorer countries are severely constrained and face the harsh prospects of water scarcity.

There are thus major challenges in improving conservation and management of water resources. Water conservation behaviour remains an important strategy to ensure future water supply. To increase conservation behaviour, its key drivers must be understood. According to Cook (2017), water conservation refers to the improvement of water availability by increasing water supply in reservoirs, tanks, and soil and catchment areas. Conserving this resource further highlights the need for its judicious use. On the demand side, a variety of economic, administrative and community-based measures can help conserve water (Dilling *et al*. 2018).

In summary, water governance refers to the political, social, economic and administrative systems in place that influence water's use and management. The aim of sustainable water management is to sort out all the many elements of water management and optimize the advantages. This may be accomplished through a variety of methods, including water reuse, water collecting, and water conservation. Through ecological processes, nature maintains a delicate balance, but irrational human consumption produces an imbalance. Sustainable water management may be described as the reduction of water use through changes in user behaviour as well as the use of water efficiency technologies.

This includes the formulation, establishment and implementation of water policies, legislation and institutions, and clarification of the roles and responsibilities of government, civil society and the private sector in relation water resources and services. The next section discusses the different types of water management strategies applied in water governance.

2.4 Water management strategies

According to Al-Saidi (2017), water management has been in a state of constant change globally following the first United Nations water conference in Rio in 1992. Water sectors in many nations have responded to potential problems and water conflicts by implementing fresh institutional frameworks, decentralising the planning of water resources or creating new infrastructures (Al-Saidi 2017). The impact of the conference was so meaningful, Grubb *et al*. (2019) report that it triggered serious

changes towards a more integrated water management system. A survey undertaken at the conference in Rio in 2012, showed that 80 percent of the 130 surveyed indicated that they had adopted reforms towards an integrated water reforms management (IWRM) system. Furthermore, 79 percent of respondents had adjusted their water policies since the 1992 Rio conference, 65 percent introduced IWRM plans, and 71 percent facilitated water management at the basin level (Allouche 2016).

Benson, Gain and Rouillard (2015) found that for the past two decades IWRM has been regarded as the dominant water resource management framework. In fact, it is one of the most important policy models in river basins world-wide, even in Africa.

Key components of IWRM are integration and participation of stakeholder engagement in water management institutions. Integral to IWRM is the following four principles that emanated out of the Dublin Statement on Water and Sustainable Development (Development 1992). According to Mehta *et al*. (2017) the principles recognise:

I. The intrinsic essence of water and its key role towards the sustainability of life, growth and the environment.
II. The significance of collaborative and participatory approaches in water development and management.
III. The crucial role of women in providing, managing and safeguarding of water.
IV. The financial and competitive value of water and the need to recognise it as an economic driver.

However, while the role of IWRM to strengthen water management functions and introduce institutional and legislative reforms is unquestionable, Benson *et al*. (2015) argue that its adoption does not fulfil the original expectation of an extensive policy solution to domestic water management problems. Al-Saidi (2017) concurs that there has been a lack of tangible developments as stakeholder engagement and commitment remain comparatively small while funding for these IWRM facilities, and water services in particular, remain poor and have not changed substantially.

One crucial aspect in the management of water is the protection and minimisation of water loss, including the efficient and effective use of drinking water. In other words, this refers to water conservation. The next sub-section discusses water conservation which is an integral part of this study.

2.5 Water conservation

A number of researchers such as Wang *et al.* (2016); Francés *et al.* (2017); and Munasinghe (2019) have indicated that an appropriate water management strategy, including water conservation, can improve the existing supply and demand balance in countries where water is considered a scarce resource. This in itself is a gap in research because, as reported by Soto *et al*. (2018), there is a lack of public and private sector investments in research, development and implementation of water conservation behaviour frameworks that are required to balance the supply/demand ratio. Several approaches have been implemented across the world to encourage water conservation in urban settings including monetary measures such as pricing, as well as information or communication initiatives aimed at raising awareness of water shortage and encouraging water conservation Francés *et al.* (2017).

However, new advances in applied behavioural economics, imply that this approach might be effectively complemented by simple non-monetary behavioural interventions, which may play a meaningful role in lowering water use and are, more crucially, affordable (Datta *et al*., 2015). Behavioural interventions, or "nudges" have been found to be beneficial in other related actions, such as electricity consumption, organ donation, and influenza vaccination uptake, have been found to be effective. Nonetheless, despite the fact that reducing water consumption is a policy priority for many countries across the world, such behavioural interventions on water use remain relatively unexplored. This is especially true in developing nations, even though policymakers in these countries are under pressure to limit the quantity of water residents consume (Datta *et al*., 2015). Therefore, the creation of cost-effective methods informed by the literature on applied behavioural economics that may be employed by policymakers in developing-country jurisdictions emerges as an important research priority. This has resonance to this study which aims to proffer a behavioural model framework for better water use amongst indigent people.

Loucks and Van Beek (2017) report that water demand reduction is a more viable option than increasing water supplies and could be accomplished through various conservation actions. This requires that consumers understand the value of water and

the long-term effect of water wastage and change their behaviour. Akhmouch and Clavreul (2016) believe that the water sector cannot successfully address water challenges without the co-operation of users and as such, education plays a pivotal role. This aligns with Mahlanza, Ziervogel and Scott (2016) who assert that if users are not educated about the importance of water conservation, they may view conservation measures as punitive. Du Plessis (2017) lists some strategies to promote water conservation which include installing prepaid meters, regulations and by-laws, and improving reticulation design and plumbing standards. In addition, the study further notes that water utilities could enter into negotiations with developers and offer incentives to those that can show that they are adopting water conservation methods in their developments.

The above incentive-based strategy is significant to this study as part of the behavioural framework uses the Nudge theory as a foundation towards generating behavioural change in water users. Importantly, in view of the water crisis, some water managers have been challenged to find effective ways to satisfy future demands without compromising the long-term viability of existing water resource systems. A study by Fullerton, Ceballos and Walke (2016) indicates that a short-term conservation measure is water restriction. Wanjiru and Xia (2015) found that this has been a common practice in South Africa in the past decade as a result of prolonged periods of droughts. Apart from water restrictions, Table 2-2 highlights some of the long-term water conservation methods.

Table 2-2: Some long-term water conservation measures

Pricing	The price a consumer pays for water can have a significant effect on the amount of water used (Munasinghe 2019)
Regulations	Measures to conserve water can take the form of: • Requirements for new construction • Water use restrictions such as only watering gardens at night etc. An example of water conservation policy is the United States' Federal Energy Policy Act of 1992 which mandates the uniform water efficiency standards for plumbing products (Milman and Polsky 2016)
Education	• Consider the viewpoint of all water users. • Programme must be honest and convincing on why the public must conserve water

	• The public must perceive the immediate need to save water • Some methods of communication include direct contact with customers; mass media; in-school training; and participatory campaigns (Alegre *et al*. 2016)
Hardware	Water-saving devices such as low-flow showerheads; toilet tank inserts, dual-flush toilets; pressure reducing valves; water efficient landscapes (Abansi, Hall and Siason 2018).

2.6 Water pricing as a conservation mechanism

Stavenhagen *et al*. (2018) believe that water pricing is an appropriate tool in water demand management at the household level. This is grounded in the belief that the demand for water is decreased when prices rise. This view is supported by Lucas and Cordery (2019) who assert that the pricing of water is reflective on its scarcity and as such will inform users on the value and real cost of supplied water. In this way, it will promote effective water conservation behaviour towards water resources. Wichman, Taylor and Von Haefen (2016) state that the benefits of using a pricing mechanism allows households to respond to rising water prices in the way they want, rather than implementing a mandated technology or reducing specific uses. For example, high water tariffs in countries like Germany, Austria and Spain have been shown to reduce demand significantly (Stavenhagen *et al*. 2018).

In South Africa, the Department of Water and Forestry Affairs (1994) White paper report acknowledged that water has an economic value, and thus be recognised through a sliding tariff. The paper identifies three approaches of water pricing scale, namely, lifeline or social tariff, normal tariff, and marginal tariff. As highlighted in the White paper, lifeline tariff covers the basic human needs and thus the quantity of water usage should not exceed 25 litres per capita per day. The normal tariff, on the other hand, is the use of water for normal household use. The White paper highlights that normal water usage should not exceed 250 litres per capita per day. The marginal tariff, by contrast, is link to when water consumption exceeds 250 litres per capita per day, and thus attract charges. Thus, the more you use the higher the rate per kilolitre you will pay. However, the water consumption in the low-income households were high to such an extent that when interviewed on 12 July 2018 the strategic executive manager at eThekwini municipality, Mr Teddy Gounden indicated that the full cost recovery for the excess water within the low-income community is proving to be a

challenge for the local authorities. His words echo the sentiment of Hazelton (2019) who noted that unpaid water bills might contribute towards financial collapse of many municipalities across South Africa. This study takes cognisance of the excess water consumption in LCH areas and aims to support the local authorities (municipalities) in identifying mechanisms towards promoting effective water conservation behaviour.

In general, Addo, Thoms and Parsons (2018) observe that approaches towards implementing water conservation behaviour measures can either be “command and control” which relies on policies and regulations; or “voluntary” which involves economic and social incentives that encourage good water use. It is important to mention that according to Gianfrate *et al*. (2017) whilst technological devices are readily accepted by domestic water users, the savings resulting from their use is minimum compared to those that can be achieved through behavioural changes. The advice of the above-mentioned study is considered in this research in developing the framework for water behaviour for indigent consumers.

The global concern of climate change has called for a need to re-evaluate the water resources management strategies currently in place in South Africa. Particularly, countries in the global south such as Brazil, India, Australia, Singapore and South Africa are faced with an enormous challenge to meet the water demands of her citizens. The populations of developing countries, particularly those in the global South, are particularly vulnerable to the impacts of climate change on water availability because they are exposed to high levels of water-related risks, have limited coping mechanisms, and have a limited ability to recover from loss, which is frequently caused by factors other than climate change (MacAlister, and Subramanyam 2018). The next section examines the water resource management approaches applied in the above-mentioned countries. The overall objective is to determine whether South Africa can adopt ideas and strategies from countries with related water resource problems in order to develop its existing methods and practices.

2.7 Trends in the global south

Governments around the world advocate for access to safe and affordable water which is recognised as a basic human right (Connor 2015). However, as indicated in Chapter 1, climate change, coupled with rapid population growth, urbanisation and industrialisation is compelling governments to address water-related issues in order to

ensure sustainable social and economic growth. This section compares and evaluates water management strategies employed in nations such as Brazil, Singapore, India, and Australia in an attempt to enhance water management approaches for South Africa. This is illustrated in Figure 2-3.

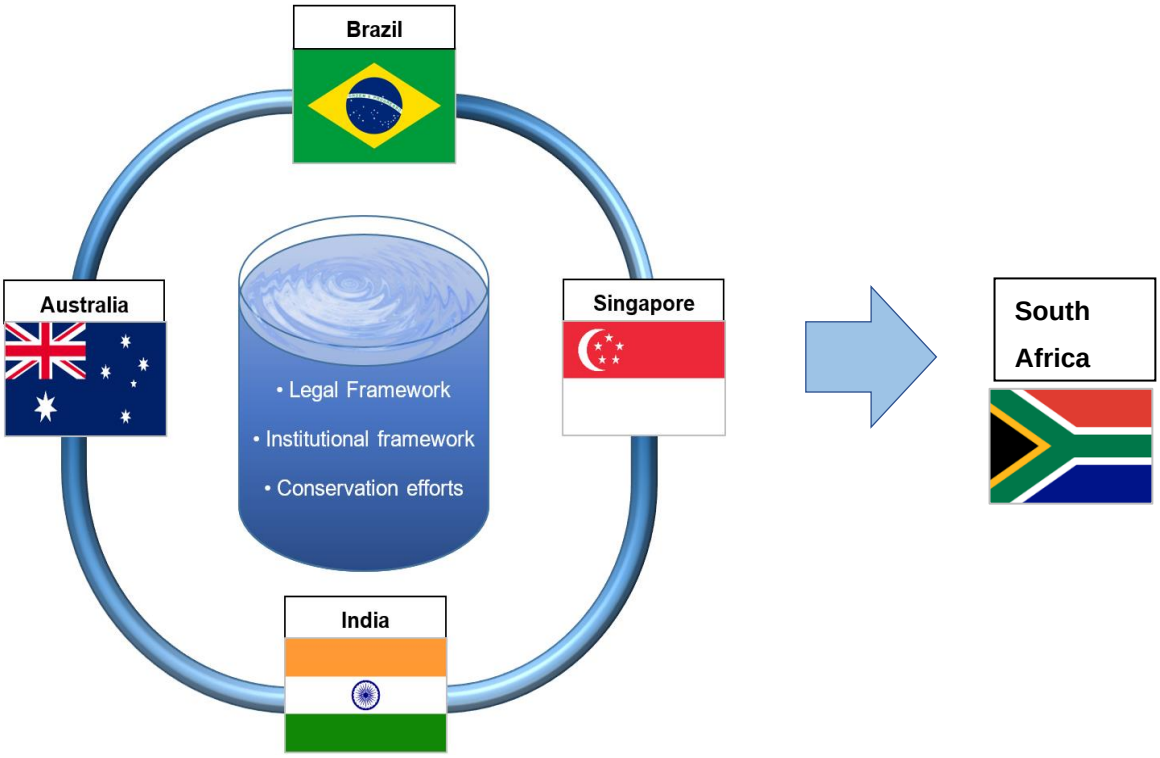


Figure 2-3: Schematic illustration showing the interrelationship in the water conservation framework existing amongst Brazil, Singapore, India, and Australia

2.7.1 Brazil

Several studies (Montambeault 2016; Fearnside 2016; Schulz and Loris 2017) describe Brazil as a *paradox* when it comes to its water sector. Situated in South America, it has almost 12 percent of the world's surface water resources within its boundaries. However, this perceived water abundance, as noted by Victor, Almeida and Wong (2015) has been blamed for the delay in realising that the country is afflicted

with economic water scarcity due to the uneven water distribution amongst its five geographical regions. According to Kayser *et al.* (2015), 68 percent of its fresh water can be found in the northern part of the country, predominantly the Amazon region, which is home to only seven percent of the total population of 200 million people.

This means only 32 percent of Brazillian water resources are available to 93 percent of the people. Other parts of the country where majority of Brazillians live are left arid and water-scarce. The challenges of uneven water distribution is further exacerbated by poor investment in infrastructure development as a result of Brazil's poor management approach as well as excessive water use practices, stemming from a "culture of water wastefulness" based on the notion of the country's water abundance (Victor, Almeida and Wong 2015).

Barbosa and Brusca (2015) maintain that water losses have stayed constant in most towns over the past few years with few indications of recovery. For one thing, according to Dabelko and Parker (2018), about forty percent of treated water is lost through leaks, illegal connections and "other irregularities" in 100 towns with populations over 250,000. Other issues include non-registration of meters, inconsistent meter readings and water fees that are set too low to give the resource a significant value to curb wastage by customers.

In an effort to address the above challenges, Sousa Junior *et al*. (2016) report that the country has made noteworthy changes to its legal and institutional framework in the last two decades. Management of water resources is a fundamental part of Brazil's strategy to fuel sustainable growth by increasing water access to the majority of its populace. In addition, Brazil has made major inroads in the development of hydraulic infrastructure. According to Victor *et al*. (2015), this sustains the country's large biofuel crop industry and hydroelectric irrigation system. However, it is noteworthy to mention that hydropower energy uses and disposes large amounts of the country's water resources.

There are two challenges faced by the Brazilian water sector in managing its water resources effectively. First, the uneven water distribution across the regions has impacted on the livelihoods and health of many communities living in regions with very little access to fresh water. For example, two million households (out of 3 million) in the Northeast, live in extreme poverty. Second, water pollution in the more urban

areas has led to environmental damage and comprised the health of the poorer downstream users. A study conducted by Crow-Miller, Webber and Moller (2017), reports that Brazil has substantially changed its water policies and practices through the adoption of a legal framework aimed at a more coordinated and participatory catchment / basin management strategy based on the best available data.

Brazil's water management strategy is based on the IWRM approach, which supports the creation of basin committees. This approach has resulted in the issuing of water licensing certificates, monitoring by water bodies over water uses, water charges, and development of conflict-solving institutions. The sections that follow discuss Brazil's legal and policy frameworks, institutional frameworks, and water conservation efforts.

(a) Legal and policy frameworks

Faced with the challenges of uneven water distribution and poverty, law makers in Brazil have over the past two decades reformed their strategies towards a more participatory and integrated model. The National Environmental Policy Act (NEPA) of 1981 categorised water as a *limited resource* and a public good. This view was supported by then-President Fernando Henrique Cardoso in 1999 when he remarked that the biggest challenge facing the nation is water (Victor *et al*. 2015).

According to Garcia and Bodin (2019), Congress passed Law 9433 in 1998. This replaced the Water Code, a centralised top-down sectoral structure policy, which was in place since 1934. In an effort to adopt a more participatory management model, Barbosa, Alam and Mushtaq (2016) state that changes in Brazil's water resources management began in 1997. Significantly, the new model allows for the coordination of all dimensions such as environmental, economic, political, social and territorial. Law 9433 established the National Water Resources Policy (NWRP) and created the National Water Resources Management System (NWRMS). As pointed out by Sousa *et al.* (2016) important changes were introduced to the administrative, legal and institutional structures. In fact, Law 9433 decentralised water policies by steering it towards a more integrated management model which follows the principles of IWRM.

The NWRP and the NWRMS advocate the following principles in Brazil (Sousa Junior *et al*. 2016):

I. Integration of all stakeholders into the governance of the water sector.
II. Water is an economically valued resource.

III. Water management should be decentralised and entail user and community participation, and priorities should be set for human consumption in cases of a water shortage.

According to Veiga and Magrini (2013), Brazil's water management framework consists of five levels. This is the National Water Resources Council (NWRC); State Water Resources Management Institutions (SWRIs); State Water Resources Councils (SWRCs); River Basin Committees (RBCs); and Water Agencies (WAs). Barbosa, Mushtaq and Alam (2017) state that the most significant aspect of the framework is the inclusion of both governmental and non-governmental representatives in the River Basin Committee. A river basin is a territorial unit where the water resources policy is implemented. The basin committee is the management body and meets periodically to resolve conflicts, approve and monitor water resource plans, and employ systems for charging for water use. Implementation of the Basin Committees has garnered international recognition for innovation as a participatory management model.

In addition, water is considered as an economic good, and as such water charges were affected as a means of generating a balance between supply and demand. Sousa Junior *et al.* (2016) maintain that paying for water not only promotes a harmonious relationship between competing users, but it also improves effluent quality and finances the sector. In summary Brazil's legal framework for water allows all water users from all sectors of society to be part of decision-making processes. However, in practice, government still has a strong hold over the water sector (Sousa *et al.* 2016).

(b) Institutional frameworks

Garcia and Bodin (2019) say that the distinction between federally controlled water and state-controlled water made in the 1988 Constitution has impeded the effective administration and control of some of the major rivers. The above authors state that while federal water refers to rivers, lakes as well as lagoons across state borders, state water refers to rivers and groundwater within state boundaries. This had led to concerns as the main stem of a federally controlled river cannot be effectively managed without supporting the development of water resources on the state-controlled river systems (Barbosa, Mushtaq and Alam 2017). The National Water Resources Management System is made-up of an integrated structure comprising of

both the public and private organizations, as well as civil society representatives who are in charge with executing the principles of water resources management. The institutional framework is illustrated in Table 2-3 below.

Table 2-3: The institutional framework of Brazil's WRM (Adopted: Peuckert 2016)

The National Council on Water Resources (NCWR)	The highest power within water sector. Responsible for fostering the integration of national, local and consumer planning of water resources.
The National Water Authority	Implements the planning strategies for water resources formulated by the NCWR.
The River Basin Committees	Is made up of stakeholders from the different sectors of society who are involved in decision making processes.
The River Basin Water Agencies	Comprises the River Basin Committees executive secretariats.
The Water Resources Civil Organizations	Made-up of representatives from the river basin associations, academia and researchers, non-governmental organisations, and domestic water users, amongst others.

Al-Saidi (2017) alludes to the fact that even though, on paper, Brazil follows the principals of IWRM, which are integration, participation and sharing of knowledge, the water management system is still afflicted by lack of integration efforts which give rise to a conflict of views from different stakeholders in the energy, mining, agriculture, waste treatment, and recreation sectors. Accordingly, this has caused unbalanced trade-offs and disputes.

(c) Conservation efforts

Brazil's water supply infrastructure is more developed than its wastewater infrastructure (Schmitt 2016). This underinvestment in wastewater treatment, as reported by Val *et al*. (2019), has resulted in most cities fighting water pollution due to untreated sewage discharge, intensified by unsatisfactory rubbish collection, a poorly maintained water and drainage infrastructure, and insufficient wastewater infrastructure. Along the same lines, a World Bank report (2016) asserts that Brazil's failure to treat wastewater suitably implies that pollutants are being released straight

into the water or stored in poorly regulated septic systems. This has severe implications on the quality of the water and subsequently for the well-being of society.

The afore-mentioned World Bank report (2016) further emphasises that uncontrolled pollution will affect the standard of living of Brazil's poorest citizens and therefore, policies and efforts related to water conservation are required to protect them.

Significantly, Brazil's recent climate predictions show a substantial decline in rainfall in the southeastern, central, and northeastern regions, compounded with an increase in temperature. This drop in rainfall could be 20% beneath the long-term average by 2040, and an unprecedented 40% below the average by the next century (Almagro *et al.* 2017). These developments could have an impact on water supply, agricultural growth and energy production, particularly in a country which is the world's second largest food exporter.

In a highly populated state such as São Paulo, water supply is of vital significance for sustainable growth (Franca *et al*. 2017). A study by Breach and Simonovic (2018) observes that problems with water shortages in this city of 40 million inhabitants, are compounded by a constant degradation in the quality of water resources, because only 60 percent of the raw sewage collected is currently treated. Moreover, the 2014 – 2017 drought created a water crisis when reservoirs dropped to levels of 5, 2 percent creating frequent cuts in water supplies to the city of Sao Paulo and Rio de Janeiro. Cohen (2016) lists other variables that contribute to water scarcity such as the high-water loss due to the inefficient water use. In addressing this, the government embarked on an innovative approach in the form of the São Paulo Water Recovery (REÁGUA) Project which intends to address the water scarcity issue by widening the supply of clean water in the five most critical watersheds of the state. According to Stepping (2016) this project has seen private water services providers being funded by government to reduce water losses and promote rational use of water in public schools. In addition, they are also responsible for improving wastewater systems. Under the project, approximately 47 million cubic meters of water per year have been recovered (Stepping 2016).

In summary, several scholars highlight the challenges affecting the water management sector in Brazil (Lorz *et al*. 2012; Tundisi and Tundisi 2016; Sousa Junior *et al* 2016; and Victor *et al*. 2015). For instance, Victor *et al*. (2015) states that challenges arose

from the mismatch between Brazil's freshwater resources and the locations of highly populated areas, along with other factors like population growth and changing weather patterns.

Other studies (Lorz *et al*. 2012 and Tundisi and Tundisi 2016) attribute the challenges to water supply and demand as a result of declining groundwater supplies; deteriorating water quality, and lack of wastewater infrastructure. The next section discusses Singapore.

2.7.2 Singapore

Singapore is in Southeast Asia with a total population of 5.6 million people (Arora *et al*. 2019). There are no natural water resources within its border, and as such Beal, Gurung and Stewart (2016) state that strategies for water resource management is a crucial part in the approach towards sustainable economic development. In terms of performance, Singapore is one of the world's top 5 percent urban water utilities. According to Irvine, Chua and Eikass (2014), the country embraces a holistic approach to water management by directing its efforts in the direction of suitable supply and demand management policies. In addition, emphasis is on wastewater and rainwater management through good institutional efficiency. As such, Singapore has developed cutting-edge, comprehensive strategies to make certain it can meet present and projected water requirements. As stated by Beal, Gurung and Stewart (2016), these approaches encompass all aspects related to water resource management such as conservation programmes, planning and integration management policies which include development, governance, finance and technology-related strategies. Significantly, more recently this includes water consumer behaviour. In addition, Amy *et al*. (2017) notes that large investments into wastewater treatment and desalination have been undertaken to ensure that rivers and waterways are pollution-free as well as to protect water catchments areas. The above-mentioned stratagems have resulted in the entire population of Singapore having access to modern sanitation and the collection and treatment of all wastewaters.

According to Goh *et al*. (2017), Singapore has a network of underground culverts to collect all used water as part of its water reclamation programmes. Consequently, a part of the treated effluent from these plants is recycled to harvest what Singapore calls 'NEWater'. Beal *et al.* (2016) reveals that the country has pursued membraned

technologies with the aid of nanotechnology to produce high quality recycled water, at a practical cost.

It can be concluded that Singapore's innovative approach to water resource management has resulted in the country becoming self-sufficient and slowly moving away from importing water from neighbouring Malaysia.

A comparison with South Africa may not be fair as South Africa's population is ten times larger, and GDP (General Domestic Product) is far less. However, there is a lesson to be learnt in that Singaporeans view water as a precious commodity which costs a lot to manage, treat and store. As such, there is deep respect towards water and Singaporeans are very conservation conscious of it. The sections that follow discuss Singapore's legal and policy frameworks, institutional frameworks, and water conservation efforts.

(a) Legal and policy frameworks

Water resource management in Singapore is under the control of the Ministry of the Environment and Water Resources (MEWR) which is tasked to ensure a clean, sustainable environment and water supply for Singapore (Tan and Kwek 2016). According to Zhang *et al*. (2017), Singapore is guided by four legislative frameworks, namely the Public Utilities Act, the Sewerage and Drainage Act, the Environmental Protection and Management Act, and the Environmental Public Health Act. These pieces of legislations make sure that industries and the domestic users abide by strict rules to prevent water pollution and be able to use water sparingly (Lee and Tan 2016). This legislation also ensures that the sewerage and drainage infrastructure is periodically upgraded. Luan (2010) finds that the above policies provide an integrated approach to water management using principles of Integrated Water Resources Management (IWRM). The author further notes that Singapore's policy framework encloses all aspects of water management from storm water and wastewater collection, treatment, distribution of potable water (including water importation from Malaysia, local reservoirs, and desalination), and water reuse schemes as a single, closed-loop system.

Singapore is signatory to four water agreements with Malaysia. There is mutual agreement with Malaysia to import water and in return the agreement allows Malaysia to purchase treated water from Singapore (Chakraborti and Chakraborty 2018). In

addition, Singapore adopts a strict pricing policy for water whereby all citizens are accountable for their domestic use (Zhang *et al*. 2017).

Pricing of water is set at market rates and is considered a highly effective policy instrument for the government in its efforts to encourage prudent water usage. The water-pricing formula is subjected to increasing block tariffs which includes a water conservation tax in an effort to promote water conservation behaviour.

(b) Institutional frameworks

The national water agency in Singapore is the Public Utilities Board (PUB) which regulates and oversees Singapore's water system (Chuah, Ho, and Chow, 2018). This body manages and maintains all public sewerage systems from the storm water drainage systems to the drainage reserves. Accordingly, PUB regulates the construction, maintenance and improvement of the sewerage and land drainage systems. In addition, it advises the government on issues of collection, production, and supply of water, and to sewerage and drainage. According to Zhang *et al*. (2017), there are three operating departments within PUB in charge of assuring a reliable supply of water. In order to maintain water quality, PUB also employs contractors to make sure that the drains and canals are regularly cleaned and maintained (Lee and Tan 2016).

The above studies show that the Singapore government has over the past 25 years implemented various strategies to diversify its sources of water supply, manage water demand, and support the development of its local water technology industry. The work by the afore-mentioned studies suggest that this city-state developed and deployed highly efficient management practices on demand and supply.

(c) Water conservation efforts

Singapore is one the very few countries in the world that depends on imported water as its major source of water supply (Ng 2018). As a result, the water administrators are making a positive effort to make sure that their water supplies are secured on a long-term basis in terms of quality and quantity. Singapore has managed to put in place an effective management strategy for catchment areas to collect rainwater. This has led to an effective supply of water and at the same time avoided conflicts among beneficiaries (Jensen 2019). In addition, the supply of water is expanded by reducing uncounted for water (UFW), which is identified as actual loss of water owing to

leakages, and perceived water loss resulting from meter inconsistencies (Tortajada and Buurman 2017). Significantly, Singapore has avoided any illegal linkages or connections to its water distribution systems. At the core of the country's conservation efforts, Chuah *et al*. (2018) reported that Singaporeans adhere to the following principles:

I. Capture every drop of rain that falls on Singapore
II. Collect every drop of used water
III. Recycle every drop of water more than once

As reported by Zhang *et al*. (2017), there are four reused water plants and two seawater desalination plants operating in Singapore, meeting up to 30% and 25% of the country's total water demand respectively.

In summary, Singapore presents the best-case study for water management practice as its holistic water management framework responds to supply and demand simultaneously. PUB has put in place a well-thought out and comprehensive demand management policy. Strategically, the PUB has encouraged consumers to conserve water as a way to maintain water consumption at a sustainable level amidst the population and economic growth. In so doing, PUB set the water tariff at a rate that recovers the full production and supply costs (Tortajada and Buurman 2017). The government provides specially targeted assistance to lower-income families as regards equity. The next section discusses India.

2.7.3 India

India has a population of 1, 3 billion people. This is 17 percent of the total world population and yet India only has four percent of the world's renewable water resources (Mekonnen and Hoekstra 2016). This situation is further aggravated by climate change, population growth, urbanisation, water pollution, and inadequate sanitation, amongst other factors. As a consequence, large portions of the country are water-stressed which has led to a detrimental impact on human health and the economy. The country's primary source of water supply is groundwater, of which 85 per cent is used to meet rural demand. The rest is for urban requirements and irrigation needs. However, Bassi (2016) observed that the groundwater table has dropped significantly due to overuse as a result of unregulated extraction.

According to Ahluwalia (2016), the supply of water in most of the cities is available for four to five hours per day. This also includes piped water which is accessible to less than 50% of the urban population.

Wakode *et al*. (2018) established that the average use of the urban water is 126 litres per person per day. In addition, many urban residents are dependent exclusively on water vendors and during periods of scarcity and drought, they are the only option for the poor (Nayar 2017).

Whilst India enjoys abundant rainfall, poor management has led to water scarcity and economic strain. According to Rana and Guleria (2018) this is expected to intensify in the future. One of reasons is that the status quo of water has become a highly political issue, according to Araral and Wu (2016). As a consequence of poor infrastructure development and management of policies, the gap between water demand and supply is on the rise and has led to poor water quality. Water supply to built-up areas is lower compared to other developing countries, and the availability of water has waned in many cities (Ercumen *et al*. 2015). For example, in Bangalore, water restrictions were only four hours a day in the early 1980s, but by the year 2006 the city had no water for up to 22 hours a day. In Chennai, water was available 10–15 hours each day in the 1980s; however, by 2006 Chennai only had water at least one hour a day. Today the city is in the throes of a Day Zero where severe restrictions on water have been implemented.

Talbot-Jones and Bennett (2019) assert that to operate effectively, the water sector requires, a well-defined water rights system; a consistent, detailed set of trade laws; management bodies to oversee the supply of water, and a judicial body for oversight and dispute resolution. In addition, water pricing is a contentious issue in India, especially in the context of equity and meeting minimum needs, particularly for the poor (Shen and Reddy 2016). For instance, in the absence of regular water supply to households, any increases of tariffs are socially and politically unacceptable.

Larsen *et al*. (2016) indicate the need for a more holistic and integrated approach for water and sanitation related issues. Kumar and Bharat (2017) concur that India should aspire towards an approach similar to Singapore. Such an approach would see water treated as an economic good in order to promote its efficient use.

However, currently, in an effort to manage its water demand challenges, the Indian government has embraced a participatory irrigation management system (Reddy 2016). The sections that follow discuss India's legal and policy frameworks, institutional frameworks, and water conservation efforts.

(a) Legal and policy frameworks

As per the Constitution of India, water is identified as a state commodity. The government's jurisdiction extends to water supplies, irrigation and canals, drainage and embankments, water storage, and hydro power (Cronin *et al.* 2014). According to Kumar (2018), the country's water laws are often partial to the political status quo as well as the ideology of the time. The Easement Act of 1882 gave every landowner in India significant powers over ground water that was present within their property (Bassi 2016). As such it was the right of landowners to collect and dispose, as per their own discretion, all groundwater on this property. However, as reported by Cronin *et al.* (2014) this creates challenges in terms of regulation in relation to the extraction of ground water. Noting the above challenge, the Indian government published the Model Bill for Ground Water Management in 2011. It outlines key principles towards a National Water Policy which includes usage, infrastructure and pricing aspects of water (England 2018).

The National Water Policy of the Government of India advocates basically on the following key points (Kumar and Bharat 2014:4-5):

I. *The principle of equity and social justice must inform the use and allocation of water resources.*

II. *Planning, development, and management of water resources need to be governed by common integrated perspectives considering local, regional, and national context, having an environmentally sound basis, keeping in view the human, social, and economic needs.*

III. *Safe drinking water and water for sanitation should be considered as pre-emptive needs, followed by high priority allocation for other basic domestic needs, supporting agriculture for food security and minimum ecosystem needs.*

The government released the National Water System Bill in 2013 as a result of the above-mentioned Legislation.

.

Notably, the Model Bills and the National Water Policy tackles, among other things, the question of groundwater governance in compliance with the public trust doctrine aimed at safeguarding the public resource and, as such, cannot be transferred to private property (O'Donnell and Talbot-Jones 2018). The subject of water pricing is another significant part of the National Water Policy.

According to England (2018) water pricing is aimed at encouraging water conservation amongst water users. The Water Regulatory Authority (WRA) has been established to regulate the water tariff. However, according Bassi (2016), in the absence of an appropriate fiscal model, concerns have been raised on how water is to be allotted to people with limited means to afford it.

(b) Institutional frameworks

The Ministry for Water Resources is the head of the water sector and is therefore in charge of the country's water management governance (Suhag 2016). In addition, groundwater management projects are overseen by the Ministry of Rural Development. According to Shiva (2016), the Ministries of the Environment, Forests and Climate Change manages all issues relating to environmental degradation, including groundwater pollution.

Groundwater projects are managed by four major central institutions. As reported by Suhag (2016), the institutions are summarised below:

I. **Central Water Commission** monitors water quality and coordinates water conservation strategies for the country".
II. **Central Ground Water Board** develops and disseminates technology related to ground water use. It also monitors on sustainable management of groundwater".
III. **Central Ground Water Authority** oversees the usage of groundwater and can resort to penal action on abusive users".
IV. **Central Pollution Control Board** is responsible for the implementation of the Water Prevention and Control of Pollution Act, 1974 which seeks to restore water quality**.**

According to O'Donnel and Talbot-Jones (2018), the design of institutional mechanisms for the allocation of water and river flows in India has long been a legal, constitutional and societal issue. These authors insist that the water sector in India is faced with numerous institutional challenges.

Suhag (2016) reports that institutional challenges are divided into three key areas, namely, poor performance and maintenance of irrigation systems; over-extraction of groundwater which has led to economic and environmental problems; and the shift from a water management focus to an integrated management system.

The institutional framework that oversees water thus remains a main concern in the policy debate in India.

(c) Water conservation efforts

India is faced with severe water shortages, coupled with lack of systems to monitor domestic use. Leaks as a result of poor infrastructure and poor water governance has led to the loss of nearly 50 percent of usable water (Kumar and Bharat 2014). Moreover, Nayar and Kanaka (2017) assert that consumers of water are of the view that provision of water is the responsibility of the government.

As agriculture accounts for about 69 percent of all withdrawn water, Woodhouse and Miller (2017) suggest that conservation efforts should be directed in this area. The authors assert that by improving the management of agriculture by at least 10 percent, this could effectively increase the effectiveness of irrigation and preserve enough water to double the quantity available for drinking. Furthermore, in an effort to minimise the wastage of water, places such as Haryana, Rajasthan, Uttar Pradesh, Karnataka, Gujarat and Maharashtra have adopted micro-irrigation which uses both drip and sprinkler irrigation methods. This has proved to be an effective tool for saving water and increasing the quality of water usage in contrast with traditional surface irrigation methods. The next section discusses Australia.

2.7.4 Australia

In Australia, Marshall and Alexandra (2016) state that water scarcity poses a serious problem. King, Karoly and Henley (2017) report that in the past few years the Australian weather patterns have shifted very quickly from long periods of drought to very rainy seasons.

As such, these climate variations threaten the management of water sustainability. The above study notes that as a result of these extreme weather patterns, extensive studies were conducted on methods to enhance water management and conservation for domestic and economic purposes. Tularam and Murali (2015) established that factors such as rapid urban development of the Australian population has raised fears about water safety, impacts on quality of water and exploitation of the environment. Hence, studies have focused on environmental water technologies.

Mechanisms to drought proof urban areas, improving the standard of water in urban and rural areas, enhancing natural flows, and providing adequate water for agricultural needs have been focused on in studies (Black 2016). Research areas, amongst others, include stronger climate change modeling frameworks, evaluating effects on water supply and efficiency, focus on how to increase the use of reused and recycled water sources, and social reactions to developments in domestic water management (Black 2016).

As the driest populated continent in the world, Australia has many years of expertise in handling issues related to water scarcity and the country has often been regarded as a global leader in water policy innovation. This distinctive circumstance of being a dry nation, according to Papas (2018), has significant consequences on the approach by which water is collected, stored and distributed, as does the fact that the country has elevated levels of salinity which cause a decrease in crop production, ecosystem and freshwater allocation. This had led to poor water quality and soil fertility (Argent, Smith and Dharssi 2016).

Australia has experienced a number of protracted droughts during the last century, including the 1895-1902 Federation Drought and the 1937-1945 World War II drought. In fact, the Millennium drought of 2001–2009, created the maximum destruction, brutally plummeting water runoff and therefore water quality, resulting in a significant loss of ecosystem functions and biodiversity (Alexander and Arblaster 2017).

Parallel to the emergence of IWRM, Furlong, Gan and De Silva (2016) reported that water-related issues were further addressed from an urban approach and ideologies such as Integrated Urban Water Management (IUWM) and Water Sensitive Urban Design (WSUD) emerged.

Massive institutional changes to water services, notably in integrated public water infrastructure planning have taken effect in certain parts of Australia, particularly Melbourne. Furthermore, according to Furlong *et al*. (2016), the city of Melbourne implemented IUWM. This is described as an urban water management strategic planning model that encourages the participation of all water supply services and the relevant stakeholders to ensure the best service delivery results for the communities. The World Bank's Water Partnership Program strongly supports the implementation of IUWM, and asserts as follows:

> "*An IUWM approach that … focuses on the integration of water supply, sanitation, and drainage with urban planning, and takes into account water resources … may provide an opportunity to avoid infrastructure lock-in in expensive traditional solutions"*, as reported by Closas, Schuring and Rodriguez (2012:15).

According to Furlong *et al*. (2017) IUWM offers a set of principles that combines water sector usage, water infrastructure, and water management. More importantly, it supports alternative water sources and aims aim is to preserve, conserve and exploit water at its source. The sections that follow discuss Australia's legal and policy frameworks, institutional frameworks, and water conservation efforts.

(a) Legal and Policy Frameworks

Each state in Australia has its own water authority. This is largely attributed to the big distances between states, according to Binnema (2017). Australia's water supply management is dependent on the Commonwealth and other state and local governments for a range of legislations and cooperative arrangements. According to Moggridge, Betterridge and Thompson (2019), water in Australia is guided by two key pieces of legislation, which is the Water Management Act 2000 (WMA 2000) and the Water Act 2007, with the former being introduced in response to the Millennium drought. After an extensive period of public consultation, the WMA2000 was passed by the Australian parliament in December 2000. It establishes a completely new statutory framework for managing water in New South Wales (NSW). Seago (2016) report that the WMA2000 is grounded on the notion of *ecologically sustainable development to* ensure that future generations are able to meet their needs. According to the afore-mentioned author, the Act recognises:

I. The protection of wetlands, rivers and groundwater systems, floodplains and estuaries.
II. The integration of water management with other natural resources such as soils, vegetation and land.
III. Water management needs to be a collective effort between the government and civil society.
IV. Decisions on water management shall include environmental, social, economic, cultural and heritage consideration.
V. Safe and efficient use of water would bring social and economic benefits to the state.

The Water Act 2007 addresses the need to restore over-allocated rivers. Central to the Water Act 2007 is the imposition of a statutory limit on water extractions across the whole Murray-Darling Basin (MDB), ending decades of unsustainable practices. The government provides national leadership in water policy and legislation reform for all Australians (Department of Agriculture and Water Resources 2018). To manage water as a public good, the government coordinates national action for reform, in consultation with state and territory governments.

For an effectiveness of water supply and demand, Australia has engaged in water pricing reforms to address mainly three points (Poddar, Qureshi and Shi 2014). These include:

1. The overall level of prices to ensure prices recover the full, efficient cost-of-service provision from customers.
2. The structure of tariffs in order to introduce more cost-reflective pricing to provide a signal for efficient water use through consumption-based charges, with remaining revenue.
3. Price-setting processes and related institutional arrangements to move toward independent economic regulation.

Alexandra (2018) notes that the above price reforms were aimed to ensure that costs were efficient in meeting levels of service that customers were willing to pay for. It further aimed to ensure transparency and make certain that revenue collected through fixed service charges is on a defensible cost basis.

(b) Institutional Frameworks

Australia's institutional water governance duties can be divided into five operational areas: policy, service delivery, economic regulation, environmental regulation, and health regulation (Byrnes 2013). The Council of Australian Governments (COAG) and state governments play a major role in water management. The COAG, which comprises the Prime Minister, State Premiers, Territory Chief Ministers and the president of the Australian Local Government Association, is in charge of developing and monitoring policy reforms including water policy. In addition, the state water agencies manage storage, fiver flows and water deliveries. Table 2-4 outlines this.

Table 2-4: Australian institutions dealing with water management (Margerum and Robinson 2015)

Organisation	Responsibilities
Independent Pricing Tribunal	In charge of water pricing for the urban water sector.
Office of Water	Responsible for water planning and management. Its key role is to administer the WMA2000 and Water Act 1012.
Land and Property Management Authority	Governs the water market by assessing all water dealing applications.
State Water Irrigation	Supplies water to urban and rural areas. They also manage public reservoirs

(c) Water conservation efforts

The Millennium Drought (1997-2009) affected most of Australia. Despite the dire situation, Zhao, Velicogna and Kimball (2017) observe that by implementing a variety of policies and programs, Melbourne decreased water demand per capita by nearly 50 percent. Governmental agencies' integrated policy and response enabled a culture shift towards less water. Citizens also invested to install water tanks for the collection of rainwater — almost one in three Melbourne citizens had one by the end of the drought (Turner *et al*. 2016). Significantly, rainwater was diverted to rivers, water restrictions took place, and educational programs to promote participation in water conservation was introduced.

According to Tong, Fan and Niu (2017), some of the measures undertaken by the Australians were:

I. **Legislation:** Prior to the drought, in the late 1980s, legislation was passed that set the groundwork for an integrated government response in case of a drought. Funding was allocated to the state of Victoria and the city of Melbourne to implement conservation strategies in the wake of droughts. A regional water manager had the power to force water utilities, city agencies and reservoir managers to cooperate.

II. **Infrastructure development:** Large sums of money were spent on infrastructure development that included a pipeline that would supply water over the mountains. In addition, $6 billion has been spent in constructing the Wonthaggi Desalination Facility which is a water treatment plant.

III. **Rebate programmes:** Through incentive schemes, domestic water users were encouraged to use grey water systems for their gardening.

IV. **Recycled water:** Substantial investment by the government to increase the use of recycled water for the agricultural and urban sectors.

The actions taken by the Australian government can be used as a blueprint for water-stressed areas around the globe.

2.8 Summary

It can be deduced that addressing challenges of water supply and demand, and sustainable development, is a multifarious issue as it is different from one country to another. More importantly, the balance between economic development and protection of water resources is pertinent in preventing a gap between availability and demand. This means that in order to safeguard the long-term sustainability of water use, water bodies need to capitalise on the value of current supplies. Furthermore, it is suggested that the main challenge in moving towards more viable water governance and management is to transform the governing of water governance. However, it is cautioned that water reforms are often greeted with resistance from local community groups whose traditional practices and atitudes are premised on water being a common resource meant to be provided sparingly and not restricted. The next chapter examines water governance in South Africa

Chapter 3: The provision of water supply in South Africa

This chapter reviews literature on the governance of water in South Africa. The review presents an overall view of the state of water in relation to policies, institutional frameworks, and conservation measures with particular attention to water scarcity, availability and demand, and the impact of water shortages on the community, health and agriculture sectors. The aim of this chapter is to compare the South African water management strategies to the countries explored in Chapter 2. This is in line with Objective 1, which is to compare the South African approach to water resource management with Brazil, Singapore, India and Australia.

3.1 Introduction

In South Africa, water is key to winning the fight against poverty. This is asserted by Ozturk (2017) who concurs with Mabhaudhi *et al.* (2016) that water scarcity is a growth-limiting factor. Nechifor and Winning (2018) argue that without water, there can be no socio-economic development. Furthermore, Cheeseman (2016) cautions that the situation in South Africa is exacerbated by periods of prolonged droughts and the growing demand associated with continual population growth within the context of a developing economy. As illustrated by Rodina (2016) when the rains fail, drought sets in and with it the associated water supply problems. The above observations are significant because South Africa is a country dependent on rainfall to fill its dams and reservoirs. This study takes cognisance of this as the above factors have given rise to a serious water calamity affecting municipalities across the country who are finding it difficult to meet water demands.

3.2 The South African context

Significantly, within the South African context, Rogoll (2017) points out that the issue of water and sanitation is intricately linked with the history of the country and in particular the discriminatory approach of Apartheid with respect to discriminatory urban planning and the allocation of resources. This view is supported by Knox, de Groot and Mohlakoana (2017) who emphasise that under the Apartheid system, racial segregation systematised the forced relocation of minorities into townships, which often lacked basic services and infrastructure.

According to Mpofu and Hlatywayo (2015), the issue of basic needs and services were one of the foremost challenges to be addressed by the first democratically elected government in 1994. In turn, and as indicated by Sutherland, Scott and Hordijk (2015), the government recognised water as a social good that is fundamental towards transformation and growth as those who were deprived by sufficient water cannot exercise a number of other constitutional rights. Consequently, access to water and sanitation services is prioritised under the state's Reconstruction and Development Programme (RDP) (Mkhwanazi, Mbatha and Khulekani 2019).

Rodina (2016) notes that despite the historic change from an apartheid to a democratic form of government in 1994 and its considerable remedial efforts, water resources still remain unevenly distributed across the country. Hellberg (2017) describes water as a *bio-political tool* which symbolises a key component aimed at transforming the lives of previously disadvantaged South Africans. Ramírez, De Clercq and Jackson (2019) report that during that during the apartheid era, approximately 13 million South Africans lacked access to safe water. Successively, in its efforts to fundamentally restructure its water laws and regulations, the government introduced new legislations that represent water as an instrument in the *transformation of society towards social and environmental justice* (Hellberg 2014:227).

The legislation and water policy framework adopted by the new South African government centres on the constitutional recognition of the right to water access, according to Yates and Harris (2018). While on the one hand, the introduction of the right to water contributes to the development of free entitlement to water for consumption and domestic use, the access to basic water services and the distribution of water are still very different today. Hellberg (2017) contends that this is not only the fault and consequence of the Apartheid system, but also the result of the poor economic approach to water policy.

The right to water is entrenched in the Constitution. Chikozho, Danga and Saruchera (2017) state that this right is part of several legislative and policy documents aimed at restructuring the water framework. The two main acts are the 1997 Water Services Act (WSA) and the 1998 National Water Act (NWA). The Constitution of the Republic of South Africa (1996: Section 27) allots the management of water resources to the national government, while local governments (called municipalities in South Africa) are responsible for the management of water and sanitation services.

3.2.1 Institutional frameworks

The management of water resources in South Africa is the responsibility of the Minister of Water Affairs (Njiraini, Thiam and Coggan 2017), while the Department of Water and Sanitation (DWS) is accountable towards the policy development and implementation and answers to the minister. The DWS is made-up of a number of directors, all assigned with different functions. According to Du Plessis (2018), the Integrated Water Resource Planning (IWRP) structure under the chief directorate has to ensure, through a holistic planning approach, availability of sufficient water which is safe for human use. In addition, the portfolio of infrastructure development falls under the ambit of the IWRP. This means considering all the needs of water users. A key area of the IWRM in South Africa is the Catchment Management Agencies which were established under the auspices of the National Water Act to manage water in a defined Water Management Area (WMA). Pahlow, Snowball and Fraser (2015) report that presently there are 19 WMAs across the country providing a platform for local communities to participate in water-related decisions that affect them. In addition, water service authorities, known as municipalities, are in charge of ensuring affordable, economical and practical access to water services across households in the country.

3.2.2 Water policies to address inequality

Hellberg (2018) writes that water distribution in South Africa was closely intertwined with a nationalist and racist agenda during the apartheid era. In the 1994 transition to democracy, water became an important issue, both symbolically and materially, in the form of equitable redistribution to all within the country. According to Knüppe and Meissner (2016), after the first democratic election in 1994, the new government sought to shift the ideology, goals and strategy of the country in the management of water resources. Immediately a high-profile political agenda was put in place for clean water and sanitation for the majority of people in South Africa, as well as the need for fair distribution of water, and benefits of water use were prioritised. According to a report by WHO (Supply, Programme and Organization 2015), in the year 2003, approximately eight million South Africans still lacked adequate water supply and about 38 percent of the population was without adequate sanitation. The following section discusses the policies in charge of water governance in South Africa.

In South Africa, the regulations embedded in the Constitution of the Republic of South Africa (Constitution for 1996), the National Water Act of 1998, the Water Services Act of 108 of 1998, are the three key laws which govern water provision.

I. Constitution of RSA, 1996

South Africa is one of the first countries in Southern Africa to constitutionally define water as *a basic need* and a *human right* (DWAF 1997). Section 27 of the Constitution of the Republic of South Africa, 1996 states that:

- 27(1*) Everyone has the right to have access to…*
- 27(b) *sufficient food and water; and …*
- 27(2) *The state must take reasonable legislative and other measures, within its available resources, to achieve the progressive realization of each of these rights….*

The constitution allows citizens access to a stipulated amount of water per day, and the water must be safe and clean (Soyapi 2017). However, regardless of this provision, Couzens (2015) observes that the country has been barraged with a number of challenges in relation to water provision. Some of the problems include poverty, underdevelopment, governmental inefficiency, poor service delivery to the poor, harsh environmental conditions and poor water behaviour on the part of consumers. The work of the authors above thus indicates that the challenges highlight the need for municipality to deliver better quality service delivery to its jurisdiction. The eThekwini municipality is in charge of supplying a stipulated amount of safe water and a reliable supply to communities within its jurisdiction. This includes low-income areas such as Waterloo, which is the focus area of this research.

II. National Water Act of 1998

Hellberg (2018) refers to the policy as a "*key milestone*" in the government's effort to reform the water paradigm and further believes it will have far reaching effects on social and economic development in the country over the coming decades. As reported by Seago (2016), the NWA creates a legal framework for the management of water resources in South Africa which includes rivers, streams, dams and groundwater. Du Plessis (2019) further highlights that whilst the management aspect of the resource is the responsibility of the national government, delivery services such as drinking water and sanitation are regulated by the municipalities to households.

In addition, Viljoen (2017) notes that the main purpose of the Act is *to "ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways which take into account amongst other factors"*. Although the NWA created a window of opportunity for broader social inclusion in the water sector, Couzens (2015) submits that there is a major point of concern due to lack of greater public and stakeholder participation in policy formulation and decision-making processes. This view is supported by Turok and Borel-Saladin (2016) who state that the policy lacks enforceable solutions for balancing social equity and political obligations. This in itself is a gap in research because there still remains inequitable distribution of water in South Africa, particularly in the rural communities which lack basic services such as sanitation.

The NWA is seen as one of the most progressive legislative and policy frameworks for water management in the world (Tissington *et al.,* 2008), and is built on the principles of integrated water resources management (IWRM), which emphasises the need for participatory processes at all levels. However, lack of capacity and technical skills has seriously impacted on national and local authorities' ability to control and manage the water sector. This study takes cognisance of this as it is reported that South Africa is losing over 1, 5 billion cubic metres of water a year due to failing infrastructure, as piping infrastructure has outlived its lifespan (Ramulongo, Nethengwe and Musyoki 2017). Of concern, is that South Africa economically loses more than R7 billion worth of water annually because of leaking taps and faulty pipes (Mavundla 2016). Within the "deemed" poorer areas, the efficient supply and conscientious use of water resources is important, with the former a basic right and the latter an opportunity for research given that the country is in the grips of its worst drought in decades.

III. The Water Services Act 108 of 1997

Whilst the NWA regulates the management of water in South Africa, the Water Services Act 108 (WSA) regulates the accessibility of water by domestic users. Enacted in 1997, the WSA defines water as a public right. As stated by Rogoll (2017), the Act enshrines the rights of all citizens to access clean water and sanitation. Furthermore, this Act provides for the creation of water services agencies, which would fall under the jurisdiction of municipalities in charge of service delivery. According to Beck, Rodina, Luker and Harris (2016) it is the responsibility of local municipalities to implement reasonable measures towards ensuring the realisation of these rights.

Each municipality, for example, must ensure strategies within its development plan to ensure that the provision of water is non-discriminatory and reasonable to the public. As such, Subsection (2)(C) provides for the conditions for payment and tariffs, and the circumstances under which water services may be limited or discontinued must be made public to the citizens (Jafta *et al.* 2017).

Whilst the Act enshrines the right to access to water *to each and every citizen*, it also endorses the idea of water as an *economic good.* It stipulates strict conditions for payment and rates and sets out reasons and the circumstances for which the water services may be restricted or discontinued. Clark (2016) points out that the above conditions, as postulated in the Act, have be transparent and communicated to the citizens.

Importantly, as part of the constitutional right to access of water, the Free Basic Water Policy (FBWP) was adopted in 2001. The next subsection explores FWBP as it forms an important part of this study. Inhabitants of the study focus area are recipients of this policy.

IV. Free Basic Water Policy (FBWP)

Nel *et al* (2017:556) defines 'basic water supply' as: "*the prescribed minimum standard of water supply services necessary for the reliable supply of a sufficient quantity and quality of water to households, including informal households, to support life and personal hygiene*". According to Nel *et al*. (2017), this policy targets the water needs of the most impoverished citizens by guaranteeing each household a free minimum quantity of potable water. While the FBW policy is set at six kilolitres per household per month, however, the stipulate quantity of free water provided varies in some municipalities (South African Government 2016). For example, in Rustenburg, 12kl was set as the free allocated limit per household per month (Park *et al.* 2009). In eThekwini, in an email conversation with the strategic executive manager, Mr Teddy Gounden states that the stipulated quantity varies from 9kl during wet season and 6kl during drought. These regulations are based on the assumption that each individual person needs 25 litres of water per day. The amount of free water is the same for every household, irrespective of wealth and number of persons comprising it.

However, the policy has faced criticism from civil society commentators for failing to reach all the poor, including too many nonpoor users, for providing insufficient water

and for charging too much for water supplied beyond the free amount (Koop and van Leeuwen 2017). More so, concern was expressed by politicians about the apparent inequity of the “non-poor” receiving a “free” allowance, even though tariffs for higher usage had been increased to compensate. There was a technical concern, shared by most of the critics and indeed by government that water requirements for sanitation – indeed the provision of a basic sanitation service – had not been dealt with adequately (Ramulongo *et al*. 2017).

Another criticism is that the policy fails to address the needs of large households that the amount of water provided free is inadequate where there are special needs, for instance, where a household member is in the terminal stages of HIV/AIDS.

Furthemore, several studies (Koop and van Leeuwen 2017; Fisher-Jeffes, Carden and Armitage 2017; Weaver *et al*. 2017; Hazelton 2019) have revealed numerious challenges related to the cost and recovery on the provision of water.basic water services. Tussupova, Hjorth and Berndtsson (2016) state that a limited number of water users are able to pay; customers who should pay do not pay; eligible customers for the free basic service consume more than stipulated amounted and do not pay for extra amount; limited available water sources; amd there is a high cost of municipal water consumption per capita. Furthermore, Hoekstra, Buurman and van Ginkel (2018) point out that even though some households have a water supply connection it, however, does not adequately meet their respective demand.

Several studies (Sutherland *et al*. 2015; Marson and Savin 2015; Tully 2017) argue that due to the scarcity of this resource government should not be providing it for free but rather put a price on its availability. Del Saz-Salazar *et al*. (2016) insist that cost recovery is key to maintaining sustainable water services as without this water cannot be provided free and has to be priced accordingly. On the other hand, Chatterji, Arlosoroff and Guha (2017) maintain the initiative of using price as a demand management measure could give rise to more challenges facing municipalities. McGoldric (2018) find that in many parts of the world, especially amongst rural communities, water is considered a gift from a spiritual creator and as such a price can not be put on it.

Bond (2017) further emphasises that in addition to civil protest action, communities unable to afford water will be susceptible to poverty and water-borne diseases. This

study takes cognisance of this and seeks to assess water behaviour of inhabitants of low-cost housing areas in South Africa.

3.2.3 Water supply in urban, peri-urban and informal settlements in sub-Saharan Africa

Although water is an inalienable right to everyone as enshrined in the United Nation Development Goals, some critics have argued that there are economic and environmental costs implicit in the production of water for human consumption which ought to be recouped by putting an economic price on it (Allen, Davilla and Hoffman 2006). In sub-Saharan Africa (SSA), the ability of the state to effectively manage and control water resources remains problematic and the traditional top-down approach to water supply and sewage disposal, as observed by Ramirez, de Clerq and Jackson (2019), is still in question. Significantly, the top-down approaches to the supply of water have continued to create water inequality between the rich and the poor, and between urban, peri-urban (low-income areas) and rural divides in terms of access to water.

Adams, Sambu and Smiley (2019) report that there were over 800 million people, predominantly in SSA who lack access to safe water sources. The study also notes the inequalities in the access to water between urban areas and the informal settlements in this region. Chowns (2015) finds that most clean water within many countries in SSA is provided by community-managed water sources such as hand pumps for a number of users. However, an earlier study by Taylor (2009) showed that about one third of these water points were non-functional as in the case of Tanzania where about a quarter of new water points become non-functional within two years of installation. Significantly, Adams and Zulu (2015) believe that community-based collaboration models offer a win-win condition to address water supply disparities between urban areas and informal settlements by enabling stronger partnership between communities and state-based utilities. Studies (Budds and McGranahan 2003; Adams and Zulu 2015) note that the attempt to involve private investors in water supply have not yielded the desired results of expanding network coverage to peri-urban settlements.

This lack of results is due to the fact that they are less profitable than supplying water to wealthier and more central city areas. Consequently, private and public utility agencies tend to cherry-pick wealthy areas over low-income and peri-urban

settlements which has contributed to the systematic marginalisation and under provision of services in the peri-urban settlement (Swyngedouw 2006; Bakker 2013). As a consequence, human rights approaches to water supply in SSA have had little practical impact on the mitigation of inequality in water (Silvestri *et al*. 2018). Informal settlements in particular lack access to fresh water and improved sanitation facilities, along with quality and durability of dwellings and the security of tenure (Swilling et *al*. 2013).

The quest to improve water access in the peri-urban settlement is hindered by multiple factors such as insecure and uncertain land tenure, poor or lack of piped water infrastructure, as well as dense population of the area characterized by poverty (Adams and Zulu 2015). Martson (2014) points out that neglect by government and poor capacity of central and municipal government authorities further complicates water provision in the peri-urban settlements. In the South African context, Silveti and Andersson (2019) point out that inequality also runs along urban–rural lines. Other SSA countries like Malawi and Uganda are also faced with an extreme inequality with water supply and broader social benefits to the urban poor (Adams and Zulu 2015).

Given these concerns, Tortajada (2014) warns that water supply infrastructure has to be improved as it is an indispensable component of the United Nation Development Goals' long-term goal of reducing poverty and inequality. In achieving these goals, Tortajada (2014) advises that infrastructure must be properly planned, managed, operated, and maintained to deliver universal coverage. While the few studies that have been conducted in urban areas have shown promising results regarding water supply goals (Jimu, 2008; Opare, 2011; Marston, 2014), major gaps remain in how community-based water management plays out in peri-urban areas.

3.2.4 Water availability in South Africa

A study by Harrison *et al*. (2016) reports that the quantity of water needed to sustain human activities and habitats depends on the availability and sustainability of the sources of fresh water. A report by Umgeni Water (2017) notes that the desired amount of water varies between catchments, since the usages differ.

In South Africa, the freshwater resources include the rivers, reservoirs, aquifers and wetlands, most of which require rain as a primary source of supply (Ozturk 2015). According to Kapangaziwiri *et al*. (2018), water availability in South Africa remains unpredictable across catchment areas, as management and consumption levels vary

across the country. South Africa's two main freshwater sources are surface and groundwater. Water recycling accounts for 14% of the total water supply as illustrated in the pie chart in Figure 3-1 which depicts the nation ‘s water allocation from the three main sources.

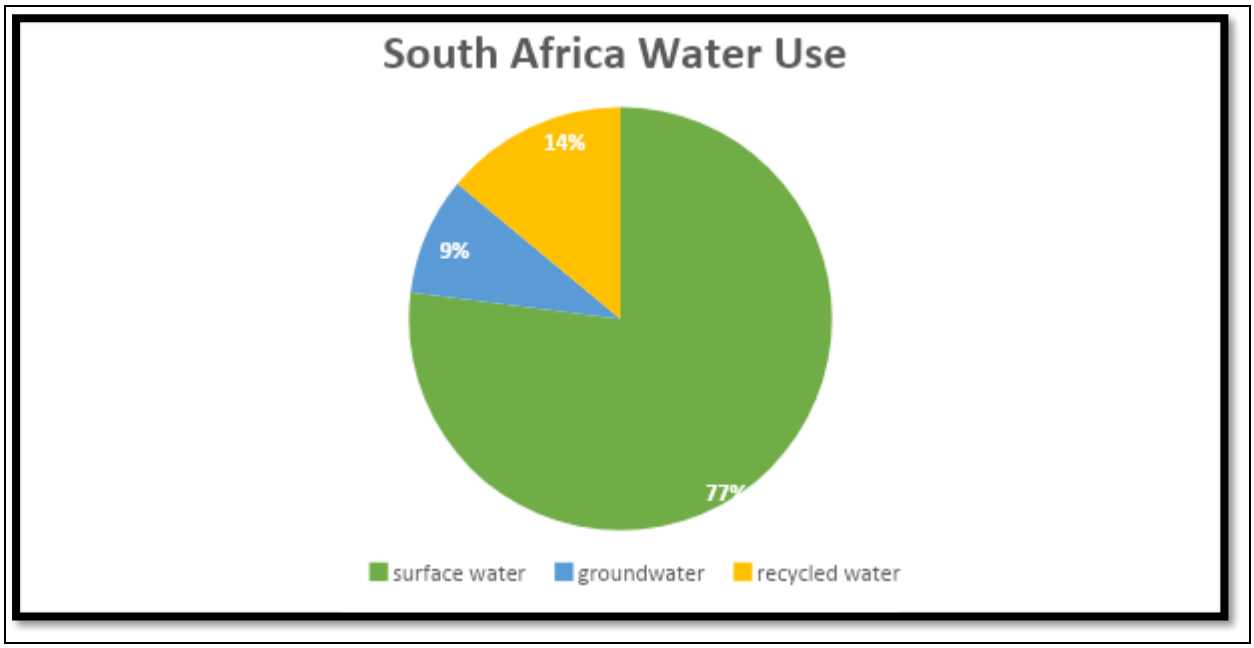


Figure 3-1: South Africa’s main fresh water resources (adopted from Fuller 2019)

The availability of water sourced from surface and ground water is discussed below.

a) Surface water

Donnenfeld, Crookes and Hedden (2018) state that surface water derived from rivers and dams, accounts for approximately 77 percent of South Africa ‘s total water usage. With an estimated 320 major dams within its borders, there is a total storage capacity of approximately 60 percent of the country’s mean annual runoff (MAR). The Oxford dictionary defines MAR as: “*The average amount of water that flows down a particular river, per year, expressed either as a depth (in millimetres) of water spread evenly across the entire drainage basin, or as a volume (in cubic metres) of water flowing past a given point*” (Mean annual runoff 2019).

Namugize, Jewitt and Graham (2018) found that these dams are dependent on surface runoff from major catchment areas. The total MAR is approximately 49,000 million m^3; however, only 27 percent of this is available as reliable yield (Umgeni Water

2017). Worryingly, whilst rainfall is the main source of fresh water, Diamond and Jack (2018) observe that only nine percent of South Africa‘s mean annual precipitation (MAP) reaches rivers and dams. The afore-mentioned study attributes this to the country‘s location as it is situated on a negative runoff area, whereby the mean annual evaporation (MAE) exceeds the Mean Annual Precipitation (MAP) by a factor ranging from 1, 2 to 4.

b) Groundwater

According to Lapworth *et al*. (2017), groundwater makes up about nine percent of South Africa‘s total water usage. Edokpayi *et al*. (2018) charge that groundwater is often considered to be the best alternative to collecting water from streams, lakes and rivers, owing to natural protection from pollution when compared to surface water. Off concern, Barlow and Clark (2017) point that the use of groundwater as a source has increased rapidly in many countries of the world due to population growth, increased industrialization and scarcity of water related to climate change. The South African government is in the process of identifying new groundwater sources to assist already depleting surface water reserves, in meeting the growing population’s future consumption demands (DWAF 2007).

c) Rainwater

Rainwater Harvesting (RWH) is described as the collection, storage and use of rainwater for small scale productive purposes (Campisano *et al*. 2017). It is one of the major sources of water supply nowadays. However, the full potential of this type of water supply has not been fully exploited in South Africa to date. Identified internationally as one of the most key interventions necessary towards meeting the Millennium Development Goals in Africa, RWH enhances water productivity by mitigating temporal and spatial variability of rainfall and providing water for basic human needs and other small-scale productive activities (Kahinda, Taigbenu and Boroto 2010).

3.2.5 State of water scarcity in South Africa

South Africa is a semi-arid country that is among the 30 driest countries in the world. Mastrorillo *et al.* (2016) write that although various data from the South African weather services indicate that some parts of the country have higher precipitations than others, the country has the lowest annual rainfall (450 mm per year) compared to the global

average of 860 mm per year. The Western Cape Province in South Africa, for example, had suffered from below average rain, which had consequently result, to a prolonged drought and acute water scarcity (Otto *et al.* 2018). As such, unevenness in timing and distribution of rainfall may leave many communities without access to water for even the most basic daily requirements (Gude 2016). Unpredictable changes in climate in the future may result in greater irregularities in the availability of water for daily use. Furthermore, issues such as water contamination and climate change may severely affect the limited quantity of freshwater resources accessible in the country. Gebrehiwot and Gebrewahid (2016) state that it well known that the availability of water resources is represented by an indicator known as water per capita. South Africa's water per capita is 1 000 m3 per person per year. A comparison between South Africa and neighbouring countries shows that their available water per capita is greater than South African's. This is justified by the fact that neighbouring countries have water sources from higher rainfall sites and/or lower inhabitant areas (Bwapwa 2018). In his 2012 budget speech the then Finance Minister Pravin Gordhan stated: "*On current projections, South Africa's water demand will outstrip available supply between 2025 and 2030*" (SAPA 2012). This proves that if the water demand is not managed appropriately, the country will face a crisis in the very near future.

Water problems in South Africa are the result of the decreasing quality of water and dysfunctional municipal water infrastructures that have resulted in the potential water crisis widely publicised in the media. This is according to Loucks and van Beek (2017) who further state that South Africa's water sector faces numerous challenges such as increased water deficits, water pollution and decreasing water quality that not only affect availability of water but impact negatively on human health, ageing water and wastewater infrastructure; a severe lack of skilled human resources; the impact of climate change on water resources; the illegal use of water; and the inappropriate use of funds by different spheres of local government. The above findings have resonance to this study as one of the objectives is to determine whether South Africa can adopt ideas and strategies from countries in the global south with related water resource problems. This is in an effort to develop its existing methods and practices based on their experiences.

3.2.6 Causes of water shortages in South Africa

The deficit between supply and demand of fresh water around the world arises from a number of different contributing factors. Holland *et al.* (2015) argue that these factors have become global concerns and a clear understanding of individual and collective impacts are required in order to establish water conservation and mitigation measures. The causes and impacts of water shortages, specifically over-consumption, leaks and poor infrastructure, are briefly discussed in the following sections:

(a) Over-Consumption

South Africa is one of the few countries in the world in which the access to potable water is a right, as per constitution. However, this basic need is extremely over exploited as the average water consumption per person is estimated to be 235 l/day, approximately 60 l/day greater than the world average water consumption (Stats SA 2017). With many of the country's dammed water resources on the brink of depletion, excessive usage has been prohibited and mandatory water restrictions have been implemented in an effort to replenish dam and ground water sources (Dillon and Arshad 2016). This approach has had little success as water losses due to leaks account for 37 percent of treated water supplies which translates to R7 billion annually in monetary terms (Mavundla 2016).

(b) Leaks as a result of non-revenue water (NRW)

Leakage is one of the most serious components of total water losses in a supply delivery system (Kanakoudis, Tsitsifli and Demetriou, 2016). It is one of the main challenges faced by South African municipalities as a result of non-revenue water (NRW). This refers to the considerable difference between water put into a distribution system and the amount billed to consumers (van den Berg 2015). Al-Washali, Sharma and Kennedy (2018) list three components of NRW, namely:

1. Physical loss – leakage from all parts of the system and overflows at the utility's tanks caused by poor operations and maintenance, the lack of active leakage control, or aging infrastructure.
2. Commercial loss – caused by customer meter under-registration, data handling errors and theft of water.

3. Unbilled authorisation consumption – water used by the utility for operational purposes such as firefighting and water provide for free to indigent householders.

(c) Poor Infrastructure

Abu-Mahfouz *et al*. (2016) report that another critical source of water losses is aged infrastructure. Lambert, Fantozzi and Thornton (2013) found that the frequency of breakage and failure of pipes in water distribution networks increases over time. This is mainly due to the deterioration of infrastructure. Deteriorating water pipes increase operation and maintenance costs while the hydraulic network capacity and quality of service decrease. The rate at which the water mains deteriorate until they cause water losses is determined by different physical, environmental, and operational factors (Abu-Mahfouz *et al*. 2016).

3.2.7 Consequences of water shortages

The consequences of water shortages at a community, agriculture and health level, are discussed next.

(a) Community level

According to Collins *et al.* (2019), a lack of clean water can have far-reaching consequences for a community. Clean water is necessary for the day to day running of a household.

In low-income communities where individuals often don't have the disposable income to buy bottled water, lack of clean water can have devastating consequences (Amrose, Burt and Ray 2015). The afore-mentioned study, highlighted cholera, diarrhea and malaria as water-borne diseases.

In a study conducted by Dotse (2016), water scarcity has been shown to negatively affect projects for gardening and brick building in, for example, the town of Taaiboschgroet. Projects such as landscaping and brickwork, for example, are well known to require a lot of water and projects that created much needed employment in the town of Taaiboschgroet started to collapse due to water shortages. The collapse led to the people who gained a livelihood from these ventures becoming unemployed. The community's livelihood in this village was affected negatively by water scarcity.

(b) Agriculture

Water scarcity can often result in fewer crops which may have an adverse effect on the communities that engage in agricultural activities and the consumers that need them. In short, there's going to be hunger, warns Mugambiwa and Tirivangasi (2017). Rainfall shortages have led to decreased agricultural productivity. Antwi *et al*. (2018) explain that manure needed water to decompose in order to help the crops get nourishment. This can lead to poverty because of the significant consequences of water shortages. For instance, Babar Hassan *et al*. (2016) noted that during 2002-2003 wheat yields were reduced in Pakistan, due to water shortages. The target for wheat has decreased from 22 to 19 million tons. During that season, Pakistan's textile industry was forced to import cotton. The consequences of the reduced yields were poverty and retrenchment.

In South Africa, Agri SA (2016) reports that the prolonged periods of drought experienced have had an impact on all South Africans. As a result, natural grassing has become severely depleted, summer sowing has declined, the temperatures are extremely high, and the grains deficit is growing.

(c) Health

In a study by Oyekale (2017), it was reported that 30% of child deaths are due to poor water conditions and sanitation in South Africa. Palanaippan *et al*. (2017) state that women and children are more economically disadvantaged due to the fact that they are burdened to travel (usually by foot) long distances in search of water.

WHO (Organization 2019) warns that water shortage will lead to malnutrition and may pose a serious risk to children and people suffering from chronic illnesses such as HIV and tuberculosis. Furthermore, conditions like gastrointestinal motility due to diarrhea can be the resultant of water scarcity. Therefore, it can be inferred that access to a safe and clean water environment promotes a safe and healthy living condition for human beings.

3.2.8 Water conservation in South Africa

Water scarcity in South Africa is a matter of growing concern as the government strives to provide every citizen with this basic necessity. Förster, Downsborough and Chomba (2017) argue that sustainable water conservation and demand strategic approach for water stressed areas must be addressed. These water conservation practices must,

in turn, be sustainable interventions, as reported by Loucks and Beek (2017), and to allow for the restoration of depleted resources. While South Africa is well-known for strategy planning and policy development, the implementation of water demand management remains the foremost challenge in improving service delivery to the 5 million South African citizens who remain without a basic consistent supply of water and sanitary facilities (Govender 2016).

In this respect, the key problems are access to infrastructure (particularly for urban poor people); over-use of water supplies; contamination of land and surface water resources; health implications (deficient sanitation facilities and polluted drink supplies); and up to 50% leakage resulting in wastage in some city water distribution systems (UNW-DPAC 2010). At present, South Africa remains in the grip of its worst drought in decades (South African Weather Services 2017). Climate change is an important contributor to the water crisis, as global warming hinders water systems, precipitation and drinking water (Barlow and Clark 2017).

Onyenankeya, Caldwell and Okoh (2018) report that the Department of Water and Sanitation (DWS) is engaged in a battle to curb increased water use in the face of a growing water crisis and ensure that available water supplies are used in a more sustainable way. This resonates with the work conducted by the DWA (2013) who note that the water conservation/water demand management strategies designed by DWS are aimed to address irresponsible behaviour which may lead to water wastage.

DWA hopes to stem the gap between demand and supply through reduction of "*water demand in urban areas to 15 percent below the business-as-usual scenario by 2030*" (DWA 2013:05). Musavengane and Leonard (2019) observe that rural and water conservation efforts tend to differ as many rural residents are unaware of the methods for reducing water demand and do not actually understand the importance of water conservation. Onyenankeya and Salawu (2018) argue that issues of water are not, after all, the only protection of urban residents and commercial bodies, particularly the judicious use of water. In fact, to enable positive water behaviour, a measure such as a water saving campaign has the possibility of turning itself into a social movement that requires the awareness and participation of all South Africans. This is consistent with an earlier study by Zolli and Healy (2012) who maintain that participation in the water conservation drive of all South Africans, including rural communities, is vital not

only to build resource sustainability but also to build the resilience needed by citizens in the face of physical water shortages.

One meaningful conservation measure, termed “Indigenous technical knowledge” has presented itself as a feasible option for cost-effective and sustainable development particularly in African countries, including South Africa where there is a need to conserve natural resources (Kapangaziwiri *et al*. 2018). For example, many studies show that the use of indigenous technical knowledge toward resource management practices is a valuable option to minimise the effects of drought (Barnhardt and Kawagley 2005; Woodward *et al*. 2012; Robinson *et al*. 2016). According to Street (2016), this knowledge system is reflective of the adaptive skills of local communities to the environment when faced with natural disasters and hazards. It is communicated orally and passed down from generation to generation. In recognition and appreciation of indigenous knowledge, the South African government gazetted the Indigenous Knowledge Bill in 2016, which introduced the protection and commercialisation of indigenous knowledge systems (Street 2016). This has provided local communities with a means to tackle innumerable types of risks, either natural or man-made including climate change. In order to resolve such threats, the local communities tend to practice local, community-based approaches acquired from their indigenous knowledge systems.

3.2 9 Water supply management in eThekwini municipality

Water and sanitation in the eThekwini Municipality is managed by the eThekwini Water and Sanitation Services (EWS). The region is home to approximately 3, 5 million people (Statistics South Africa 2016) and up until 1983 was considered a water abundant region. However, severe water shortages caused by hot weather patterns and low rainfall led to the formation of the Water Contingency Planning Committee in 1983. The committee called for a revaluation of the water management practices and to consider water conservation strategies to mitigate water shortages (The Civil Engineer 1985). As a result, many restrictive techniques were implemented and these included restricting the use of automatic flush toilets, only washing cars on weekends and Mondays, and not filling pools with drinking water. It is apparent that factors such as education, community engagement, advocacy and even changing behaviour was not considered to promote water conservation.

However, post-apartheid South Africa saw a change in water management practices. In fact, in 2000/01, the Water and Sanitation Department of eThekwini proved how a pre-determined amount of water (at 200 litres per household per day), as a constitutional right, could be distributed free of charge to residents (Hellberg 2017). By providing the 6 kl of free basic water, it hoped to eliminate the illegal connections by some poorer communities, and as such make them part of the administrative system of water provision. This consequently provided the impetus towards the provision of free basic water and contributed towards the development of the national policy in 2001 (DWAF 2007).

In his budget speech for the year 2008/09, the eThekwini mayor, Obed Mhlaba, announced that municipality increased the supply to 9 kilolitres litres per household per day for all customers within 200m of the household (eThekwini 2009). All residential households received free basic water until July 2012, when only semi-pressure households, or full pressure households in properties with a rateable valued of less than R250,000 receive free basic water. Significantly, in line with Section 5(2) of the Municipal Systems Act the municipality is compelled to provide basic needs to the local community and ensure that all members, even those who cannot afford to pay, have access to minimum level of basic municipal services. This is inclusive of *indigent* customers described as a customer or any household or category of households, including a child headed household, who or which qualifies for tariff assistance, according to the National Framework for Municipal Indigent Policies (2005). Arising from discussions with the eThekwini municipality (July 2018), it emerged that free basic services including the provision of free water was presently only allocated to indigent people. A stipulated amount of 9 *kl* was provided except during periods of drought whereby this limit was decreased to 6 *kl*.

All other households are charged on a rising block tariff depending on the volume of water consumed (eThekwini Water and Sanitation 2012). This approach is to recover cost through a system of cross-subsidisation whereby the wealthier households are subjected or charged higher prices to subsidies poorer households which are usually charged lower prices. The Inclining Block Tariffs (IBTs) effectively charges per consumption (the higher the consumption, the higher the price to be paid). Klassert *et al.* (2018) noted that the application of block tariffs on water pricing is widely used in arid countries for instance, in the Middle East, where water is a scarce resource.

Whilst the municipality been considered a pioneer in sustainable service provision, criticisms have been raised on the application of basic free water policy, which has been seen as disproportionately unfair towards the poorer communities (Hellberg 2014). Whilst this management of water introduced a tighter control on each household's supply of water, the municipality's installation of flow restrictors in poorer communities to curb over consumption was seen as being disengaged on how it perceived water and the way it is valued in communities (Hellberg 2014).

Moreover, the eThekwini the water supply system continues to experience stress due to periods of drought, water quality detoriation, lack of proper infrastructure and urban growth (Roberts and O'Donoghue 2013. This has hindered the provision of fresh portable water. According to Meisner *et al*. (2018), due to the fact that the region experiences higher rainfall periods, the public has the notion that the water availability is not a big problem. Sutherland *et al.* (2014) posited that the high levels of rain did not equate to a steady supply of water because of poor infrastructure planning and development in the past two decades as well as the increase in water demand. This has further impacted on the future supply of water in the Municipality.

Some of the challenges faced by the eThekwini municipality in its provision of water are noted by Gumbi and Rangongo (2018) as follows:

I. **Poor maintenance of infrastructure**

The majority of the infrastructure is dilapidated and outdated. Water leakage and loss occur as water is transferred from water sources to end-users due to defective infrastructure, which includes leaking pipes. Furthermore, aging infrastructure is vulnerable to problems such as constant pipe bursts, which result in additional water loss.

II. **Lack of skills**

Some municipal employees tasked with providing services lack the necessary skills, particularly in financial management and technical infrastructure construction and maintenance. Revenue collection and record keeping are all dependent on financial services.

III. Vandalism of infrastructure

This stems from the intentional destruction of urban water infrastructure, as well as the theft of water pipes and other infrastructure. This devastation puts a strain on the already aging infrastructure.

IV. Illegal connections

Leaking pipes and connections are made worse by illegal connections. Illegal connections often lead to unauthorized water consumption and make it impossible for the municipality to determine who to collect money from.

From the above, it can be inferred that local water authorities must engage with the local communities in projects that guarantee a sense of ownership of infrastructure within their communities, thus reducing vandalism. Furthermore, it must engage the services of suitably trained individuals to efficiently manage and improve water infrastructure timeously. By doing so, the municipality will ensure that all levels of government provide effective, fair, and long-term water supply services.

3.9.1.1 Conservation measures by the eThekwini municipality

As this research is focused on water conservation behaviour of low-income residents with the eThekwini municipality, some of the water conservation strategies employed by the municipality to curb water wastage are listed below (Awareness campaign to reduce water loss in city 2017):

- Installation of water restrictors to enforce sparing use of water.
- Public awareness and enlightenment on reasons and strategies for water conservation.
- Shuttling of water reservoirs from 19:00 to 06:00.
- Improvement in response times to bursts.
- Creating awareness via a variety of media.
- Embarking on wastewater treatment works via the engagement of private firms through the Public Private Partnership (PPP) initiative. The relationship provides grant funding and serve as strategic advisor, capacity building and knowledge sharing.

Despite these efforts, Meissner *et al*. (2018) note that it remains a challenge for the municipality to meet infrastructure and household service needs of the region due to

drought, old infrastructure, high levels of vandalism and poor water use behaviour on the part of most consumers.

Significantly, in the wake of the increasing water crisis globally, research on water conservation attitudes in rural and peri-urban areas in South Africa has remained minimal, especially for general water problems such as water losses and water security (Onyenankeya 2017).

This research therefore seeks to address the knowledge gap in one such community in KwaZulu-Natal, in the form of the Theory of reasoned action (TRA) by presenting actions and behavioural attitudes.

3.3 Comparison of the selected countries

This section compares the strategies of water supply and demand approaches employed in countries such as Singapore, Germany, Brazil and India to South Africa. Water is a strategic resource for Brazil, Singapore, India, Australia and South Africa including the rest of the world in terms of sustainability and economic growth.

As noted from the reviewed literature presented in this chapter, the countries under study here face challenges to secure a safe and sustainable water supply. For example, Singapore, as a country with no freshwater resources, presents itself as a good example in having adapted a holistic management strategic which focuses on both the supply and demand management side of water. This includes wastewater and storm water management. More significantly, the country has adopted strong institutional framework to ensure enabling environment towards water conservation.

From the above aforementioned countries, and as shown in Table 3-2 below, all have put in place a legal and policy framework instrument to address the imbalance between water supply and demand, however, the effectiveness of institutions to respond to the supply and demand needs poses challenges including non-efficient strategies and poor management.

Even though all the countries under study in this research have adopted the principles of IWRM, their effectiveness in water governance is varied. For example, Brazil is yet to achieve good water governance as it struggles with economic water scarcity due to the uneven distribution of water resources. Australia has implemented strong conservation measures in the face of prolonged droughts. India has very poor water

management practice in that water governance is only as good as the political status quo at the time.

Significantly, the imbalance between supply and demand can lead to conflict. Nickum (2019) shows that in India the tendency towards conflict over water intensified as a result of increasing demand, inaccessibility to water, and water rationing. Also, conflicts related to water supply emerged in Brazil. In South Africa water-related conflicts emerged in the city of Cape Town. With the increase in the price of water many municipalities and informal households struggled to maintain their water consumption within the strict restrictions (Lanza and Gonzalez 2019). Whilst many residents reacted in a positive manner to mitigate the crisis) others responded angrily to the city's new water tariffs. Many saw this as water privatisation and organised demonstrations to seek viable solutions (Ziervogel, 2018).

To resolve conflicts strong institutional frameworks must guide institutional bodies in charge of water towards better water governance.

Table 3-1: Comparison of effectiveness of water management strategies

WATER MANAGEMENT					
SUBJECT	**Brazil**	**Singapore**	**India**	**Australia**	**South Africa**
Water management strategy	IWRM	IWRM	IWRM	IWRM	IWRM
Water classification	Water stressed	Water-stressed	Water-stressed	Water-stressed	Water-stressed
Population as of 2019 (approx. in millions)	215	5	1370	25	59
Average rainfall per annum (mm)	1739	2340	600	554	450
% of population with access to drinking water	93	100	89	100	93

WATER MANAGEMENT					
SUBJECT	**Brazil**	**Singapore**	**India**	**Australia**	**South Africa**
Legal and policy framework	▪ The National Environmental Policy Act (NEPA) of 1981 ▪ Law 9433 in 1998 ▪ National Water Resources Council (NWRC) ▪ State Water Resources Management Institutions (SWRIs); State Water Resources Councils (SWRCs). ▪ River Basin Committees (RBCs	▪ Ministry of the Environment and Water Resources ("MEWR") ▪ Public Utilities Board ("PUB") ▪ National Environment Agency ("NEA")	▪ National Water Policy ▪ National Water Framework Bill (2013)	▪ National Water Initiative (NWI) ▪ Water Management Act 2000 (WMA 2000)	▪ National Water Act (Act No.36 of 1998) ▪ The Water Services Act 108 of 1997 ▪ Free Basic Water Policy (FBWP)
Enforcement of regulations	Poor	Strict	Poor	Strict	Poor
Water sources	Groundwater	Imported; Recycled Water	Groundwater	Groundwater	Surface water
Supply and demand of water	Supply strategy	Efficient demand and supply management practices	Supply strategy	Supply strategy	Water Conservation and Demand management
Water pricing mechanism	State Governments and strong	Independent regulator and Government	State Governments	Independent regulator and Governments	DWAF

WATER MANAGEMENT					
SUBJECT	**Brazil**	**Singapore**	**India**	**Australia**	**South Africa**
	stakeholders influenced				
Challenges related to water management	▪ Mismatch between supply and demand leads to conflicts among different stakeholders. ▪ Uneven distribution of water resources; rapid urbanisation. ▪ Growing demand for energy, agriculture, and other large water uses, declining groundwater supplies. ▪ Deteriorating water quality, and lack of wastewater infrastructure. ▪ Wide array of organizational and legal rigidities makes water-using sectors impractical	▪ External water resources, conflicts over limited supplies could arise ▪ Imported water presents uncertainty for future demand	▪ Unpredictable monsoon, depletion of groundwater, inadequate harvesting of rainwater, dearth of reclamation and reuse water, loss of water through leakages; contaminated water / pollution of water; low maintenance and support and poor management of water bodies. ▪ Insufficient distribution coverage, poor functional systems for water quality; poor infrastructure resulting in leakages, high non-revenue water theft, Poor storage quality, poor pipe condition;	▪ Highly variable rainfall and, sometimes, severe droughts ▪ Lack of a holistic and durable framework	▪ Difficulties to manage water demand between a black water bureaucracy and a white-water engineering fraternity, legacy of inequitable water allocations ▪ Wastewater management is a regional challenge ▪ Climate change is predicted to impact negatively on the country's water resource adequacy ▪ Growing water shortages ▪ Imbalance between water

WATER MANAGEMENT					
SUBJECT	**Brazil**	**Singapore**	**India**	**Australia**	**South Africa**
	▪ Overlapping jurisdiction problems		and High energy consumption ▪ Lack of water metering; inefficient fixtures; Low consumer awareness; and Lack of rainwater harvesting ▪ Inadequate sewerage distribution system; Centralized treatment system; Low efficiency of treatment		usage and reliable yield
Watershed administration / arrangement	▪ Committees are formed through the permission of the National or local water bodies and include agents from government and civil society. They are in charge of local water management. ▪ Focus in placed on water planning and conflict resolution.	▪ The Intelligent Watershed Management programme aims to leverage developments in instrumentation, controls and information technology for hydrological, hydraulic, water quality and ecological research, the Communications and 3P Partnerships Network Division	▪ Only partial control over staff, labour laws restrict incentive	▪ Good principles regarding corporate business and regulation of management by sanctions and incentives for staff. Execution of water schemes is through relevant departments of the state government.	▪ Water Resource Commission (WRC) established by the Act of Parliament (Act 522 of 1996) to oversee and regulate natural water resources

*Population has been approximated to the nearest million **Source: Compiled by researcher**

3.4 Lessons from Brazil, Singapore, India and AustraliaData on four countries, including Brazil, Singapore, India and Australia, has been compiled to highlight characteristics of water management. Throughout the comparison, the results reveal that water management strategies are very different in each country. Water management is a deeply complex subject and influenced by a wide array of factors ranging from clear vision, framework, policy, supply and demand system, and challenges including population growth, economic development, urbanisation and climate change (Dow and Downing 2016). Lessons South Africa can learn from Brazil, Singapore, India and Australia are listed below:

(a) Lessons from Brazil

River Basin Committees: The bottom-up approach applied by the Brazilian government in the form of the creation of River Basin Committee, will enable all stakeholder in South Africa to be part of the decision-making processes. Engaging in participatory forums with all the main stakeholders, will help South Africans feel that they are contributing solutions towards the water crisis. While so much has been achieved in South Africa to address the differences of past political dispensations, relatively little has been done in engaging the residents around water usage. Judging by the vision of the national regulator in terms of the essence of water demand management, it is clear that it cannot simply be the domain of the technocrats but requires the participation of the consumer as the beneficiary of the technical interventions to ensure optimal implementation of an effective water management system.

São Paulo Water Recovery (REÁGUA) Project: As in Brazil, in an effort to reduce water losses, South African water authorities can fund private companies to promote the rational use of water in schools etc.

(b) Lessons from Singapore

*Innovation and research***:** By investing in research and innovation, South Africa can find alternative ways to increase water supply.

*Water Conservation Tax***:** In order to create a value for water, this can be an option for South Africa. It will also promote and encourage water conservation behaviour. South Africa can also implement water conservation and demand reduction measures.

(c) Lessons from India

Groundwater: South Africa's groundwater resources are mostly untapped with the potential to increase agriculture and food security (Birhanu and Tabo 2016). This can provide a good source of water for the agricultural sector.

(d) Lessons from Australia

Infrastructure development: South Africa must invest in repairing aged infrastructure which is costing the country a loss of R7 billion a year. South Africa must use water more efficiently. This can be achieved through a combination of infrastructure repairs, the implementation of new building codes, incentives to install water efficient appliances and a tiered pricing structure. Policy measures should be supplemented with campaigns to raise awareness about water use and conservation.

Recycled water: The government should look at recycling as a source of water for the agricultural and urban sectors.

3.4 Summary

This chapter reviewed literature related to the global south perspective of water resource management including policy framework, institutional framework and conservation measures, and covered five countries - namely Brazil, Singapore, India, Australia and South Africa.

In Brazil, water management strategies focus on the IWRM approach for effective water management. Several challenges were noted including lack of integration in the water management sector which results in conflicting views from different stakeholders in energy, mining, agriculture, urban supply and waste treatment, and recreation. A lack of ensuring an integrated and unified system implemented across the country mainly in water scarcity areas is also a challenge. Furthermore, it was revealed that the mismatch between supply and demand leads to conflicts among different stakeholders involved in water production, consumption, and distribution.

Singapore is reported to offer the best-case study for water management practice as its holistic water management framework has encouraged good water behaviour by users. Its approach focuses on supply and demand management, wastewater and storm water management, and institutional effectiveness.

In addition, Singapore creates an enabling environment, which includes a strong political will, effective legal and regulatory frameworks, and an experienced and motivated workforce.

In India, it was noted that the country is faced with several challenges including poor institutional frameworks to focus on resource management rather than resource development.

As a drought-stricken country, Australia is dependent on the National Water Initiative (NWI) as the blueprint for water reform across the country.

These aforementioned countries have aligned to a resolution adopted by the United Nations Human Rights Council in 2010, which affirms that water and sanitation are human rights. These countries have water rights and strong legal status in place, except in India where there is limited power and limited water rights.

Significantly, in South Africa, inequality of access to water is a key issue. Water challenges are still deeply rooted in the historical accounts of apartheid regime structures and attitudes on current water management practices. These historical challenges also include a legacy of inequitable water allocations. In addition, South Africa does not have a national inventory and database of water use and users. A further discussion of Ch 2 and 3 is presented in Chapter 8. Section 8.1.

Chapter 4: Theoretical framework

There are several approaches to changing behaviour towards water conservation measures. This chapter outlines and discusses the two behavioural theories applied in this study. The Nudge theory is discussed by exploring social norms in general with the aim of determining behavioural solutions for more responsible water consumption habits. The Theory of reasoned action (TRA) focuses on consumer behaviour with a specific understanding of attitude and knowledge patterns concerning water consumption practices.

4.1 Introduction

Several studies (Gleick 2018; Lester and Rhiney 2018; Abell *et al*. 2019) show that water conservation is becoming an urgent practice globally, as, in recent years, the availability of freshwater to urban communities has become a focus issue. Mekonnen and Hoekstra (2016) note that the rise in demand for freshwater in the last few decades has been threatening the sustainable development of human society. This view is shared by Dalin *et al*. (2017) who state that natural water resources are fast depleting as a result of climatic changes and rapid population growth.

From a South African context, water scarcity is a reality. Households in various parts of the country have already endured water restrictions through the past years as a consequence of prolonged periods of drought (Vogel and Olivier 2019). South Africa's available water supply has already, on past water consumption patterns, been allocated for future use. However, if conservation measures prove inadequate, or climate change persists, there will be a supply-demand crisis (ActionAid South Africa 2016).

This study consequently aims to develop a strategic intervention through the form of a behavioural model, using Nudge Theory that is premised on the Theory of reasoned action. This study proposes that behavioural science in the form of nudges can be used to promote water conservation in areas that receive free provision of water within the eThekwini municipality.

Nudge theory contributes to incrementally change human behaviour (nudges) through positive reinforcement of good practices (Arno and Thomas 2016).

With respect to water and its usage, the behavioural change sought is to encourage water usage within the free water allocation limits as stipulated in the FBWP. More specifically, the need to reduce the high-water consumption and wastage in the LCH areas within the eThekwini municipality is the underpinning motive for the development of an intervention model. This strongly aligns with Bennett *et al.* (2017) that the best available data and appropriate conceptual frameworks should therefore guide conservation policy and practice.

As a first part towards the goal to proffer a community-based water behaviour model, this chapter reviews literature related to the theories which underpin this study. As low-income households receive an internationally acceptable amount of water free of charge per month, the Nudge theory is proposed in this study. Hellberg (2018) argues that since water is provided free of charge, there are no incentives on the part of recipients to use the resource more sparingly. Therefore, this study explores the use of nudges to bring about behavioural changes in this communities and the TRA to identify the beliefs, attitudes and subjective social norms in relation to the behaviour of conserving water in low-income households.

4.2 Nudge theory

The Nudge theory, developed by Richard Thaler and Cass Sunstein (2008), is an approach in behavioural science and economics. It offers positive reinforcement and subtle ideas to influence the reasons, incentives and choices made by groups and individuals to improve their life and well-being. Thaler and Sunstein (2008) further describe it as tool used by policy makers for improving the effectiveness of policies through the promotion of good behaviour.

While there is some controversy about the exact definition of nudges.(Rebonato 2012; Hansen 2016), the definition that is used in this study can be found in Thaler and Sunstein's own contributions (Thaler and Sunstein, 2008:14) as follows: "*Nudges are purposeful changes of people's choice architect that steer their behaviour in certain directions without significantly changing their monetary incentives or coercing them"*.

Choice architecture (CA) refers to the external factors that can subtly guide one's action in either direction (Nayar and Kanaka 2017). In other words, it is the manner in which choices are presented, framed, and structured.

Given the existence of a CA, it is assumed that a choice architect exists (Hafner, Elmes and Read 2019). According to Munscher, Vetter and Scheuerle (2016) this is a person or group of individuals who customize the environment to make it more likely to select a certain choice. For example, pieces of items that are placed at eye-level in a shop are more frequently selected than those at the top of the shelves. Therefore, to nudge someone is to purposely intercede in a given CA, without the need to offer financial incentives

Conceptually, a nudge refers to: "*any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives*" (Thaler and Sunstein, 2008:14). Current water conservation measures like water restrictions, price increases, ground water management, and recycling, amongst others, are most times too expensive to uphold in the long-term. This creates a need for better approaches towards the management of water for domestic use. In addition, Nudge theory introduces a new set of approaches, known as "*nudges*," that have the scope for low-cost and wide-ranging applications to make healthy lifestyle choices without restrictive regulation (Arno and Thomas 2016). Significantly, with several policy-making bodies globally now considering its use, the afore-mentioned authors have called for further examination of the efficacy of nudges.

Nayar and Kanaka (2017) consider *nudges* as simple low-cost behavioural interventions. This is supported by Waylen (2018) who reasons that it is more effective to use a nudge to change people's behaviour and alter their decisions than to change legislation. Hence, *nudges* are broadly viewed as probable complements to more conventional information and incentive-focused regulation.

4.2.1 Conceptualising Nudge theory

Thaler and Sunstein (2008) maintain that by applying nudges to policy-making decisions, these decisions can not only be more effective but also generate positive feedback amongst the general public. In fact, they argue that if the design of policies is regarded as the map, and development results as the destination, then the road signs can be the nudges gently guide you along the best route. Schubert (2017) further contends that the aim of nudges is generally to produce sensible, low-cost policies that are closely related to how people actually think and behave.

Several studies (Bernartzi *et al*. 2017; Sunstein 2014) report how nudge tools were successfully applied by governments to change individuals' behaviour towards policy objectives. Some examples include the United Kingdom's establishment of a nudge unit in 2010 to encourage desirable behaviour towards policies. Consequently, other countries such as the Netherlands, Singapore and Australia followed suit by directing their agencies to integrate behavioural sciences into their public health campaigns. Mont, Lehner and Heiskanen (2017) also considered nudges as promising tools towards the promotion of environmentally friendly and sustainable consumption behaviours. This is known as "green nudge".

An example of green nudge is reflected in a South African study undertaken during the 2017 drought period when the city of Cape Town was in the throes of heavy water restrictions. Brick, de Martino and Visser (2018) found that green nudges might be an especially useful aide to more traditional demand-side management (DSM) measures. The above-mentioned authors believe that in contrast to more traditional DSM tools, green nudges do not feel punitive and regressive to poor households (who are not able to obviate the hardships associated with higher tariffs and physical restrictions).

4.2.2 Key concepts of Nudge theory

Several research studies confirm the rrelevance of Nudge theory (Whitehead *et al.* 2014; Cooper 2017; Loewenstein, and Chater, 2017; Nielsen *et al.* 2017; Dianoux *et al.* 2019). The Nudge theory advocates mainly that "*nudging people into new patterns of behaviour is based on the insight of behavioural economists that people routinely behave in non-rational ways*" (Whitehead *et al*. 2014:12). These authors stress that the theory is constructed on readings in the field of behavioural psychology and cognitive design which suggest that the environment in which individuals make decisions can be reshaped so that they can embrace the financial, health and environmental behavior that is best for themselves.

Furthermore, the theory suggests that a range of social problems can be addressed at minimum cost while also protecting the personal freedoms of individuals (Whitehead, Jones and Pykett 2019). Moreover, Cooper (2017) stated that the Nudge theory attempts to help individuals to make decisions that would be in their best interest.

Finally, the relevance of the nudge theory is to push individuals in a particular way to make certain specific decisions without taking away their freedom of choice (Nielsen *et al.* 2017).

4.2.3 Application of Nudge theory

Various nations globally use Nudge theory to deal with a variety of social problems while protecting the personal freedoms of individuals (Shakespeare *et al*. 2019). Similarly, Nudge theory can be used in different life cycle processes associated with the use of products and services, from the decision to buy, in the usage of that good or services, and, finally, making a decision on the management of waste at end of its life cycle (Nielsen *et al.* 2017).

Kosters and van der Heijden (2015) cited several studies where the application of Nudge theory was used successfully. In a major study in the USA, the location of the signature box at the beginning, instead of at the end, of an insurance form prompted a more truthful response (Cabinet Office 2012). Here, customers had to declare their recorded vehicle miles which meant that more miles recorded the higher the premium. The study found that those that signed at the top of the form reported travelling at least 10 percent more miles than those that signed at the bottom. In another study, Gallagher and Updegraff (2012) reported that letters sent out to health specialists to pay outstanding taxes were found to be more effective if the letter was made shorter with the consequences of non-payment highlighted rather than being buried in the text. Furthermore, a study by Broers *et al*. (2017) showed that students were more likely to choose vegetables if it was presented to them more attractively.

It is advocated by Rasul and Sharma (2016) that water conservation measures have the ability to reduce water demands. Furthermore, studies as indicated in *1.5 Causes of water scarcity*, have urged water utilities to consider long-term strategies such as behavioural changes. In addition, this study applies the Nudge theory as a behavioural intervention method to assist the eThekwini municipality in its efforts to reduce the high-water consumption in low-cost housing areas.

In the sub-sections that follow, Nudge theory is explained in relation to policymakers, environmental consumption, water consumptions, behavioural economics and behaviour change.

(a) Nudge theory and policymakers

Jung and Mellers (2016) outline two ways nudges are used by policy makers:

1. To counteract the negative impact of other actors' (e.g. business, media) attempts to subconsciously influence human behaviour and thus reduce behaviour deemed undesirable (e.g. consumption of fatty, salty and sugary food).
2. To promote certain behaviours and thus increase behaviour deemed desirable, for example, consumption of healthy food.

Nudges comprise four types of tools as illustrated in Figure 4-1 below**:**

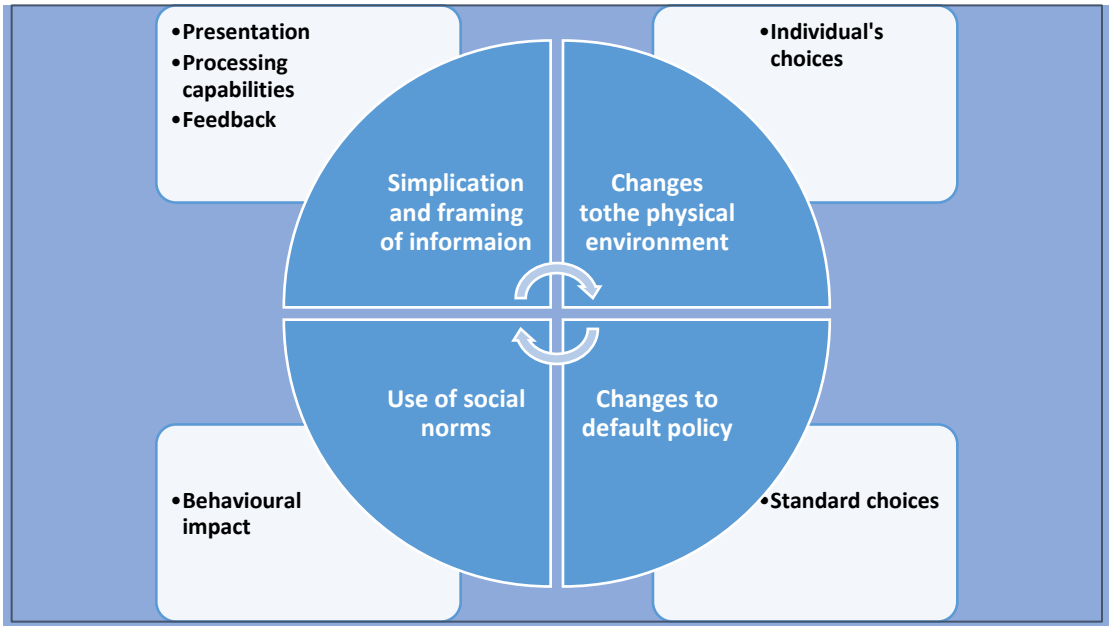


Figure 4-1: Types of tools used in Nudges (Adopted from Sustein 2017)

1. **Simplification and framing of information**: It builds on the concept that not only is the accessibility of information to people important, but also how it is presented. Simplification ensures that communication is streamlined and presented in such a way that suits the individual's information processing and decision-making capabilities. Its value can be applied in complex services and products, like decisions on finances or investment. Another way the information can be simplified and framed is through feedback. Feedback on how one meets one's pension savings goals, for example, will help employees stay on target with retirement plans (Thaler 2017).

2. **Changes to the physical environment**: The physical environment has been considered to have an important impact on an individual's choice. For example, many retail stores nudge people into buying certain consumer goods by *"careful product placement"*, which is placing those at the eye-level of customers (Smith and Toprakkiran 2019).

3. **Changes to the default policy**: Generally, according to Sustein (2017), individuals follow a path which constitutes the least effort. As an illustration, they choose to procrastinate unless they have to act or make a decision. As such, they may be strongly influenced by defaults, that is, standard choices that decide the outcome in situations where you don't need to take action. For example, a one-sided print option is a default that contribute directly to higher volumes of paper than if a double-sided copy is the default. In a Swedish study, 30% of paper usage was determined by default. However, paper consumption was by 15% by changing the default to double-side paper consumption (Lehner, Mont and Heiskanen 2016).

4. **Use of social norms**: As observed by Muldoon (2018), social norms are a formidable force which shapes human behaviour. Chung and Rimal (2016) argue that in order for it to have a behavioural impact on an individual, it must be salient or visible. For example, a study by Masseo *et al.* (2017) reported on fruit consumption in two schools. Employees at the cafeteria at the first school asked pupils: "*Do you want fruit or juice provided with your lunch? while* no such verbal prompt was issued at a second school. The intervention resulted in the first school seeing 70 percent of children eating fruit at lunch, compared with less than 40 percent in the second school.

Using nudges has thus shown that through peer comparisons in conjunction with information on consumer consumption habits can be an efficient way to minimize the usage of scarce resources such as water and energy (Nielsen *et al.* 2017).

(b) Nudge theory and environmental consumption

Nudging has become a widely recognised framework across many environmental sectors in recent years, including energy use, managing pollution and waste efficiency (Chern 2017). This recognition has attracted the attention of policy makers and private organisations who indicate that nudging can be an effective tool making citizens' lives easier, healthier or simpler within communities. Significantly, Goepel, Svanhall and Rahme (2015) believed that the features of the nudge approach, such as effortlessness and rapidness, can potentially lead to sustainable behaviour towards the conservation of natural resources. Furthermore, Schubert (2017) report that the previous research (Reese, Loew and Steffgen 2014; Lehner *et al*. 2016; Chern 2017) into changing consumer behaviour to promote responsible ecological consumption can be applied to the context of social responsibility consumption, such as scarce resources like fresh water. Equally, a Nielsen *et al.* (2017) study revealed, for instance, that information-based nudges targeting energy efficiency generally show both quantifiable and substantial impacts (influencing energy consumption by +1% to -40%).

Furthermore, Nudge theory was used in a study conducted by Goepel *et al*. (2015) in relation to changing behaviour towards a sustainable society. Their findings reveal that, on the one hand, nudges can break down the large, abstract and complex concept of unsustainability into smaller, tangle, measurable actions; whilst on the other hand, nudges have potential in shifting behaviour towards incremental sustainability on a larger and more systemic scale.

(c) Nudge theory and water consumption

In alignment to the current subject, Nudge theory was used in a study conducted by Datta *et al*. (2015) on the feasibility and limitations of low-cost behavioral water consumption measures in Costa Rica which is a middle-income country. The study is set in the city of Belen, shows that simple one-time behavioral-based approaches are successful in curbing water consumption. Households were divided into three treatment groups and a control group. These cost-effective measures were in the form of a coloured sticker taped to the monthly water bill, along with water saving tips to the treatment groups. The stickers were either happy face or frowny faces dependent on the water consumption of that group.

Their findings reveal that there was significant reduction in water consumption among the treatment groups of households by at least 6,720 m3 each month. The results indicate that the monthly savings in water from the domestic perspective could, on a monetary basis, be estimated at $5 to $10. The intervention of producing the stickers costs approximately $400.

A similar study was conducted by Nayar and Kanaka (2017) in India. They found that behavioural interventions applied to water consumption resulted in an average monthly 10.3 percent water saving, which amounted to a 9 689 litres reduction in water consumption.

Nayar and Kanaka (2017) put forward two water conservation approaches, *Pecuniary* or *Non-Pecuniary,* to reduce water consumption in urban areas. The *Pecuniary* approaches comprise financial related measures to persuade residents to reduce their water consumption habits and thus conserve water. However, a study by Abansi, Hall and Siason (2018) maintains that any tariff increases, in the absence of regular water supply to households, may be considered socially and politically unacceptable. Furthermore, van Wilgen and Wannenburgh (2016) note that in the absence of water saving devices, any incentive to save water is not feasible - despite the economic benefits associated with efficient water management through the use of water efficient devices.

On the other end, policy makers frequently rely on the *non-Pecuniary* (psychological interventions) approach to manage water resources, such as rationing of water supply in an effort to reduce the demand supply gap (Camos and Estache 2017). According to Nayar and Kanaka (2017), this calls for policy level resolutions on fixing prices for the supply of water. Moreover, Datta *et al*. (2015) observe that this approach involves providing appropriate information on issues related to water scarcity in an effort to encourage water conservation. Conversely, Ashby *et al*. (2010) observes that while offering information to the consumer may increase awareness of a topic, it rarely offers actionable understanding or any significant behavioural changes.

For example, Straus, Chang and Hong (2016) found that while individuals who attended a two and half month workshop related to water conservation displayed

change in knowledge of the need to save water, this did not show any ensuing change in water consumption patterns.

In this study, non-pecuniary approaches based on simple and inexpensive behavioral interventions are adopted to examine their potential to promote good water behavior among users in LCH areas.

(d) Nudge theory and behavioural economics

Behavioural economics applies the insights of psychology to economic decision-making (Bhargava and Loewenstein, 2015; Lourenço *et al.* 2016; Goepel, Svanhall, and Rahme, 2015; Thaler and Sunstein, 2008; and Whitehead *et al.* 2014). As a field it is primarily concerned with the limits of rationality of economic agents and is sometimes discussed as an alternative to neoclassical economics. It examines psychological, social, cognitive, and emotional factors on the impact of economic decisions of individuals and institutions (Goepel, Svanhall and Rahme 2015).

Behavioural economics is defined as the discipline that: "*applies psychological insights into human behaviour to explain economic decision-making*" (Lourenço *et al.* 2016:10). Correspondingly, behavioral economics blends psychology and economics towards the development of a human behavioural model with due regard to minimal complications (Nayar 2017). Furthermore, behavioural economics not only has potential to assist individuals or organisations in achieving objectives, but in the current case, to also assist to drive down water usage and to achieve a measurable gain in water conservation and efficiency when used strategically. However, this concept conflicts with the view from traditional economics which over-emphasises that human beings are rational and constantly pursue their self-interests to maximize welfare (Bhargava and Loewenstein, 2015; Thaler and Sunstein, 2008).

According to Ruggeri (2018), behavioural economics, when it is used judiciously, has the capability to achieve organizational objectives and, in this case, to reduce water use and achieve measurable successes in water conservation behaviour. In India, as reported by Nayar (2017:75), householder have not committed to invest despite showing interest in efficient water products and practices, regardless of the "*economic benefits associated with efficient water management*". The literature review related to water consumption and behavioural economics interventions reported interesting points. These interventions led to behavioural change in the consumption of water at

inexpensive cost (Datta, Miranda and Zoratto, 2015). However, the literature found that water use reductions with behavioural interventions as a policy remains relatively underexplored.

(e) Nudge theory and behaviour change

Behaviour change refers to the transformation of human action (Michie 2018). In general terms, behaviour change refers to the nature of the behaviour, how it could be changed. The duration or extent of the change remains unspecified (Whitehead *et al*. 2014). In the same light, behaviour is usually characterised by conformism, which may lead to higher or lower levels of stress (Nielsen *et al*. 2017). To illustrate, Nielsen *et al*. (2017) stress that waste sorting and energy consumption depend on whether the information provided is “higher” or “lower” than the individual decision maker’s initially intended behaviour.

In designing and implementing public policies, behavioral policies are typically recognized as policies that understand that changing individual actions is key to the success of any form of interventions employed by government (Strabheim and Beck 2019). Such policies are particularly concerned with the drivers of human action that are unconscious, automatic and emotionally oriented. As reported by Benartzi (2017), related policies indicate that behavioural change should be sought not only through incentives, awareness and education but also by the use of more emotional approaches, including implicit nudges, peer-to - peer encouragement and social media among other measures. As such, many policymakers, psychologists and behavioural analysts engaged together through comprehensive studies to better understand the factors influencing sustainable and environmental decision-making and behavioral change (Baddeley 2018).

4.2.4 Shortcomings of the Nudge theory

Many behavioural economists believe it is improper to nudge since it impacts people's choices without their agreement. As such, there is a heated debate over the ethics and political morality of nudges (Selinger and Whyte, 2011). In essence, nudges are regarded as morally problematic since they are considered to consistently override people's own interests when modified decision structures are used (White, 2013). Critics thus challenge nudgers' statements that they are simply influencing people's

behaviour in directions that are consistent with their own preferences (Thaler and Sunstein 2008.

According to White (2013), nudges are intended to influence *'the behavior that policymakers desire to see'* rather than interacting with people' real preferences in any meaningful way. Examples include the fact that, contrary to what behavioural policymakers believe to be true, people may have legitimate personal reasons to continue smoking, eating unhealthily, or declining medical care (White 2016). In this way, nudging, according to ethicists, undercuts people's autonomy, self-government, and dignity, while also deliberately exploiting their constrained rationality in order to further the agenda of politicians and institutions. Such ethical qualms are exacerbated by the fact that many nudges function secretly (Oliver 2015), influencing people's behavior without ever disclosing the normative objectives and motives that lay behind the nudges in a transparent manner, therefore raising questions about their legitimacy.

This study argues that depending on how it is utilized or generated, the nudge can be beneficial or harmful. For example, nudges can lead individuals in a specific direction, such as a menu with a list of meals or a simple billboard that claims that going to the gym is beneficial for your health and offers to buy a membership. This type of advice may truly help individuals make better judgments and avoid making negative ones. However, most behavioral economists say that such manipulations are immoral and that individuals should not be influenced without their consent; nevertheless, if people were not encouraged to be healthy, illnesses such as cancer, obesity, and diabetes would skyrocket (Wilkinson, 2013). Furthermore, according to Yashar Saghai (2013), nudging has a lot to give the world, but it requires conceptual clarity as well as ethical defense.

In reviewing the literature related to behaviour change, nudging theorists assume that most of the decisions people make are not rational, but are subject to certain heuristics (Van Deun *et al*. 2018). This opens new opportunities for changing citizens' behaviour as well as increasing effective decision-making.

Furthermore, the literature on nudging also reports that data in real-time provides, for example, for in-house smart meters to inform the householder on their energy consumption. Nielsen *et al*. (2017) says this gives transparency to the user regarding their energy consumption and the cost in order to reduce peak usage. As a result,

consumers have credible and accessible information to reduce the complexity of choice.

The rationale for interventions can be to solve a problem that arises from economic factors, behavioural factors, or a hybrid of the two (Loewenstein and Chater, 2017). For example, the plan-making intervention to reduce the average water consumption has demonstrated significant results in reducing water consumption (Datta *et al*. 2015). The authors suggest that communication and awareness programs tend to be the most common non-pecuniary strategies to minimize water demand without attempting to change explicitly how much is charged for it. For instance, in South Africa (in 2007) and India (in 2013), “Water Wise” communication campaigns resulted in reducing the demand when people were given information on the benefits of saving water. In summary, poor water conservation behaviour can lead to water shortage. Therefore, this study suggests that well-placed nudges can save the government money, encourage desirable actions, and more importantly, increase the efficiency of scarce resources like water.

The next section discusses the Theory of reasoned action. It covers constructs of TRA, TRA and communicating climate risks, TRA and water conservation, and examples of TRA studies.

4.3 Theory of reasoned action (TRA)

According to Aziz, Husin and Hussin (2017), there are several theories such as the Theory of planned behaviour, Attitude social influence-efficacy model, and the Innovation diffusion theory, amongst others that are applied to study behavioural relationships. This study focuses on the TRA which is applied to explore an individual’s behaviour towards water conservation in a low-income setting. Created by two renowned scholars, Martin Fishbein and Icek Ajzen in 1975, the reasoned action approach is grounded on initial study work on the Theory of attitude.

Haggar (2019) notes that TRA is one of the most influential approaches to predicting and understanding intentional behaviour, has been extensively applied across multiple behaviours, contexts, and populations.

Chaudhary *et al*. (2017) further assert that the popularity of TRA is due to its simplicity, versatility, and its effectiveness in understanding variance in behaviour.

TRA suggests that an individual's behaviour is influenced by behavioural intentions. This means that the probability of individual behaviour being realised is greater if there is a strong intention to perform that behaviour.

Haggar (2019) contends that the process underlying all human social behaviour is fundamentally the same and can be described by a small set of constructs. Fishbein and Ajzen (2011) also suggest that human behaviour is best predicted from a person's intentions. They assert further that these intentions are determined by the person's attitudes toward the behaviour, perceived norms regarding the behaviour, and perceptions of control regarding that behaviour. This is illustrated in Figure 4.1.

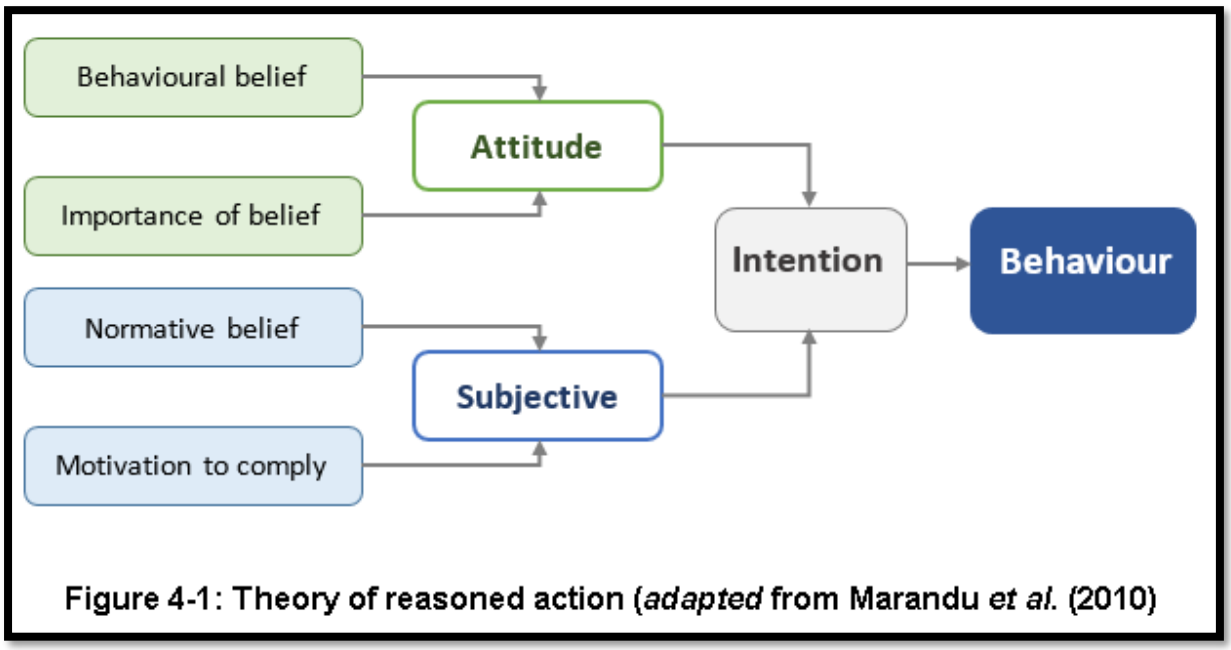


Figure 4-1: Theory of reasoned action (*adapted* from Marandu *et al.* (2010)

TRA is relevant in this study as it offers a means to identify the beliefs and attitude components, social norms and perceived control in relation to the behaviour of conserving water in low-income households. The TRA is based, as stated by Marandu *et al*. (2010), on the premise that human behavior is a result of a rational way of thinking. Its origins derive from a number of scientific advancements in the area of social psychology, which attempted to define, among other factors, why and how attitudes affect behaviour. As already noted, Haggar (2019) argues that the central construct of the theory is intention which is a motivational concept which is considered the most determining factor of behaviour.

Haggar (2019) conceptualises intention as a function of two belief-based constructs: attitudes and subjective norms. Montano and Kasprzyk (2015) note that while attitude reflects on whether an individual's behaviour is evaluated as "*favourably or unfavourably",* subjective norms, on the other hand, denotes the perceived social obligation to practice this behaviour or not. In this study attitudes toward water conservation and subjective norms are hypothesized as antecedents of water conservation behaviour. Although the seminal report of Fishbein and Ajzen (2010) described norms as purely subjective, this singular view of norms has, however, since been discarded (Gold 2011). More recently, and as revealed by Gold (2011) and Ajzen (2012), norms are now conceptualised in two ways which are: Injunctive norms (inferring what important others want us to do), and descriptive norms (perceptions of the observed or what others are actually doing). The aforementioned expansion of normative conceptualisation will be taken into consideration when designing the research instrument. As shown by the afore-mentioned studies, TRA is based on three defining constructs, namely, behaviour, attitude and subjective norms. These are discussed next in relation to this study.

4.3.1 Behaviour, attitude and subjective norms constructs of TRA

According to studies (Untaru *et al*. 2016; Paul, Modi and Patel 2016; Tahir, Sa'ari and Johare 2017), the behaviour, attitude and subjective norms components of the TRA have been applied positively to predict behaviours such as domestic water conservation, ecological practices and driving violations, amongst others.

(a) Behaviour construct of TRA

Montano and Kasprzyk (2015) recognise that behaviour usually, but not always, reflects established attitudes. The behavioral intention which basically defines the actual behaviour (Ajzen 2015; Sheeran and Rivis 2017), is an additive feature of two variables: attitudes which may constitute a positive or negative evaluation of the performances of one's behavior, and subjective norms which is the perceived influences others have on your actions.

For example, Albarracín, Kumkale and Vento (2017) argue that marketing and election organizations are both focused on the assumption that behavior reflects attitude. This is in line with Andrews and Shrimp (2017), who observed how marketing campaigns modified customer behaviour through the effective use of innovative marketing

techniques to either improve or deter their current behaviour. The work of the aforementioned authors suggests that social marketing is in fact "*selling*" attitudes which sublimely affects the subsequent behaviour. As such, it can be considerably assumed that an individual who firmly believes in the value of water conservation would more likely practice its conservation consistently.

(b) Attitude construct of TRA

Ye, Bose and Pelton (2017) note that one of the earliest researchers to conduct a study on how attitude influences behaviour was Charles Darwin in 1872. Darwin described attitude as the physical manifestation of an emotion which he asserted had a "*directive or dynamic influence on individual response to all objects and situations*" (Marandu *et al*. 2010: 90). Darwin observed that this behaviour could be verbal or non-verbal, such as facial expressions or body language. This tri-component model is the contemporary form of this paradigm. As illustrated by Lee *et al*. (2019), attitude and behavior are positively influenced by three key components: the *cognitive, the affective and the conative.* This resonates with a study conducted by Ahn and Back (2018) which argues that the *cognitive* component suggests that to develop an attitude towards any product or issue one must have *knowled*ge (also called *beliefs*) about it. The afore-mentioned author argue that the *affective* component is the consumer's evaluation of the *beliefs* or *knowledge* about a product; it is about feelings or emotions about a product; it is the extent to which an individual rates the object as "favourable" or "unfavourable," or "good" or "bad". The *conative* component is the individual's tendency to undertake a specific action or behave in a particular way in relation to the product in question. In business, it is the likelihood of a consumer purchasing a product or behaving in a certain way. The prevailing view that attitude and behaviour are interrelated is taken into consideration in this study.

(c) Subjective Norms construct of TRA

According to Chaudhary *et al*. (2017), subjective norms are defined as the measure of influence individuals in a social environment have on one's behavioural intentions. Chang (2013) further states that this would also refer to the influence by others, such as friends, family, acquaintances or business partners.

Subjective norms capture the person's feelings related to the social pressure they experience on a specific behaviour. Han *et al*. (2010) found that consumers who have

positive subjective norms towards a given behaviour are more likely have positive intentions. This is supported by Khare (2015) who observed a positive link between subjective norms and intentions. For example, when an individual perceives that their significant others endorse their behaviour towards recycling, they are more prone to adopt these behaviours.

In this study, subjective norms are assessed by requesting respondents to consider how likely it is that people who are important to them, such as family, friends, and the municipality, would approve or disapprove of their behaviour.

4.3.2 TRA and communicating climate risks

Moura *et al*. (2017) report that communicating the challenges of climate change to vulnerable groups in order to motivate them to take adaptive actions, remains a major challenge in many parts of the world. Pointedly, TRA suggests that attitude and subjective norms are important for persuasive communication. Part of this study assesses how to apply TRA, its constructs and other relevant factors, to predict behaviour intention and beliefs and to change behaviour tendency in an effort to reduce high water consumption by inhabitants of LCH areas.

Several studies (Ho, Wang, Yen 2015; Nguyen, Lobo and Greenland 2017; Du Toit, Wagner and Fletcher 2017; Nguyen and Lobo 2017) find that TRA is widely used in the field of sustainability research, in areas such as recycling behaviour and purchase behaviour. Likewise, Taylor *et al*. (2007) write that TRA provides a theoretical framework for health studies, including slimming and eating behaviour, addiction to smoking and alcohol abuse, condom use and HIV. Recently, some studies (Martins and Viegas 2015; Nadlifatin *et al.* 2016; Alzahrani, Hall-Phillips and Zeng 2019) have applied TRA to energy, green IT technology adoption, environment-friendly energy use, waste management, and vehicle use. On the other hand, it is unclear whether attitude and behaviour theories that are primarily derived from Western practices are appropriate for explaining water conservation behaviour in the arid and semi-arid areas of developing countries. Gilpin (2018) observes that in these countries, economies remain underdeveloped and environmental protection is not considered the primary need of the public in the face of global capitalism.

4.3.3 TRA and water conservation

Yazdanpanah *et al*. (2015) and Mango, Siziba and Makate (2017) comment that there is a lack of academic attention to household domestic water conservation behaviour particularly in arid and semi-arid areas of developing nations. Shackleton *et al*. (2015) reiterate that water scarcity is a vital factor inhibiting sustainable social and economic development in sub-Saharan Africa and across the world.

A study by Martos *et al*. (2016) believes that by understanding residential water conservation behaviour, an effort can be made towards designing intervening measures that help individuals develop more environmentally friendly water consumption behaviour. The advice of the afore-mentioned authors will be considered in this study.

4.3.4 Examples of TRA studies

In light of the above literature, a summary of four studies conducted between 2010 and 2017, which are related to the theoretical framework underpinning this study, are highlighted below.

(a) Study 01: Marandu *et al*. (2010)

This study examines the power of the TRA to explain residential water conservation in Botswana. The research was considered timely because Botswana was in the midst of an unprecedented water crisis. In July 2007, the Gaborone dam's water levels dropped significantly, when it contained water to last about four months. In response, the Government called on its citizens to familiarise themselves about water conservation.

Botswana, considered a semi-arid country afflicted with a drought prone climate, has only about 10% of the cultivable land. There is a shortage of surface water, and the main surface reserves are situated long distances from the demand areas. As a result, there are high costs associated with the use of available surface water resources. At present consumption levels, Botswana's water supplies are expected to be depleted between 2028 and 2035.

The study authors believe that policy tools, such as regulations, pricing and awareness campaigns, can help influence water use and conservation. In light of the above, a survey was conducted with 462 respondents residing in Gaborone which has a population of 186 007 people.

Data were obtained mainly at the Botswana Water Utility Collection Points in Gaborone from customers that were waiting to pay their water account. The questionnaire contained 13 questions that assessed knowledge and behavior with respect to water conservation practices, 7 behavioural belief strength statements, 7 outcome evaluation statements, 5 normative beliefs, 5 motivations to comply statements, and 1 intention statement. The study found that the two theoretical constructs (attitudes and standards) were statistically important predictors of conserving water. Secondly, the findings have validated previous work that attitude is a bigger factor in order to understand water conservation behavior.

Third, given statistical significance, the research revealed very low explanatory power for attitudes and norms. The implications for policy makers are that messages on conserving water should seek to change attitudes and norms. The research was important since most water studies in Botswana focus on water supplies and resource demand forecasts. The survey undertaken was important as it examined residential water conservation behaviour and it was the first analysis to apply the Theory of reasoned action in the Botswana water context.

(b) Study 02: Chang (2013)

This research, based on a questionnaire survey, analyses factors that affect the water conservation behavior of urban residents in Zhangye City, China. Zhangye City is located on the upper catchment of the Heihe River, which is China's second largest inland river, and has a population of 200 000. The climatic conditions at Zhangye are hot and dry, with 140 mm of annual precipitation compared to 1400 mm of annual evaporation making this area water scarce.

A survey was conducted with 900 participants during a public holiday from October 1–7, 2010. The target population were local visitors to the Zhangye Central Square and the northern Ganquan Park, as well as participants selected from three residential areas. The questionnaire included water conserving behaviour related to tooth brushing (using a glass), bathing (turning the water tap off after soaking), dishwashing of vegetables (filled the sink with water and then turned off the faucet), washing of clothes (washing with hand for little loads), re-using of water from the washing machine and the bathtub. The main findings in the study indicate that the beliefs of participants regarding local water supply have impacted their behaviour and attitude

towards practicing water conservation habits. Significantly, while the findings indicated that researchers and local government representatives were worried with the current water shortages and its effect on economic and urban development, many urban inhabitants remained undaunted. Their attitude was that economic and social growth did not affect them, since they were acclimated to their local living standard and, as such, no intention was required on their part to improve it.

It was further found that majority of the urban residents were only concerned with their household water supply, assuming that there was no scarcity in Zhangye water supply since there was no interruption on their domestic water source. Therefore, this study concluded that the belief in sufficient water supply can lead to water wastage or a dearth of water conservation practice. This study is relevant to the current study since there is a perceived belief that water is an infinite resource and as such there is no intention to use it judiciously. This is, according to Jacobs-Mata *et al.* (2018) prevalent predominantly among residential water consumers.

(c) Study 03: Hurlimann and Dolnicar (2010)

This survey research of 1495 people reveals that Australians are usually very positive about the conservation of water. Such positive attitudes, however, are not consistently reflective of actual behaviour. The major obstacles identified in the study to adopting water conservation behaviours are the perception of inconvenience and impracticality, and also the expenses associated with having water-saving devices.

In recent years, due to the widespread drought in many areas across Australia, the focus was on attempting to address the water problem in several ways, ranging from increasing behaviours in conserving water to reducing water demand. The results in this study illustrate the fact that, despite water conservation initiatives, there is still considerable potential to be generated in this area. Respondents were asked whether or not they agree with a series of 19 questions about water conservation. Overall, respondents display a positive attitude to water conservation with 97% saying that it is necessary to conserve water.

In addition, the majority of respondents in this study agree that water conservation is important due to water scarcity (94 percent) and that they conserve water wherever possible (92 percent). However, while attitudes towards both water conservation and energy-efficient appliances are favourable, this study shows that these attitudes are

sometimes not translated into practice. The study concludes that while almost all Australians claim that water conservation is relevant, self-reported behaviours indicate that there is still a substantial room for improvement. It seems that attitudes are converted into practice where it has been easy to do so, when water conservation may not bother people.

This study is significant because it shows that although Australians are open to the idea of water conservation, it is important for water authorities to provide citizens with more knowledge in order to change their behaviour, as well as to provide incentives that will mitigate the economic strain and probably reduce the perceived difficulty of implementing water-saving measures in their daily lives. The study concludes that this shift of attitude can be accomplished by further implementing public policy initiatives such as financial incentives, as well as social media strategies to communicate relevant information on water-saving devices.

(d) Study 04: Ramsey, Berglund and Goyal (2017)

In this study it is reported that social norms, income, age, and self-efficacy (the perception of one's actions capacity to make a difference) have an influence on water conservation behaviours. A household survey conducted in Jaipur State in India studied the conservation attitudes and behaviours of water users and the impact of their demographic characteristics, environmental beliefs, and social pressures. Out of the 248 households, 29 houses were situated in the informal settlements. Jaipur, a semi-arid region with a population of 5 million, receives 525 mm of rain per annum. Water is supplied through the Bisalpur Reservoir which has 40 percent dependability of continuous water supply during drought conditions. At these times the supply of water is limited, and households have access to clean water at least 2 hours each day.

The study argues that policies on pricing, such as block pricing and higher tariffs, had a minimal effect on water usage given the limited capacity for local government to implement such pricing. Non-price policies (NPPs), that include awareness campaigns and water-efficient technology rebate programs, can however reduce domestic water demands. The study further avers that the efficacy of NPPs can be partially determined through current technologies and the possible reasons of water consumption behaviour. Accordingly, majority of the respondents report having practiced at least one measure in conserving water. When water saving behavior

increases in cost or commitment, its popularity decreases. The study found that turning the faucet off when brushing teeth was the most popular known practice in 94% of households.

It was found that water-conservation behaviours requiring some degree of effort but no financial cost, such as water reuse from water filtration systems, were substantially less popular. An important finding of the study shows that conservation technology measures such as water saving devices which require financial costs but no additional effort after installation, are less common than initiatives that require effort but no financial costs. The study concluded that the most critical component of cultivating conservation habits is to standardise behaviour; that is, if people believe someone else is doing their share to conserve water, they will be more motivated to participate in conservation behaviour.

4.3.5 Shortcomings of the TRA

The model has several flaws, according to Miller (2017), such as the possibility of confusing attitudes and norms because attitudes might be reframed as norms. Another restriction is the notion that once someone decides to act, they will be free to do so. In addition, Sana'a (2016) argues that TRA ignores the fact that some conditions required for a behavior are not available to individuals. The TRA can't anticipate behaviors that need access to particular opportunities, skills, conditions, or resources since it concentrates on decisive actions. Also, some intents do not always play a role in linking attitudes and actions.

This study argues that TRA is not without limits and, like any other theory, requires continual refining and modification, particularly when applied to choice and goals. Ajzen (1985:12) agreed, "*Some actions are more likely to cause control issues than others, but we can never be sure we will be able to follow out our plans. In this perspective, it becomes obvious that every desire is a goal whose attainment is uncertain*."

4.4 The relevance of the theories

The two theories reviewed in this chapter is undertaken to help the eThekwini municipality to develop an integrated and responsive water conservation strategy to address thehigh water demands, particularly in its low-cost housing areas. This study

argues that behavioural changes towards water conservation can provide insights to policy-makers to prompt quick behavioural adaptions in the face of water conservation challenges . Previous studies (Seyranian, Sinatra and Polikoff 2015; Esther and Kumar 2016; Song and Wu 2019) maintain that traditonal demand-side management tools to reduce water consumption, such as price hikes, tiered tariff structures, or water restrictions, are no longer sufficient enough for behaviour change, particularly in communities which cannot afford to pay for services. Therefore, non-priced approaches such as nudges can be appllied to promote water-wise practices (Meissner *et al*. 2018). For this reason, the Nudge theory, is a feasible, low-cost method to motivate behavioural changes in LCH areas. In this study it provides a useful framework to identify, assess and reshape existing choices and influences that are given to people by the governments. As such, according to Sunstein (2019), its application presents a significant opportunity, given that many of these choices that people are given are no longer achieving its intended purpose. Significantly, since it recognises that those individuals have certain behaviours, awareness, and attitude towards water conservation practices, the application of the TRA is used to explain these factors. Furthemore, TRA suggests that developing positive attitudes may be a crucial factor in any programme to promote good domestic water use (Shamim, Panhwar and Iftikhar 2019). Therefore, both Nudge Theory and the TRA is proposed to reduce water demand and raise awareness by identifying which incentives are well-placed to motivate FBWP households to curb their water usage.

4.5 Summary

Recognising that water use behaviour plays a critical role in water management, this chapter assessed the applicability of two behavioural theories, Nudge theory and Theory of reasoned action. In summary, the application of the Nudge theory as an effective way to promote water conservation in a LCH setting without restricting the freedom of choice, is advocated. In addition, given the findings by the afore-mentioned studies discussed in this chapter (Marandu *et al*. 2010; Chang 2013; Hurlimann and Dolnicar 2010; Ramsey, Berglund and Goyal 2017), that the TRA is a useful framework to predict the currrent water behaviour, it is reasonable to believe that the TRA provides a good theoretical foundation for identifying the community's main beliefs and attitudes related to trying to conserve water, and it enables the

identification of the individuals who influence this attempt to save water (social norms). For these reasons, Nudge theory and the Theory of reasoned action are plausible theoretical frameworks for this study.

Chapter 5: Research design and methodology

This chapter explains the research design and the methodological rationale adopted in this study. The research methodology is introduced and justification for the research is explained. The research methodology discussion compares the two main research approaches (qualitative and quantitative) and provides an argument for why a mixed methodology was chosen for this study. The pilot study conducted is reviewed and the main study is introduced. The collection of data and the sampling method used to generate data is described. Finally, the analysis of data is discussed.

The qualitative phase of the research employs semi-structured interviews and focus group discussions. Relevant stakeholders from government and community-based organisations, and academics were interviewed to gather data on factors contributing towards high water consumption in poorer communities in Kwa-Zulu Natal. In addition, residents of the Waterloo community were engaged, through four focus group interviews, to determine their awareness of the current water scarcity experienced in the country. In the quantitative phase of the study, a survey was undertaken with residents in order to identify the beliefs and attitude components, and subjective social norms, in relation to water use and conservation in the Waterloo community. These investigations will assist in the development of a community-based conservation behavioural framework for LCH areas within the eThekwini municipality.

5.1 Introduction and background

Water conservation studies (Feike and Henseler 2017; Tuncok and Eslamian 2017; Lede, Meleady and Seger 2019) argue that conservation measures are considered a viable tool for optimising existing supplies of water. They posit that conservation measures are the cheapest, fastest and most reliable way to stretch existing water supplies whilst still ensuring a high quality of life. In this way, and as indicated by Arfanuzzaman and Rahman (2017), water conservation practices are being adopted by communities globally to ensure the optimal utilisation of declining water resources. In South Africa there are many water conservation programmes being implemented, however, not all citizens, particularly those in rural areas, consider it a social priority (Onyenankeya and Salawu 2018).

As stated in Chapter 1, there are many factors that can be attributed to the growing water crisis in South Africa, such as climate change, drought and population growth (Hedden and Cilliers 2014; Gumbi and Rangongo 2018; Li and Qian 2018). Other factors include poor water infrastructure, poor water governance and poor water behaviour on the part of many consumers. This has resulted in higher water usage as many municipalities across the country are finding it hard to meet the growing water demands. More worrisome is the warning from Minister of Human Settlement, Water and Sanitation, Mrs Lindiwe Sisulu, who expresses concern that South Africans are not saving water and warns that the water crisis in the country would worsen if consumers do not limit their water usage. As reported by Odendaal (2019) at a live news conference, the minister advises that: *"There will not be a need for water shedding if consumers adhered the calls to save water…".* Despite the growing concern, research illustrates that South Africans consume at least five times more water than the global average (Gleick 2011).

This study focusses on the water behaviour of residents of the Waterloo community. According to the strategic executive of eThekwini Water and Sanitation, Mr Teddy Gounden, who was interviewed on 12 July 2018, water usage in this area is high and therefore express concerns on the challenge of recovery the cost of excessive water consumption beyond the stipulated 9 kl of free water provided as part of the FBWP policy. This study thus sets out to identify the most prominent drivers of, and impediments to, water conservation in this area. This study also endeavours to provide a more rigorous and robust account of water behaviour by residents living in this area, with a view to helping policy makers provide greater focus for their decisions on implementing measures to encourage water saving.

Concomitantly, the study will consider the advice of Yazdanpanah *et al*. (2016); Fielding *et al.* (2016) and Wells *et al. (*2016) that water conservation attitudes and behaviour are closely related. According to the afore-mentioned authors, a changing attitude provides a critical foundation towards water conservation programmes. They argue that a better understanding of what informs the behaviours of less responsive water users is necessary to change behaviour in order to promote water conservation practices. Hence, the research approach adopted for this study uses both deductive processes (testing ideas against observations) and inductive processes (developing ideas from observations).

Deductive processes are generally associated with quantitative research, and inductive processes with qualitative research (Creswell and Plano-Clark 2011; Schutt and Check 2012). Additionally, it has been pointed out by Creswell and Plano-Clark (2011) that by combining both deductive and inductive processes, the researcher tends to base knowledge claims on pragmatic grounds.

Moreover, as stated by Check and Schutt (2012), quantitative and qualitative approaches are often combined to enhance research, in particular in education. This aligns with Babbie and Mouton (2006) and Creswell and Plano-Clark (2011) who argue that both methods of study are guided by the viewpoint of the researcher, on what constitutes reality.

This study has taken cognisance of the afore-mentioned authors and as such a methodological triangulation of both qualitative and quantitative methods is adopted. Additionally, advocates of mixed methodology (Babbie and Mouton 2006; Creswell 2008; Sarantakos 1993) assert that triangulation methodologies enhance the accuracy or credibility of the study. The intention of a triangulated mixed methods design is to attain a better understanding of the research problem. This is, as pointed out by Creswell (2008), achieved through merging analysis and interpretation of qualitative and quantitative data collected simultaneously.

5.2 Research design

Several studies (Klopper 2008; Collis and Hussey 2014; Flick 2015; Creswell and Creswell 2018) concur that the research methodology is the most crucial part of any research study. It must provide information on why the research was undertaken, defines the research problem, and explains the data collection techniques and analysis used (Kumar 2019). Creswell (2013) describes research methodology as a strategy that makes available a framework for data collection, outlines the various phases involved in the study, and provides the necessary guidelines for data gathering.

Mouton (2008) states that the research methodology focuses on the problem statement and objectives of the study. The research data must be analysed in order to obtain results thereby meeting the objectives of the study. In other words, the research methodology can be described as a plan for collection, assessing and analysing information.

According to Brannen (2017), there are three broad methodological approaches for conducting research, that is, qualitative, quantitative, and mixed methods. Creswell and Creswell (2017) state that qualitative methods rely on text and image data. Johnson *et al.* (2012) add that the qualitative approach is commonly applied in settings to study the interaction between and amongst organisations, groups, and individuals from a multiple perspective, with the objective of attaining a complete picture of the phenomenon of interest.

Myers (2009) and Sprinthall, Schmutte, and Surois (1991) list qualitative data sources as:

- Fieldwork which entails observation and participant observation, interviews, documents and texts, and the researcher's impressions and reactions
- Direct observation of behaviours, from interviews, from written opinions, or from public documents.
- Written descriptions of people, events, opinions, attitudes and environments, or combinations of these.

In quantitative research, by contrast, according to Srnka and Koeszegi (2007), the researcher collects data in a numerical form which is subsequently categorised or measured in units of measurement. Results are evaluated using numerical values and are presented in the form of graphs and tables. Quantitative research uses questionnaires, surveys and experiments to gather information that is revised and tabulated in numbers, which allows the data to be characterised by the use of statistical analysis (De Vaus and De Vaus 2013).

Klenke (2008) and Creswell (2013) define the mixed-method paradigm as applying, in a single research study, both qualitative and quantitative approaches in the collection and analysis of data, incorporating the results and drawing inferences. This involves the collection and analysis of data, incorporating the results and drawing inferences using both approaches. Advocates of mixed methodology (Babbie and Mouton 2006; Creswell 2008; Sarantakos 1993) insist that triangulation methodologies enhance the accuracy or credibility of the study.

Denscombe, (2012) states that a mixed method could improve confidence in the accuracy of findings through the use of different methods to investigate the same subject. Morse and Niehause (2009) believe that a second methodological approach

is essentially more beneficial as multiple sources of evidence will generate richer data and offer better research findings. There are different types of mixed method research designs. These are listed below and adopted from Creswell and Plano-Clark (2011):

I. **The convergent parallel design:** The timing to implement the quantitative and qualitative components is applied simultaneously.
II. **The explanatory sequential design:** There are two distinctive phases of data collection. The first phase begins with the gathering and analysis of the quantitative data, followed by the collection and analysis of the qualitative data. Of significance, the qualitative results are built on the initial quantitative results.
III. **The exploratory sequential design**: Here the first phase begins with the collection and interpretation of the qualitative data. The second phase is the quantitative data which is built on the results of the qualitative data.
IV. **The embedded design:** An example of this is an experiment whereby a qualitative strand may be added within a quantitative design.
V. **The transformative design:** A theoretical perspective is applied as a central framework to quantitatively and qualitatively analyse the data.
VI. **The multiphase design**: Combines both sequential and concurrent strands over a period of time to address a programme objective. This design is generally used in programme evaluation where quantitative and qualitative approaches are used over a period of time.

As this study aims to develop a strategic intervention in the form of a behavioural model to assist the eThekwini municipality in its efforts to reduce high water consumption in LCH areas, a mixed method exploratory sequential design is used consisting of two distinctive phases (Creswell and Plano-Clark 2011).

5.3 Methodological paradigm: Mixed method exploratory sequential design

This study's central objective is to address the challenge of water losses in the LCH areas by recommending a suitable water conservation behaviour model.
The intention is that this model can be incorporated into the municipality's existing strategy. In line with Ivankova, Creswell and Stick (2006), Figure 5-1 outlines this study's research process.

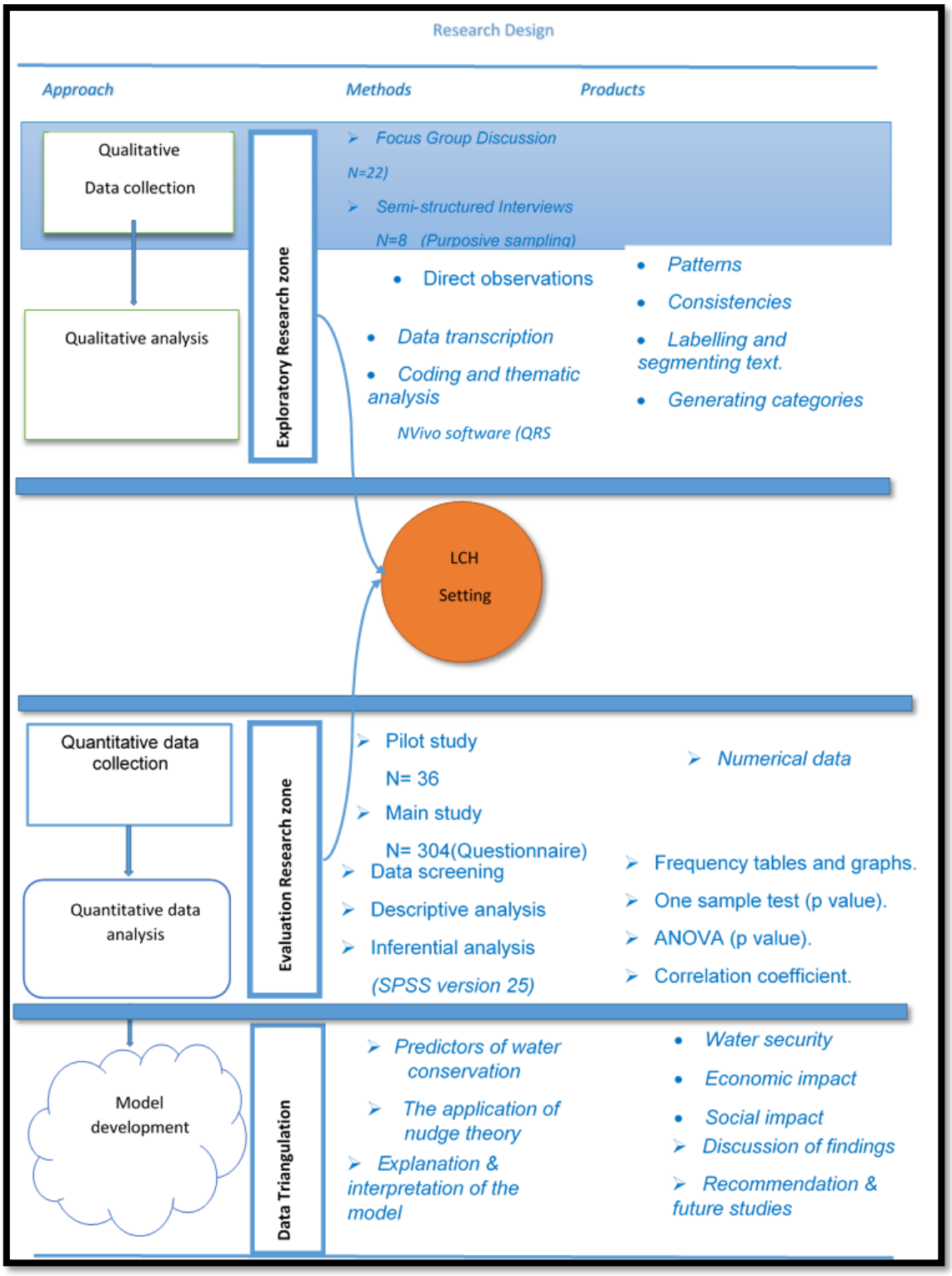


Figure 5-1: Outline of the research process

As this study examines the water resource management measures by comparing countries globally to South Africa, as well as the water attitude and knowledge within LCH areas, a methodological triangulation of both qualitative and quantitative methods

is adopted in this study. The intention of applying this method is to attain a better understanding of the research problem. Creswell (2008) points out that this can be achieved through merging, analysis and interpretation of qualitative and quantitative data collected simultaneously.

The application of a mixed method approach in this study is further strengthened by De Vos (2005) who aptly records the inseparability of qualitative and quantitative methods by stating that the quantitative methods cannot exist without the qualitative knowledge of research conventions. The author argues that it is impossible to express qualitative perspectives without communications being partially amenable to quantitative representations. This study is therefore conducted by collecting both primary and secondary data using a mixed method approach. This is in an effort to develop a behavioural model for better water practices in LCH areas.

For this study, the researcher deems the mixed method exploratory sequential design method appropriate for the following reasons:

- The study needs more data sources as initial results need to be further explained.
- It provides the researcher with the ability to develop better contextualised measuring instruments by first collecting qualitative data and analysing it and then administering it to a sample.

Creswell (2009) states that a mixed methods exploratory sequential design begins by exploring qualitative data and analysis. This is subsequently used to develop an instrument, for example a survey to be administered. The intention of this design is to explore with a sample of the population first so that later a quantitative phase can be tailored to meet the objectives of the study. Creswell and Creswell (2017) note that this design is commonly used in health research where medical officials need to understand the community before administering English language instruments.

(a) First phase: Qualitative

In the first phase of the mixed exploratory sequential design, the qualitative data is collected from the following data sources:

1. A review of literature on water management strategies in Singapore, Australia, Brazil, India and South Africa.

2. Semi-structured interviews with academics and water experts on current water provision challenges in the municipality.
3. Focus group discussions with selected participants from the Waterloo low-cost housing area.

This data collection strategy enables the researcher to explore and provide meaning through analysis of the views expressed and at the same time, allows respondents to provide their perspectives on issues related to water consumption within the Waterloo community.

The following characteristics of qualitative research (semi-structured interviews and focus group discussions) is applied in this study:

- **Natural Setting**: As noted by Creswell and Creswell (2018) researchers collect data in the field at the site where participants experience the issue or problem under study. In this way, they can gather in-depth data by talking directly to people and observing how they behave within their environment. In this study, the researcher had face-to-face interaction with inhabitants of the study area and witnessed first-hand their levels of understanding and knowledge of water conservation. This took the form of four focus group discussions which was important for the study design as it provided a platform for those who are studied to speak for themselves and to provide their perspectives in words and other actions.
- **Researcher as key instrument**: Creswell (2013) asserts that for qualitative studies, researchers are themselves responsible for the data collection which includes interviewing participants, observing participant behaviour, and reviewing the relevant literature pertaining to the study. As there is limited research on household water behaviour in South Africa, and very little data on indigent household water consumption, for this study the researcher designed the study instrument to gather the information through interviews and focus group discussions and was further responsible for analysing and interpreting the data. The researcher did not rely on questionnaires or instruments developed by other researchers as there was no information on behavioural models on water conservation for indigent communities in SA.

- **Multiple sources of data**: This refers to the various sources of data collection in a research study. In this study, data was collected from the literature review, semi-structured interviews, focus group discussions and a survey. In this way participants in this study were free to share their thoughts and ideas.
- **Participants' Meanings**: In the entire duration of the study, Creswell and Creswell (2018) maintain that it is the responsibility of the researcher to always remain focussed on the implications that the research problem has on the participants. In this study, it is vital to understand the challenges the inhabitants and the eThekwini municipality are confronted with in relation to water conservation and management in LCH areas. A reliable supply of fresh water is critical to all households.

The afore-mentioned data collection strategy ensured that the researcher was able to meet the first and second objectives of this study, namely:

1. To assess global water supply and demand approaches employed in countries such as Singapore, Australia, Brazil and India and to compare these strategies to the South African approach.
2. To determine the factors that influence water-use behaviour amongst residents in low-cost housing areas.

(b) Second phase: Quantitative

The second quantitative phase of this study was built on the qualitative results obtained in the first phase. Palinkas *et al*. (2015) assert that qualitative data can be used to improve the quality of survey-based quantitative evaluations by helping to generate evaluation hypotheses, strengthening the design of survey questions, and expanding or clarifying quantitative evaluation findings. In line with the above, in this study, the results from the semi-structured interviews and focus group discussions form part of the preliminary data and serve as a point of departure for the study to inform the questionnaire and ensuing research design.

The researcher considers the value and representations of the quantitative and qualitative phases as being equal across both phases. As was illustrated in Figure 5-1, the results of the two phases are mixed or integrated (data triangulation) during the discussion of the whole study. It is anticipated that this will enable the researcher to meet the third research objective, namely:

3. To develop a behavioural method towards consumer water consumption and preservation in low-cost housing areas by applying the Nudge theory and the Theory of reasoned action (TRA) as a foundation to identify ways to reduce water consumption.

5.4 Study Area

Situated in the northern part of Durban, KwaZulu-Nata, the Waterloo Township was established in 1996, following the first democratic elections, to systematically accommodate indigent families that had been segregated by the apartheid regime. It is the oldest RDP settlement in the province, located some 10 km from King Shaka International Airport and close to the economic hub of Umhlanga. With about 8 000 households, the area is provided with 9 kl of free water per household per month, as per the provisions of the Free Basic Water Policy. Usage above this limit is priced to recover the cost of water not covered by the FBWP. A map of the area is provided in Figure 5-2.

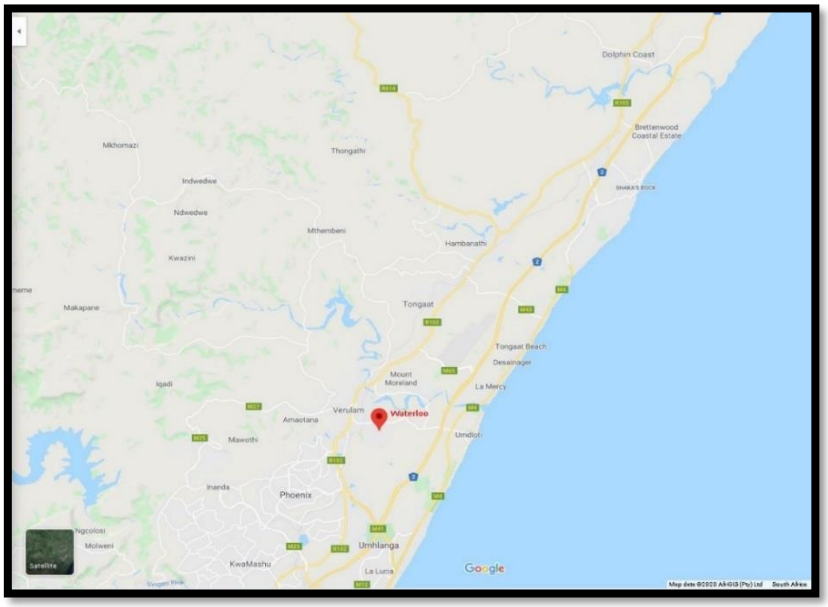


Figure 5-2: Map of Waterloo (Google Earth 7.1.2010)

Residents in Waterloo and other low-income areas have to prioritise between buying food and paying for basic services such as water and electricity when the stipulated amounts are exceeded (Living with Urban Periphery 2018). This has resulted in an

increase of illegal connections and collection of water from communal taps (water collected from outside sources rather than home).

A study by van Wilgen and Wannenburgh (2016) concludes that most indigent households in South Africa use above the stipulated 9*kl* and this contributes towards a monetary water loss within the eThekwini region of R602.6 million rand per year.

This study is designed to examine consumer behaviour towards water usage and develop a behavioural model for water conservation in the Waterloo area. The next section details the data collection and analysis procedures applied in the qualitative as well as the quantitative phases.

5.5 Data collection

As stated by Johnson and Christensen (2012), data collection is considered a vital feature of any type of research study. Inaccurate data collection can impact the results of a study and ultimately lead to invalid results (Creswell 2013). Ling Pan (2016) and Brannen (2017) describe data as a collection of facts and statistics with qualitative or quantitative variables. As this study uses an exploratory sequential mixed methods design, data collection takes place at two points in the research design that is, in the initial qualitative data collection in the form of semi-structured interviews and focus group discussions; and during the administration of the survey in the quantitative phase. However, Creswell and Creswell (2018) caution that this design of applying the qualitative data towards the construction of the quantitative data could be challenging to the researcher and therefore advise that the researcher ensures the validity and reliability of the qualitative data. This advice was considered in this study and is discussed in section 5.9. The main data collection techniques employed in this study are primary data collection from semi-structured interviews, focus group discussions and questionnaires; and secondary data collected through the literature review. The next section outlines the primary and secondary data collection applied in this study in more detail.

5.5.1 Primary data collection

Johnson and Christensen (2012) describe primary data as the information which is collected by the researcher firsthand or by the organization responsible for collecting it. By using primary data, the researcher is able to define the variables to be used in

the research and the techniques that will be used to measure these variables in order to get a valid result.

Primary data for this study is obtained through semi-structured interviews, focus group discussions and questionnaires. The sources of data include water researchers, community leaders, government officials and residents of Waterloo.

5.5.2 Secondary data collection

Collis and Hussey (2014) describe secondary data as data that has already been collected and published by the person or organisation responsible for its collection.

The main sources of secondary data for this study are research articles obtained from peer reviewed academic journals, technical reports and textbooks. These secondary sources provided the background to the literature review in Chapter 2 and 3 and it also provides the preliminary data which serves as a point of departure for the study.

5.5.3 Data collection instruments: Qualitative phase

Data collection instruments are the tools used for data collection (Schensul, Schensul and LeCompte 1999). These can include questionnaires, interviews, observation and reading. In addition, Mackey and Gass (2015) stress that it is the duty of the researcher to make sure that the instrument selected is valid and reliable. The afore-mentioned authors further highlight that the validity and reliability of any research study is dependent to a large degree on the suitability of the instruments. This means that no matter how the researcher collects data, the extent to which it is likely to yield the expected results has to be critically examined. In this study, the researcher undertakes to conduct semi-structured interviews and focus group discussions, and to administer questionnaires to respondents.

The data collection instruments are discussed next. As shown in Figure 5-1, the qualitative phase of the study consists of the semi-structured interviews conducted with experts and focus group discussions carried out with inhabitants of the Waterloo area.

- (a**) Semi-structured interviews**

Blanche, Durrheim and Painter (2006) believe semi-structured interviews give the researcher an opportunity to know the respondents intimately in order to understand

how they think and feel. Creswell and Creswell (2017) note that interviews can be either face-to-face, telephonic, or via the internet such as emails or skype.

Advantages of interviews include the researcher having control over the line of questioning, a high response rate, and gaining useful and in-depth information.

Semi-structured interviews were deemed appropriate for this study. In total, eight face-to-face, semi-structured interviews were held with two community leaders, two academics, two government officials from the eThekwini water and sanitation department, and two ward councillors who are intermediaries between government and the community.

The notion that there is an abundance of available water for future use highlights a concern, according to Jiang (2015). Researchers and professionals alike have stressed the importance of sustainable water management. This is particularly more important from a South African perspective, as the uncertainty and variability of water supplies increases (Luker and Harris 2019). Thus, supporting the need for a conservative measure by means of policies and guidelines to mitigate against water crisis. Additionally, and as highlighted in DWAF (2002), water resources should be managed in a sustainable manner. Hence, DWAF have integrated demand management into its water services policy which discourages the inefficient and wasteful use of water. This is achieved through pricing structures and conservation efforts. The inference is that water can be efficiently managed through the introduction of conservation measures by means of policies and guidelines. Therefore, several specific and defined questions were verbally administered (Appendix 4). This method was used to elicit the depth of detail from the participants on how to evaluate consumer behaviour in regard to water saving mechanisms and designing an intervention strategy. The interviews provided a platform for the water stakeholders to show how they perceived the current dialogue surrounding water management in the eThekwini municipality and also their own point of view on the subject of water conservation and community engagement.

Interviewees were contacted both telephonically or/and by email to the set-up date, location and time. Each respondent who participated as provided with a Letter of information (Appendix 3.A) and Letter of consent to be signed (Appendix 3.B). The

interviews were recorded using a digital voice recorder and transcribed by the researcher. Each interview lasted between 40 – 60 minutes.

(b) Focus group discussions

Focus groups are used often in mixed methods research as a way to stimulate discussion (Roulston 2010) and generate in-depth information in a way that would not be likely in a one-to-one interview situation. Wilson, Derrick and Mukherjee (2018) state that focus group discussions are used as a qualitative approach to gain knowledge, perspectives and attitudes of people on certain social issues. The method aims to obtain data from a purposely selected group of individuals rather than from a statistically representative sample of a broader population.

Cohen *et al.* (2007) highlight that focus groups play a valuable role to triangulate qualitative data with more traditional forms of surveys and observations. It can also strategically encourage quiet and shy participants to voice their opinions.

Focus group discussion was considered appropriate in this study as the researcher wanted to evaluate the local perception of water and water conservation in the LCH areas. According to Patton (2002), focus groups allows the participating members and the researcher to interact easily consequently building on ideas and conversation. In this study, it is important to find a solution to reduce high water demands in the face of the high cost of infrastructure maintenance, high cost of loss water and erratic rainfall patterns. Williams *et al*. (2016) observes that there must be a clear understanding of the local context within the target communities as well as meaningful public involvement in order for a water conservation programme to be effective. The advice by the afore-mentioned authors is considered in the design of the discussion guide by capturing dialogue of respondents residing in the Waterloo area in order to identify factors towards the water conservation framework proposed in this study.

Interested respondents for the focus group discussions were informed of the study at a monthly community meeting held by the area's ward councillor, Mr Johnson Chetty. The incentive to participate was described as helping the local government to formulate solutions to assist the community with better water management in the area. The venue for the discussions was a local crèche in the area. The researcher provided the councillor with dates and times and four sessions were held. The dates, times and venue were communicated to the respondents verbally by the councillor. The

discussion guide (Appendix 5) was developed through examples from the literature review and issues presented by participants during the semi-structured interviews. Each session was between 50 – 60 minutes and was facilitated by the researcher with the aid of an isiZulu translator. Each session was recorded using a digital voice recorder and transcribed by the researcher.

5.5.4 Data collection instruments: Quantitative phase questionnaire and pilot study

As illustrated in Figure 5-1, a survey was administered as part of the mixed methodology applied in this study. A survey, according to Bryman (2016), is a questionnaire document with contains questions related to the subject matter.

A survey assists the researcher to answer three types of questions which are descriptive questions; questions about the relationship between variables; and questions about predictive relationships between variables over time. In the design of the survey, the onus is on the researcher to organise the questions and to know what type of questions to ask. According to Nardi (2018), a survey is not a simple form of data collection as the accuracy of the data is dependent on the methodology used. On the other hand, Pandey *et al.* (2017) say that one of the justifications of using a survey is the development of computer-aided statistical programmes that ease the processing of the analysis of data. In addition, each participant answers the same question, and as such it is an ideal data collection tool for research that can be applied to a large number of people.

In this study, a paper survey using a cross-sectional population sample was used. This form of survey uses the traditional paper and pencil method of gathering data. This form was deemed appropriate as it was easily accessible for respondents who did not have access to the internet or telephone. The questionnaire (Appendix 6) was administered by the researcher with the aid of an isiZulu translator whenever it was necessary. The questionnaire in this study assisted the researcher in identifying the beliefs and attitude components, as well as subjective social norms in relation to water use and conservation in the LCH areas. A discussion on the development and design of the survey, the characteristics of the questionnaire, and measurement and scaling, follows.

(a) Development of the questionnaire

Mertler (2018) emphasises that before embarking on designing the survey, the researcher must address two important questions:

1. *What is the problem you want to solve?*
2. *What is the new information you need for the solution?*

Pointedly, the key points here are the researcher's opinion related to the problem and his/her knowledge of the problem. As this study follows a mixed methods exploratory sequential design, the two-phase design starts with the collection and analysis of the qualitative data. The list of items for the survey was formulated from the results of the qualitative phase of the research, which included the semi-structured interviews and focus group discussions.

The advice of key studies (Marandu *et al*. 2010; Chang 2013; Dolnicar and Hurlman 2015; Ramsey *et al*. 2017) underpinning the theories explored in this study as shown in Chapter 3, was considered. The themes which emerged were subsequently analysed and discussed using references from the literature review. In keeping with the research paradigm of this study, the emerging themes were used to develop the questionnaire.

The list of incentives in the questionnaire were generated during the focus group discussions when respondents were asked *what some are of the nudges, they thought were appropriate to promote conservation behaviour*. The common incentives mentioned were:

- The municipality writing off any outstanding debt
- Certain amount of free electricity per month
- Free airtime and data
- Installation of a 10 000-litre water tank per household

(b) Design and characteristics of the questionnaire

Azzara (2010) notes that the design goal of a questionnaire must meet the research objectives by attaining valid data from respondents. In designing the questionnaire for this study, the researcher took the advice of Parfitt (2005); Arsham (2005); and

Phellas, Bloch and Seale (2011) to conform to three principles which focus on three areas:

1. Wording of the questions
2. The manner in which responses are to be categorised and coded, and
3. The general appearance of the questionnaire.

Blackstone (2018) concurs that these principles are necessary to ensure that the collection of data is systematic and done in an ordered manner. This enables the researcher to quantify, categorise and analyse the data statistically. This advice forms the basis for the questionnaire administered in this study.

As per the guidance offered by Brace (2018), this study considered the following characteristics of questions when compiling the questionnaire:

- Questions must be unambiguous.
- Only use technical terms if the questionnaire is addressed to experts.
- The questionnaire should be short.
- Questions should be in the form of yes/no, a number, measurement or quantity.

(c) Measurement and scaling

In this study, the questionnaire comprised six sections. The first section included the biographical data of respondents such as age, gender, racial, educational level, employment status, housing status and the number of years they have lived in the present dwelling; and household income. The subsequent sections were built on the emergent themes from the semi-structured interviews and focus group interviews.

Significantly, in order to measure attitudes or strength of feelings of the respondents, researchers use scales. For this study a five-point Likert scale was used in the questionnaire design. Rahi (2017) point out that the Likert scale is a rating scale which has numbers associated with sub-statements. The data created by this scale is of interval data. Characteristically, a questionnaire which uses the Likert scale contains a number of statements with which respondents are required to agree, remain neutral, or disagree. Vougiouklis (2018) contend that the reliability of Likert scale is preferable to other measuring scales since it allows for a wide variety of answers from respondents

5.5.5 Pilot study: Questionnaire, findings and further development

The pilot study questionnaire and findings, and how the questionnaire was further developed, are reported here.

(a) Pilot Study: Questionnaire

Yin (2013) suggests that in order to identify possible problems and risks into the research area, the researcher should embark on a small-scale enquiry, referred to as a pilot study. Brown (2015) mentions that by piloting the questionnaire, value would be added to the reliability of study. Likewise, Arain *et al.* (2010) agrees that the execution of a pilot study ensures that observational categories are appropriate, exhaustive and effectively operationalised for the purpose of the study.

In this research, the pilot study was conducted with 37 respondents conveniently sampled from the study setting that is the Waterloo low-cost housing area.

A questionnaire comprising six sections was administered by the researcher. The pilot questionnaire contained the following number of items per section, as noted in Table 5-1:

Table 5-1: Items on pilot questionnaire

Section	Themes	No. of items
A	Demographic details	7
B	Knowledge of water-saving techniques	11
C	Behaviour towards water saving techniques	11
D	Awareness	5
E	Attitude on water conservation	7
F	Behavioural changes through incentives	4
Total no. of items		**45**

(b) **Overall findings of the pilot study**

The pilot study was conducted with 37 respondents (who were not part of the final study) and the purpose was to validate the instrument and test its reliability. The pilot study significantly identified the following:

- Respondents found that two items in the questionnaire were ambiguous, and these were thus modified by the researcher for the main study.
- The regression coefficient (r=0.319) suggests a weak causal relationship in the predicted model.
- The beta coefficients for subjective norms (0.235), and attitude (0.142) are both weak and positive which indicates a weak relationship exists between the two predictors and the predicted (water conservation).
- The R^2 values measured suggest that there is a low explanatory power (10%) for the predictors in the proposed model.

These preliminary findings were attributed to the small sample size.

(c) **Further development of the survey**

The following drawbacks of the descriptive survey were identified:

a) Respondents indicated that they found some of the written survey items ambiguous. Hence, the grammar - particularly the Likert Scale statements, was reviewed in terms of straightforwardness, ease of reading and clear understanding.
b) Respondents indicated that for section B and D, the Likert scale was not always suitable, particularly when they were unsure of their opinions. This was changed to either “Yes”, “No”, or “Unsure”.

Based on the pilot study of the survey, the following improvements were made to the questionnaires of the main study:

- The language structure in terms of ambiguity was dealt with by structuring he questions in a clearer and more concise manner. The re-structured questions of the survey also avoided items with low reliability.
- To avoid ambiguity, two sections were changed to use Yes/No responses or Unsure.

5.5.6 Ethics approval and issues: Main Study

Prior to collecting data, ethics approval was obtained from the Research Ethics Committee of the Faculty of Management Sciences (DUT). In addition, a gatekeeper's letter was supplied by the eThekwini municipality (Appendix 2). This requires the researcher to maintain a moral and professional obligation and to be guided by ethics, even when the respondents involved are unaware of ethics (Canfield-Davis and Jain 2010).

In the first phase (qualitative), each participant signed a consent form and was informed that participation in this study was voluntary and that the anonymity and confidentiality of information would be maintained (Appendix 3). The consent form describes all the features of the study in terms of its purpose, procedures and benefits, as well as the participants' rights to participate voluntarily and to withdraw at any time. Participants in the semi-structured interviews and FGD agreed to the sessions being recorded electronically by the researcher.

In the second phase (quantitative) anonymity of the respondents was further protected, as the surveys did not require their names. Furthermore, respondents were assured that the transcription was undertaken by the researcher only and was made available to the supervisor when requested. Taking into consideration that most inhabitants are English second - language speakers, the discussion guide for the focus group discussions and the survey was translated into isiZulu. In addition, a translator was present to clarify the contents of the consent form before conducting the focus group. This enabled the researcher to explain terms such as water scarcity, water conservation and water consumption levels. Overall, the confidentiality and anonymity of participants, together with their informed consent to participate in this study, ensured that the study complied with ethical codes of practice. The researcher took reasonable measures to safeguard all data. The hard copy is saved under lock and key. The captured data is password protected on a google drive (also password protected).

5.5.7 Study Population

Collis and Hussey (2009) define a study population as a precise body of people or objects under consideration for research purposes. Burns and Grove (1997:236) describe the target population as "*the entire aggregation of respondents that meet the designated set of criteria*". The study population for this study was as follows:

- **(a) Qualitative phase**

(i) Semi-structured interviews: The target population for this study was stakeholders in the water sector such as academics, government councillors, eTthekwini water and sanitation officials and community representatives. A total of eight participants were identified. This comprised two each from the water authority body (municipality), community-based organisations, and academia and community representatives in government (councillors).

(ii) Focus group discussions: Respondents were South African citizens residing in the Waterloo low-cost housing area within the eThekwini municipality in Kwazulu-Natal. Each focus group comprised between five to six respondents aged between 18 – 60 years old. Overall, 22 participants participated.

- **(b) Quantitative phase**

(i) Survey: Adult residents from the Waterloo low-cost housing area were surveyed. The area is reported to have a population of 8000 people (Chetty 2019). A total of 304 questionnaires were handed out by the researcher.

5.5.8 Sampling

Sampling is the process of selecting a representative portion of a population with some common defining characteristic for study (Babbie 1998; Creswell 2009). In general, sampling techniques can be divided into two types: Probability or random sampling and non-probability or non-random sampling.

Probability sampling means that every item in the population has an equal chance of being included in sample. The simple random sample means that every case of the population has an equal probability of inclusion in the sample. Ghauri and Gronhaug (2005) list a disadvantage associated with simple random sampling as it being costly if surveys by personal interviews are needed where the sample can be geographically widely scattered.

With regards to non-probability sampling, Yin (2009) states that this sampling is often associated with case study research design and qualitative research. With regards to the latter, case studies tend to focus on small samples and are intended to examine a real-life phenomenon, not to make statistical inferences in relation to the wider

population. Whilst the sample of participants does not need to be representative, or random, a clear rationale must be provided for the inclusion of some cases or individuals rather than others. In this study the following sampling methods were selected:

(a) Qualitative phase sampling methods

In the qualitative phase sampling for the semi-structured interviews and focus group discussions was as follows:

(i) Semi-structured interviews: Non-probability purposive sampling

Because of time and financial resource constraints, this research was restricted to non-probability purposive sampling in the semi-structured interviews.

This technique allowed the researcher to determine and/or control the likelihood of specific individuals being included or excluded in the study. The criteria for selecting the respondents for the semi-structured interview for the main study included expertise in either water-related issues and/or community engagement or development. Although 10 candidates were identified for the interviews of the main study, only eight agreed to participate. The two who courteously declined cited that company policy prevented them from adding value to the study.

The semi-structured interviews were conducted face-to-face. It is worth noting, and as pointed out by Cohen and Crabtree (2008), that the key issue in determining sample size is the type of data being collected and the extent to which generalised claims will be made. In addition, Maxwell (2012) indicates that the number of participants depends on the objective of the research; for example, smaller groups (four to six participants) are preferred when the participants have an intensive experience to share about the topic or when the researcher wants participation from each subject.

(ii) Focus Group Discussions: Purposive sampling

The recruitment of participants was accomplished through purposive sampling, in that it was entirely voluntary. It was achieved with the aid of the ward councillor.

Purposive sampling was used to select the respondents for the focus group. Criteria included being a resident in the study area and having resided for at least five years in this location. The discussions were led by the researcher who posed the questions,

and the participants gave their thoughts and opinions. The sessions were conducted with the aid of an isiZulu translator. The discussions were digitally recorded. The focus group adopted guided, interactional discussion as a means of generating information on experiences and the reasoning behind participant actions, beliefs, perceptions and attitudes (Powell and Single 1996) around the topic of water consumption and behaviour in their area.

- **(b) Quantitative phase sampling methods**

In the quantitative phase sampling for the survey was as follows:

(i) Survey: Convenience sampling

A convenience sampling technique was used in the selection of the participants. Dornyei (2007) refers to convenience sampling as a type of nonprobability sampling where members of the target population meet certain criteria namely: availability at a given time, geographical proximity, easy accessibility, or who indicated a willingness to participate for the research purpose. Although convenience sampling has the propensity for a severe hidden bias (Leiner 2014), nonetheless, due to the study location which is a government designated low housing area, convenience sampling was deemed more appropriate for the study. The following inclusion and exclusion criteria were employed to select the participants:

Inclusion criteria:

- Residents who were 18 years and older.
- Residents who understood either English or IsiZulu
- Any gender was welcomed to participate.

Exclusion criteria:

- Residents who were under the age of 18.
- Residents living less than a year in the area

5.6. Data Analysis in the qualitative and quantitate phases

The data collected for analysis in this research consisted of the digital recordings of the semi-structured interviews and focus group discussions and questionnaire

responses. As mentioned earlier, a mixed method approach was used in this study. This approach assumed that data gathered would generate a better understanding of the research problem.

(a) Data analysis in the qualitative phase

(i) Semi-structured interviews

The semi-structured interviews were transcribed and analysed using thematic content analysis. Thematic analysis looks at identifiable themes and patterns of experiences (Aronson 1995). The individual interviews were transcribed by the researcher who is able to type up data from interviews.

The data was then coded according to themes that arose. Coding is described as a process of segmenting and labelling text to form broad themes (Babbie and Mouton 2006). The themes drawn and analysed from the interviews were:

I. The state of water scarcity in South Africa in general and eThekwini region in particular
II. The economic viability of the current water management system of the eThekwini municipality
III. Strategies to monitor water usage in LCH areas
IV. Ways to change consumer behaviour in LCH areas towards water conservation
V. Options for increasing freshwater availability in the region.

A careful reading of literature on water scarcity and consumer behaviour and attitude also underpinned the construction of key themes from the data.

(ii) Focus group discussions

According to Knodel (1993), analysing focus group data is similar to analysing other qualitative data. As such, the participants ' actual words and behaviours are the basis for the answers to the research question. Wong (2008) states that coding of data could be done manually, by “cutting and pasting” or using different colour pens to categorise data. However, it is noted by Linlof and Taylor (2017) that in recent years researchers have had the option of using computer software packages such as NUDIST, NVivo and Atlas/ti, to make the task reasonably easier. Nonetheless, the

researcher continues to be responsible for the interpretive process of the analysis. In this study, digitally recorded discussions of the focus groups were transcribed verbatim. The transcripts were analysed by thematic coding using NVIVO software. Analysis of the qualitative data from these focus groups was accomplished through looking for patterns and consistencies and placing them into categories.

(b) Data analysis in the quantitative phase

(i) Survey

Two broad categories exist in statistics, namely descriptive and inferential. The purpose of descriptive statistics is to describe, organise and summarise a particular set of quantitative data (Na *et al*. 2014).

Whilst such statistics make no predictions, they are useful in summarising results for an experiment. With reference to the inferential statistical analysis, Johnson and Christensen (2012) explain that inferential statistics uses the laws of probability to make inferences and draw conclusions about the sample data. Essentially, inferential statistical tests are used to examine the research question in a study (Creswell 2009). Field (2008) indicates that correlation is most appropriate to determine the relationship between variables.

Both descriptive and inferential analysis was used to analyse and present the data in each section of the research questionnaire. The internal consistency of the research instrument was measured with Cronbach's Alpha. Pearson Correlations were further used to evaluate the relationship between the knowledge of water saving techniques and behaviour towards water-saving techniques. In addition, regression analysis was performed to establish the factors that predict water conservation. All analysis was performed using a statistical software (SPSS® - Version 24 Chicago, IL, USA).

5.7 Data Triangulation

Data triangulation implies the collection of accounts from different respondents in a prescribed setting, from different stages in the activities of the setting and, if appropriate, from different sites of the setting (Banister *et al*. 1994). Data triangulation also entails the cross-checking of the consistency of specific and factual data items from various sources via multiple methods at different times (Guba and Lincoln 1989; Patton 1990)

In this study data triangulation entailed the comparison of qualitative data received from semi-structured interviews with water stakeholders, and from participants of the focus group discussions, with quantitative data from the questionnaires on inhabitants of Waterloo. Using this dual approach does not result in a single, clear-cut, consistent picture, but rather presents a challenge to improve comprehension of the various reasons for the existence of inconsistencies between the two sets of data (Patton 1990).

The survey (Quantitative) and the semi-structured interviews and focus group discussions (Qualitative) satisfy the conditions for data triangulation (Goddard and Melville 2006).

5.8 Reliability and Validity

The advocates of mixed-method research (Creswell 2009; Teddlie and Tashakkori 2009; Creswell and Plano-Clark 2011; Isidiho and Sabran 2016) have clarified the quality differences in quantitative and qualitative data. They define the data quality in quantitative research as being focused on validity (that is, whether the data reflects the constructs that were supposed to be captured) and reliability (that is, whether the data consistently and accurately reflect the concept under review). On the other hand, the accuracy of the data in qualitative research is based on trustworthiness. This refers to two aspects, that is whether the findings are credible interpretations of the participants' data and how dependable is the quality of the integration of data collection, data analysis and formulation of a conclusion. In addition, the afore-mentioned scholars have warned against internal (contextual) threats of validity and external (generalisable and transferable) threats in the field of mixed methods research.

(a) Reliability and validity in the qualitative phase

Qualitative content analysis was applied as a measure of reliability for the interviews and focus group discussions. The data was recorded and transcribed. The results were interpreted and analysed against existing literature using thematic content analysis. Therefore, the measuring instrument for this study has met the requirements, since it was developed based on an extensive review of the literature and reviews by academics in the field of water studies and water conservation behaviour. Additionally,

triangulation was used to heighten the consistency, comprehensiveness and validity of the research.

(b) Reliability and validity in the quantitative phase

As noted, Vaske, Beaman and Sponarski (2017), Cronbach alpha is mainly used for measuring reliability or internal consistency. As such, it indicates the degree to which a test measures what it was designed to measure. It is used to assess the reliability of multiple questions (such as Likert scale) and it tells the researcher in general if the test measures the variable of interest correctly. In this study, Cronbach's alpha index was used to assess reliability for the survey.

The choice of the Cronbach's alpha index is supported by Osborne (2008) who claims that it is one of the most widely used coefficients for measuring internal consistency. For all sections, reliability scores exceeded the recommended alpha value of Cronbach. This shows a level of acceptable, reliable scoring for these research sections. Content validity ensured that the questionnaire focused on concepts and constructs that emerged from the review of literature, the semi-structured and the focus group discussions.

5.9 Summary

This chapter presented the mixed method exploratory sequential design strategy. In the first qualitative phase data was collected from the semi-structured interviews and focus group discussions. A sample population of eight was used in the semi-structured interviews and 22 for the focus group discussions. Content analysis was used to interpret results. The second quantitative phase was built on the results of the qualitative phase. A survey questionnaire was designed and administered to a sample of 304 participants. Content validity ensured that the survey focused on concepts and constructs that emerged from the qualitative phase. The internal consistency of the survey was assessed through Cronbach's alpha index. The next chapter discusses the results and discussion of the qualitative data.

Chapter 6: Results and discussion (Qualitative phase)

This chapter presents the outcomes of the data gathering process for the qualitative phase of the study. It analyses the results obtained from semi-structured interviews conducted with water stakeholders from the community, the eThekwini municipality, and academics and focus group discussions with participants residing within the Waterloo low-cost housing area[1]. Subsequently, the results are used as a point of departure towards the development of the questionnaire.

6.1: Emerging themes and subthemes from the semi-structured interviews with key informants

The analysis of the data gathered from the semi-structured interviews resulted in the identification of the themes and subthemes highlighted in Table 6.1. The quotes used are representative of the views of most, if not all, participants unless otherwise stated.

Table 6-1: Identification of themes and subthemes

Themes	Subthemes
1. Current status of the eThekwini water management system	• Sustainability of the current water management system • Affordability of the water management system • Measures to sustain water in eThekwini low-cost housing areas.
2. Reducing water consumption in LCH communities	• Reducing water consumption through education and communication • Reducing water consumption through community involvement • Using structures in place to reduce water consumption

[1] The results and discussion of the interviews were presented and published at the Water and Society Conference held in Valencia, Spain, 2-4 October 2019:

Thakur, R., Harris, G., Thakur, S. And Onwubu, S., 2019. Factors Contributing Towards High Water Usage within Poor Communities in Kwazulu-Natal, South Africa. *Wit Transactions on Ecology and the Environment*, 239: 1-10.

3. How to change consumer behaviour on water conservation	• Education on water pricing • Installing water meters • Water restrictions • Education on water conservation

Themes were identified in line with achieving the research questions in this study (Chapter 1 section 1.4.), namely:

1. Is the eThekwini water management system for low-cost housing areas sustainable and affordable?
2. What strategies can influence water-use behaviour in low-cost housing areas?
3. What is the inhabitants' awareness of water conservation issues in the Waterloo low-cost housing area?

Data from semi-structured interviews was transcribed verbatim and used during the analysis phase and relevant quotes from the data generated from the semi-structured interviews was used in supporting the discussion on themes. The names of the key informants are not published in the study to ensure their anonymity. Table 6-2 outlines how they are referred to in the study.

Table 6-2: Description of key informants

P1	Waterloo ward councillors
P2	
P3	eThekwini representatives
P4	
P5	Academics
P6	
P7	Waterloo community leaders
P8	

6.1.1 Theme 1: Current water management system of the eThekwini municipality

As reported by Maphela (2015), water availability and sustainable usage is one of the key challenges of transforming the water sector and demand management in SA. The country has continued to experience severe drought conditions plagued by limited rainfall and unpredictable elements resulting from climate change. With this in mind, it is highly essential to know, from the views of the stakeholders, whether the current water management system in the eThekwini municipality is affordable and sustainable.

(a) Subtheme 1: Sustainability of the current water management system

Given the scarce and limited availability of water in SA, Funke *et al*. (2019) advise that it is imperative that water be managed efficiently. As highlighted in several studies (Mavundla 2016; Aliyu, Modu and Tan 2017; Ramulongo *et al*. 2017) the long-term sustainability of the current water management system in South Africa is questionable when one considers the current water crisis recently faced in the city of Cape Town, and the eThekwini Municipality may well face similar challenges in the near future. Notably, and from an economic perspective, some of the interviewees expressed a concern that the current water management under the eThekwini Municipality is not sustainable. This was evident in their assertion that the cost of water supply by the municipality does not measure to the revenue generated from it. This is reflected the statement made by the ward councillor***:***

> *"The water management system is not sustainable as there is a huge gap between supply and demand. In fact, the municipality is not taking concrete steps to mitigate loss which results in non-revenue water. It's 40 percent presently and that's a very high percentage considering we are a water scarce country".* ***(P1)***

Echoing similar sentiments, and from a financial context, the eThekwini representative claimed that the city suffered a net loss of R400 million from water loss per year.

> *"-----looking at non-revenue figures of 40 percent, that's a huge chunk. If you look at what we purchase water for, around R1 billion a year, that's a net loss of R400 million".* ***(P3)***

This net loss is blamed on water wastage and illegal tap connections. This is consistent with studies that show that South Africa loses over 1, 5 billion cubic metres of water a year due to failing infrastructure.

This water loss is due to infrastructure failures such as piping which has outlived its lifespan and illegal connections. This has resulted in loss of more than R7 billion worth of water annually (Bhagwan, Wegelin and Siqalaba 2013; Ramulongo *et al*. Musyoki 2017).

With regard to FBWP, the eThekwini representative believes that the policy is no longer functional as householders are using more than the stipulated amounts of water. In addition, monitoring water usage in the area is problematic due to theft of monitoring devices. Even though there was high consumption of water in the area, there was no revenue being generated. This is consistent with the assessment that despite progressive water policies, there still remains an inability by the government to effectively manage and control water resources in vulnerable communities (Ramírez *et al*. 2019).

The eThekwini representative predicts:

> *… "If things don't change, we will be in crisis mode because we will either have to increase tariffs to those people who are paying and those people who are not paying will continue to abuse it".* ***(P3)***

However, some participants believe that even with the low storage levels currently experienced at major dams in the country, the current water management system is still sustainable. The academic cautions that dam levels are indicative of storage patterns rather than consumption patterns. He warns however, that the effects of climate change in the last decade has contributed significantly towards the scarcity of this resource.

> *..." Dam levels are indicative of what we have in storage. It's not indicative of consumption patterns. The biggest user of water is agriculture sector. Domestic users sitting at a small percentage. In the last ten years one of the destructors on the planet is climate change. Climate change has significantly impacted on the world, fundamentally so on water".* ***(P5)***

One of the most important factors fuelling the water crisis is climate change with global warming affecting water systems, precipitation, and water availability (Teotonio *et al*. 2017). From the above opinions, it is reasonable to assume that more stringent measures should be in place to sustain and conserve water in general and that high water wastage and high consumption levels within the poor communities account for

the high non-revenue loss to the municipalities. Consequently, water wastage and consumption should be monitored and limited within these communities.

(b) Subtheme 2: Affordability of the current water management system

The previous subtheme was premised on the sustainability of water in the eThekwini municipality. Whilst the majority of the key informants suggested that the current water management system is not sustainable to meet future demand, there was agreement that water wastage also contributes to losses which impact negatively on its sustainability by the municipality. Hence, given the proposed suggestion of implementing water pricing as a way sustaining water in the municipality, this subtheme aims to determine whether the communities can actually afford the cost of water. It has often been argued, according to Gaddis *et al*. (2019) that due to the scarcity of this resource government should not be providing it for free but rather put a price on its availability. On the other hand, Chatterji *et al*. Guha (2017) believe that the initiative of using price as a demand management measure could give rise to more challenges facing municipalities.

A mixed reaction was noted in the comments amongst the categories of the participants. It was found that the community leaders and councillor assume that poor communities cannot afford the water bills, whilst the eThekwini municipality representative believes that there is no intention and responsibility among the communities to pay water bills.

The ward councillor argued that water pricing should be based on affordability.

> *"It is a question of affordability. I believe those who can pay will pay. Those who can't pay won't pay".* ***(P1)***

In support of this opinion, the community leader stressed that water affordability is dependent on the economic status of the communities. This is consistent with Milimo (2017) who observes that people who reside in affluent areas are able to afford water bills, whilst those in the rural or poorer communities cannot afford it. In support with the above, the community leader pointed out that the huge water debt owed by these communities is reflective of their inability to pay for water.

> *"It is affordable but that depends on which communities you are asking. People from the more affluent areas find water affordable, sustainable and feasible. That is because of their economic status they are able to afford the services. However, it's a different scenario for communities*

> *living in LCH, rural areas and the informal settlement. Here it is not affordable as is reflective on the large debt owed to the municipality".* ***(P8)***

Similar sentiments were also reinforced by the fellow community leader. According to his perspective, the inhabitants in these communities are largely unemployed, thus contributing to the difficulty of paying bills.

> *"Currently, water is only affordable to those who can pay. These are communities in the more effluent areas of eThekwini. However, with people living in the rural, informal and LCH areas, there is a struggle to pay for water as most of these inhabitants do not have permanent jobs or are unemployed".* ***(P7)***

Moreover, and while defending the inability of the communities to pay for water, the water academic claimed that if poorer communities had to pay for water, albeit a minimum amount, they would be plagued with debt to pay which could worsen their already dire poverty. This is consistent with Bond (2017) who reports that communities unable to afford water are more susceptible to poverty and water-borne diseases.

In order to help address the water affordability concern, the water academic advocates for the use of incentive-based tactics to help mitigate and encourage the communities to pay their outstanding debts.

> *"One way will be to mediate the debt to offer a discount to people who pay historic debt on water account. If you pay your historic debt on your water, part of your electricity bill will be reduced. This will incentive people. This will help the municipality to reduce both ends of the equation".* ***(P6)***

On the contrary, eThekwini representatives disagree with the views presented by the other interviewees. According to them, the lack of social responsibility, rather than affordability, is behind the high debt incurred from using the stipulated amounts of FBWP.

> *"There is a challenge with a culture of non-payment for water in the LCH areas. The first 9 kl are free on a monthly basis; however, a tariff is in place for consumption above this limit".* ***(P4)***

The culture of non-payment, according to Nkosi (2010), can be attributed to the legacy of apartheid where the boycott of payment for services was an effective tool against the government. From the quotes by the key informants, it is reasonable to assume the problem in these communities might not necessarily be affordability of water but

rather high-water consumption. Under the FBWP, households in poorer communities are afforded free water up to a certain limit and are only charged when set limits are exceeded (Bond 2017).

Given the fact, according to Mr. Teddy Gounden (strategic executive of eThekwini Water and Sanitation) who when interviewed on 18 July 2018 stated that most households in this community owe monies to the municipality as a result of surpassing the stipulated limit of 9*kl* of free water and given their perceived inability to pay for the extra water, it is imperative to reduce water consumption. There is thus a need for a behaviour change towards water use in these communities. This assertion also aligns with the proposition made by the water academic that there is an urgent need to educate the community on the intrinsic value of water.

> *…" there is an urgent need to educate the community that water has an intrinsic value. That means there is a cost associated with accessing, pumping, treating, storing, piping, metering, controlling, maintaining and protecting this resource". **(P6)***

(c) Subtheme 3: Ways of sustaining water in eThekwini

It has been noted that the current water management system may not be sustainable in terms of the future demand for long-term water supply. Moreover, and given high water consumption amongst the households receiving the FBWP, the ward councillor suggests adding a price, albeit minimal, to discourage illegal connections and promote water conservation as a means to enhance the long-term water sustainability within the eThekwini municipality.

> *"If we get people in the low-income households to pay at least a small amount of money for water use, I believe there will be a decrease in illegal connections and wastage of water. This means that water-users will think twice before they embark on such activities". **(P2)***

Water conservation as an effective water-saving strategy was suggested by the community leader who stresses that water supply can be sustainable if people learn to conserve and avoid waste.

> *"I think water is sustainable if we don't waste it and learn to conserve it". **(P7)***

Whilst in support of water conservation, the fellow community leader voiced the opinion that there is a culture of wastage within the community and this mindset is a hindrance towards using this resource more thoughtfully.

> *"There is a perception amongst residents that water will always be available because every time you open the tap there is water coming out.*
>
> *"However, there is a lot of wastage as communities don't use water efficiently. You often see the communal taps running continuously when some residents wash their cars.*
>
> *"Even in the homes, there are many who wash their dishes with the tap running nonstop. This is also evident when washing laundry. There does not seem to be a thought that water is being wasted unnecessarily". **(P8)***

In reaction to the above, the water academic calls for more community responsibility as a way to ensure the sustainability of water.

> *"The responsibility for ensuring a sustainable water future lies with the community as a whole; everyone has a role to play to make sure that all water (rainwater, storm water, public water supply) is treated responsibly and planned for properly". **(P6)***

As such, it was noted that even though there is high consumption of water in the area, there is not revenue being generated. This is consistent with a study by Ramírez *et al*. (2019) which reports that despite progressive water policies, there still remains an inability by the government to effectively manage and control water resources in vulnerable communities. The main suggestions, then, are to educate such communities on water conservation and encourage them to manage the usage of water in a more responsible manner.

6.1.2 Theme 2: Reducing water consumption in low-cost housing communities

This theme aims at gaining the key informants' perspective on how to get water-users in poorer areas to use water more conservatively. Most of the key informants believe that education and communication engagement could play a significant role in informing residents on issues such as climate change, water scarcity and water behaviour. The key informants also note that community involvement and the use of existing structures such as ward councillors are conduits through which residents can be made more aware of such issues. The subthemes are presented below.

(a) Subtheme 1: Reducing water consumption through education and communication

Most participants suggest that water consumption in the poorer communities could be reduced through education and communication initiatives.

Community councillors call for more communication and education programmes to inform individuals on ways to conserve water and be more informed on how to calculate their daily consumption of water. For example, the ward councillor challenges the municipality to take the initiative to educate people on water use and meter readings.

> *"The municipality must take the initiative to come here and educate people on water use, meter readings etc."* ***(P2)***

Furthermore, the ward councillor laments the demise of the municipality's "War on Leaks Project", aimed at educating members of the community in locating and fixing leaks on their property, which fell apart due to what he believed was a lack of communication between the municipality and the community. The key informant pointed to the fact that the project would have created employment within the community, as well as reduce water loss as a result of unreported leaks.

> *"As a Councillor in the area, I have been here three and half years, we only had communication from the municipality once. It was for the War on Leaks project where a feasibility study was conducted to seek out young people who can be employed to report leaks. However, that seems to have fallen away. There has been no feedback from the municipality since then. It would have been an excellent initiative as it would have created employment within the Waterloo community on one hand, and decreased water loss as a result of unreported leaks on the other hand".* ***(P2)***

The project had aimed at training 10 000 youth countrywide to locate and fix leaking pipes, but it was halted due to budget constraints at the national level (Infrastructure News 2019). The councillor believed it was a short-lived vision that would not only create employment within poor communities but also save water by locating and fixing leaks.

Another concern expressed by the afore-mentioned councillor is that the residents only become aware of water consumption beyond the FBWP limits when they receive bills to settle the outstanding amounts of money for the extra water used.

> *"Unfortunately, people only become aware of their billing account when it has already become a major issue. There seems to be no concerted effort to manage water within the FBWP limit. Communal pipes are a big problem here. There is no regular maintenance and leaks are not reported timeously and furthermore, there is ongoing theft and vandalism of pipes and water meters in this area.* ***(P2)***

The above is consistent with Maphela (2015) who writes that municipalities are struggling to manage FBW due to administrative and technical capabilities. Significantly, Larsen *et al.* (2016) notes that there is widespread theft and vandalism of monitoring devices on residential properties.

Reiterating the call to educate communities on water conservation, the water academic advocates for the education of school children to learn to appreciate the value of water. This could ultimately lead towards change in their behaviour.

> *…" In terms of conserving water any other time, there is lack of communication. Education plays a role in all aspects of our lives. I believe if people are educated then there will be a change in behaviour. I also think it should start at school level. Educate the children. So that they will learn to appreciate the value of water".* ***(P5)***

There is evidence to show that householders globally (both urban and rural water users) who are aware of their water consumption are more likely to develop the appropriate water conservation behaviour (Onyenankeya and Salawu 2018). The two municipality representatives were adamant that the communication department within the municipality is adept enough to assist consumers with their water consumption and billing queries. This is in the form of roadshows, public advertisements, educational tours, school campaigns aimed at educating the people on water conservation and water demand management.

However, despite the perceived drive to educate the people, one of the representatives from the municipality acknowledged that the language barrier often makes it difficult to effectively deliver their message to the people.

> *"One of the challenges we experience is the language barrier. Many people in rural areas, English is not the first language. I believe there needs to be a change in approach. Try to be more in line with the receiving audience. At the moment, the municipality has invested in pamphlets with lots of pictures so that grass root people can understand. People can learn to conserve water by changing their behaviour. They can find and fix leaks. One small drip per minute is almost 53 gallons of water wasted per year. Buy water-efficient appliances. Turn the water off*

before a vacation. Reuse old water and insulate hot water pipes. Education plays a major role. And it should begin at school level. ***(P4)***

In order to change people's behaviour towards water conservation it is important to equip them with the correct knowledge on how to save water.

As per the observations of Onyenankeya and Salawu (2018), this effort is dependent on communication and language. However, speaking in a language that communities can relate to can encourage them to appreciate the environment as well as seek their commitment in changing their water use behaviour. From the above statement, education is crucial to changing their behaviour towards water conservation. It has been shown that a community who has been made aware of their water situation is more likely to develop the appropriate water conservation behaviour (Dean, Fielding and Newton 2016). The water academic reiterated these sentiments.

> *"Educating members of the public and especially those from areas where there is high water consumption, is critical to making them understand issues such as water scarcity and climate change. This will create acceptance and make them more inclined towards water conservation efforts. Therefore, if people have a basic understanding of how water resources management and planning functions, they will begin to understand the associated economic and environmental benefits. As such, if consumers understood how water was priced and how much their used, this can contribute to healthier water behaviour".* ***(P6)***

(b) Subtheme 2: Reduce water consumption through community involvement

From the previous subtheme, communication and education were noted as important factors towards community involvement in water conservation. This notwithstanding, the community leader was emphatic that community involvement in any of water conservation strategy is a key factor. It was noted from this statement that communities need to feel that they are part of the solution to the water problem. As a consequence, communities must be engaged at all levels in order to effectively conserve water.

> *"Community involvement is a key factor. Communities need to feel there are part of the solution. Therefore, they must be engaged at all levels. The only time we hear about water cuts or restrictions is when there is a drought. Then we are told to cut down on consumption. However, this is something that has to be communicated to the people all the time".* ***(P7)***

Community engagement and awareness programmes with municipalities may help to develop trust and more effective monitoring of service delivery such as water provision within the communities (Hove *et al.* 2019). The water academic reaffirmed the need for a community participation model as a way to reducing water consumption but lamented that the community is often excluded from the solution process.

> *…." the community is largely excluded from contributing to planning and decision-making processes". **(P6)***

Whereas most of the interviewees agreed with the above statement, it must be noted that there are many water conservation initiatives in South Africa to create awareness around this dwindling resource (Knüppe, and Meissner 2016). However, the apathy is attributed to many citizens, particularly those in poor communities, who do not consider water conservation a priority (Hove *et al.* 2019).

From the above, it can be surmised that the community has a sense of isolation from the decision-making processes on issues that affect them directly. As such, they believe that there is a need for more active engagement between the municipality and themselves. In this way, communities could feel they are contributing to a solution to a problem that affects them directly. Most participants believed that community participation is the key to changing consumer behaviour towards water use and urged councillors to engage more with their communities on such matters.

6.1.3 Theme 3: How to change consumer behaviour towards water consumption

A salient point emerging from the previous theme is that effective education and communication on water conservation could ultimately lead to positive change in consumer behaviour to conserve water. The excerpts from the interviews are discussed under the subthemes below.

(a) Subtheme 1: Education on water use

As emphasised by Thakur *et al.* (2019), water conservation is of utmost importance in a semi-arid country like South Africa given that it is in the middle of its worst drought in decades. It is imperative that communities are aware of the need to conserve water. However, it was found that the attitude of the people living in the low-cost housing areas is a point for concern. Innovative approaches to encourage a water saving culture and behavioural change are needed in the absence of any effective pricing

mechanism. As such, all the key informants agreed that the best way to change people's behaviour is to make them feel part of the solution.

> *"People who are receiving water bills are people who are using above the limit of free water provided by the municipality. That's where the municipality needs to intervene.*
>
> *"Instead of sending bill with these amounts that people in the poor areas cannot afford, they should come and see what the problem is. That is why people are using so much water. Most of the time it is due to leaks and burst pipes". **(P8)***

The ward councillor echoed these sentiments that inhabitants of low-cost housing communities are left out of the problem-solving mechanisms when it comes to water conservation.

> *"Inhabitants don't feel like they are included in problem solving mechanisms when it comes to water conservation. Therefore, there is lack of interest on their part. This is reflected in their attitude towards water scarcity and the need to save water. They feel they are not important enough to be part of solutions. The lack of communication from the water authorities has contributed towards this behaviour". **(P2)***

Given the above suggestion, the water academic reiterated the need educate the people on water management system and more importantly, on the pricing of water. According to his perceptions, when people understand the pricing system, it will in turn lead to understanding the true cost of providing high quality water.

> *"It is, therefore, important to educate people on the water management system and more importantly on the pricing of water. If they understand the pricing dynamics, they will then understand the true costs of providing safe, high-quality water and what the cost is to maintain infrastructure and repairs". **(P5)***

Whilst it is noted by Knuppe and Meissner (2016) that there are many water conservation initiatives in South Africa to create awareness around this dwindling resource, Hove *et al*. (2019) observes that the apathy is attributed to many citizens, particularly those in poor communities, who do not consider water conservation a priority. In summary, the municipality can make a greater effort to engage with communities they serve by involving them in decision making processes. In this way, communities would feel they are contributing to a solution to a problem that affects them directly.

(b) Subtheme 2: Installing water meters

According to the ward councillor, attitude is the big factor responsible for behaviour change towards water conservation.

The key informant reasoned that if people have to pay for water, then there would be a different attitude to save water but many houses in the community don't have a water meter, hence, it becomes difficult for them to know if they have exceeded their limits.

> *"In Waterloo, many houses don't have meters so there's no way of telling how much water they use. Some parts of WL are only communal taps. And when there is a leak or burst pipe at these communal taps, there is very little effort on members of the community to report it".* ***(P1)***

If water meters are provided in the LCH, the people could monitor their water usage efficiently. This in turn could limit the high consumption of water and losses in the community. This was supported by the eThekwini representative who stated that:

> *"If you have a meter on your property, you will understand your consumption and impact of it. And even if you can't afford the entire bill, if you are paying portion of it, you as a consumer will be contributing to the system".* ***(P3)***

The above is consistent with Mudumbe and Abu-Mahfouz (2015) who emphasise that water meters constitute a key component of the water management system as it allows users to be more aware of their water consumption. This in effect helps to reduce water usage.

(c) Subtheme 3: Water restriction

Given the concern of climate change and erratic pattern of rainfall in South Africa, it is expedient that the authorities and the people plough in the same direction to address the water situation. However, as noted under Theme 2, householders do not see themselves as part of the solution. The ward councillor argued that since people open their taps and always see water running, they are of the impression that it is an infinite source. With this in mind, water restrictions are the only way to call their attention to the challenges of water.

> *"It has to be forced reduction and restriction imposed to get the savings we needed".* ***(P3)***

However, the water academic warns against civil protest should only certain communities be targeted with water restrictions.

> *"It will only be a short-term solution that has the potential to give rise to further challenges such as community unrest and violence."* ***(P6)***

It was noted by the representative of the eThekwini municipality that water restrictors are often tampered with.

> *"We had restrictors in place to monitor the 250 litres per day however, people were damaging it. And we couldn't go into those areas and re-install them because of the potential for service delivery protest".* ***(P3)***

The community leader cautioned on the use of water restrictors and warned that:

> *"If your water is cut off, it creates problems between the householder and municipality. In fact, this can also lead to civil protest".* ***(P7)***

Also reacting to the negative consequence of water restriction in the area, the ward councillor mooted that placing restrictors would not work in the community. As gathered from his statement, the people would not accept any form of restriction.

> *"Unfortunately, in LCH the idea of installing water restrictors won't go well with inhabitants. They wouldn't accept it as they see water as a free commodity".* ***(P1)***

Sharing similar sentiments, the fellow ward councillor accused the authorities of a lack of communication. He lamented that the only time the community hears from the municipality is when water restriction is enforced.

> *"There's very little communication when it comes to the issue of water. The only time we hear any news is when there are water restrictions".* ***(P2)***

As a consequence of the above concerns, the councillor called for change in attitude on the part of the municipality. He advised that the authorities must engage with the leadership of each community to address the impasses.

> *"Attitude has to be changed from the top to say water is precious. Then get to the leadership of each community. Remember their existing a relationship between the government and people in LCH areas. The relationship is that they have been given a house that is free. Therefore, they are provided with free services such as water and refuge collection. As such, they have to be held accountable when they don't use these services responsibly. Because it's free does not mean that you have to abuse the system". (P1)*

Whilst mandatory water restrictions have been implemented in an effort to replenish dam and ground water sources across municipalities in South Africa (Bwapwa 2018; Dillon and Arshad 2016), this approach has had little success as it is considered a short-term solution.

More so, water losses due to leaks account for 37 percent of treated water supplies which translates to R7 billion annually in monetary terms (Umgeni Water 2017).

(d) Subtheme 4: Educating householders on water conservation

In providing a suggestion on how to change the behaviour of water usage by the LCH community, the ward councillor noted that educating the people, particularly, adult household members, is fundamental. He suggested the need to sensitize the community towards water conservation.

> *"We cannot live without water. Saving water helps to preserve our environment. It reduces the energy required to process and deliver water, which helps in reducing pollution and in conserving fuel resources. Saving water now means having water available in the future for recreational purposes, too". **(P2)***

Whilst in support of the above views, the representative from the eThekwini municipality also believes that water conservation should begin at school level and be part of the school curriculum. According to his assertion, schools need to do a lot more to change the behaviour of children from a young age on the value of water. This is reflected in the following statement below:

> *"Schools need to do a lot more. From a behavioural change aspect, it must be brought into the curriculum to teach children from a young age on the value of water. For example, most children have working parents. So, when they go home after school, there is no one around to tell them to close the tap or use water sparingly. There is no one there to tell them to close the tap. Those are the things that people just don't see as a problem and feel it's not their problem if water is being wasted". **(P4)***

While noting the importance of educating the public on behavioural change towards water conservation, the water academic took a more pragmatic approach in his assertion. According to his opinion, the best way to change consumer behaviour is through public education programmes around water conservation. For this programme to be effective, the key informant suggests that the authorities must first identify, and then target the largest water users in the area which would receive the bulk of the

educational efforts (distribution of material and assistance). He pointed out that three critical elements are needed to generate public understanding of issues relating to water conservation.

> *"Three critical elements for generating public understanding of issues related to water conservation are:*
>
> ***"**Create a process to inform, involve, and educate the public on issues related to water management and the importance of water conservation". **(P5)***

The above key informant asserted his belief that:

> *"If people are called to rally around for the 'good of the public' and in this case conserving water, they are likely to comply because they believe they are working together for the benefit of all". **(P5)***

This is consistent with Hove *et al*. (2019) who asserts that the effort to educate communities about water resource and water demand management issues is a mammoth task which will manifest itself more profoundly over time.

The word cloud in Figure 6-1 further subsumes the trends and patterns of responses across the four categories of participants. At a glance, it is observed that words like water, people, management, municipality, area, community, pay, leaks, behaviour and challenge appear to dominate the comments and responses from the participants.

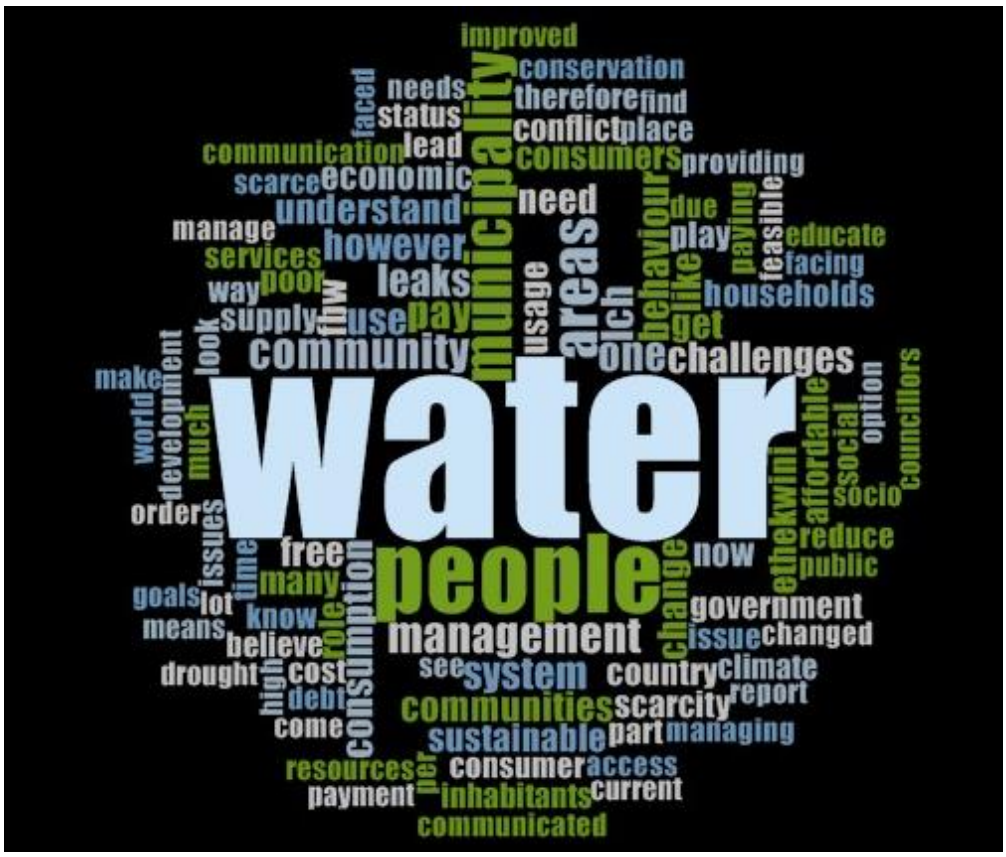


Figure 6-1: Word cloud showing clusters of similarities across the four categories of the key informants

In summary, the interviews with the key informants highlighted the challenges surrounding interaction between individuals, communities and the municipality at the local level. By understanding the reasons which influence the demand for water in poor communities, their consciousness about their water situation and their willingness to use it more consciously, one can begin to develop the appropriate strategies for implementing rational use of water for this part of the population.

The above section has shown that the ability of the state to effectively manage water resources in low-income areas remains a huge challenge due to poor water conservation behaviour on the part of inhabitants. It emerged from the interviews that this is the result of poor engagement between the municipality and the community. Stronger efforts to involve the community by making them feel part of the solution through participatory and educational programmes may be a way forward in helping them use water within the amounts stipulated in FBWP. The analysis will now turn to the focus group discussions conducted with residents in the LCH area.

6.2 Focus group discussions

This section presents the outcome from the four focus group discussions conducted with participants drawn from the Waterloo low-cost housing area. The focus group discussions process was described in section 5.6.1(b) and the questions posed by the facilitator are included as shown in Appendix 5. The data generated were analyzed thematically using deductive coding to generate categories. Coding and analysis were performed using Nvivo (version 11). The qualitative data displayed two themes and six subthemes. Theme topics, as shown in Table 6-3, range from understanding the concepts of water scarcity, water conservation, water management to municipality interventions.

Table 6-3: Emerging themes and subthemes

Themes	Subthemes
Theme 1: Water situation in South Africa	Subtheme 1: Understanding of water scarcity
	Subtheme 2: Source of water situation
Theme 2: Water conservation method	Subtheme 1: Water management
	Subtheme 2: Water consumption knowledge
	Subtheme 3: Cost of Excess water consumption
	Subtheme 4: Municipality interventions

6.2.1 Theme 1: The water situation in South Africa

The importance of water to mankind and the sustenance of other species, both plants and animals, on our plant cannot be overemphasized, according to Mekonnen and Hoekstra (2016). Water although very much essential, it is however, a scarce commodity. In South Africa, water scarcity has become a big concern in recent years. Moreover, as one of the driest countries in the world, water scarcity poses a serious and immediate risk to the economy and social stability of citizens (ActionAid South Africa 2016). Given the importance of water, it was expedient to know whether the

participants are aware of the current drought faced by many communities in the country. This theme is discussed under the following subthemes:

(a) Subtheme 1: Understanding of water scarcity

Pasquin *et al*. (2015) postulate that understanding the science of people's behaviour towards conservation is very important. Bearing this in mind, it was sensible to know the participants understanding of what drought, and water scarcity means to them. Some, however, understood water scarcity to mean water restriction. One participant noted:

> *"Water restriction means we have to use limited water".* (**Focus Group #1)**

With reference to the participants' understanding of what drought is, the following statements emerged:

> *"There is no water because there is no rain."* **(Focus Group #1)**
>
> *"It means there is no water in the area. Dams are running low".* **(Focus Group #3)**

The above statement led to one participant to lament:

> *"The way they are wasting water in this area, I do not think they know we in drought".* **(Focus Group #3)**

Nonetheless, some of the participants agreed that they do not have a good understanding of what water scarcity means.

> *"I know drought is when there is no water. But I do not know what water scarcity means".* **(Focus Group #2)**

(b) Subtheme 2: Source of water scarcity

Although most participants had an understanding of what a drought was, many conceded that they did not know the meaning of water scarcity and as such are unaware of its impact on a global and national scale. Given this gap in knowledge, the participants where asked the following question: *"Where do you get your information regarding the water situation in the country?"*

Most of the participants related that television was the most common source of information when it involves current affairs and other news. Some participants listed other sources such as friends at work, the radio, newspapers, and the internet. Regardless of these, one of the participants points out that:

> *"I haven't heard anything".* **(Focus Group #2)**

Echoing similar sentiments, a large number of participants revealed the following:

> *"We only hear about a water crisis when there is no water or when the municipality cuts our water because we owe them money".* **(Focus Group #1)**

Drawing from above theme, it was assumed that the majority of the participants understood the meaning of drought and water scarcity. It was also assumed that the participants who had an understanding of water scarcity and drought know about this from watching television. Interestingly, television is one of the most popular methods government uses to communicate to their citizens on the state of the nation (Chuma, Bosch and Wasserman 2017). Most presumably, the awareness of the water situation in SA might have been communicated through this channel.

In support of above assertion, participants were asked whether they were aware that water must be consumed wisely as it is a limited resource. A consensus affirmation was chorused by all the participants.

6.2.2 Theme 2: Water conservation methods

Water conservation is an important strategy to address the impasses of a water crisis given that the amount of available clean water is relatively scarce and as such needs to be conserved to ensure its continuous and vital availability (Griffin 2016). This theme therefore aimed to gain an insight into the water conservation methods amongst residents of the low-cost housing. The water conservation methods are discussed under the following subthemes: water management; water consumption knowledge; cost of excess water consumption; and municipality interventions on water conservation.

(a) Subtheme 1: Water management

According to Griffin (2016), high water usage in households can be drastically reduced by implementing smart conservation habits such as harvesting rainwater; waste-water

reuse and recycling, efficient laundry washes, raw water flushing and the like. However, a mixed reaction emerged from the conversation with the participants. It emerged that while some conserve water by using bucket to bath, and closing their tap tightly, others appear to have no water management strategy. These views are reflected in the narratives below.

With reference to the use of a bucket to have a bath, a large number of participants stated that they always used a bucket as opposed to using a shower.

> *"In my home, we use a bucket to bath. And we try to use very little water, because we get charged when we use a lot of water".* **(Focus Group #4)**
>
> *"My children and I always use a 20-litre bucket to bath. I think if we use the shower, it will use more water".* **(Focus Group #4)**
>
> *"I was told that you use lesser water when showering, but I'm not sure".*

Drawing from the above statement, it was apparent that most participants believe that using a bucket is more cost-effective than a shower.

On the question of whether they always ensure that taps are closed tightly in their homes, one participant claimed that her kids are always instructed to do so, even when she is not at home. However, she conceded that she is unable to verify whether her children followed her instructions.

> *"I am always telling my children to close the tap tightly. However, most time I'm not home. I'm working so I do not know if they do that."* **(Focus Group #2)**

The uncertainty of whether children were practicing water saving measures during the day water was highlighted in the statement:

> *"I'm working during the day. I only use water early in morning to bath. When I come from work, I use water to cook. I do not know how much of water is being used during the day when my children come from school."* **(Focus Group #4)**

Further to the above, it was found that water saving efforts are minimal. Another participant believed that that the current drought did not affect her as she is able to pay-off her water account each month.

> *"In my house, we use water the same way all the time. It is the same amount we use. If I get a bill, I pay it. It's not more than R200."* **(Focus Group #2)**

Following from the statement above, some participants emphasised there was a lack of water-saving culture within their community

> *"People here don't save water. Because we not asked to."* **(Focus Group #4)**

> *"Besides, water gets wasted so much when the pipes on the roads burst"; "There is so much wastage, so I don't understand why they are saying we must save".* **(Focus Group #4)**

> *"Once the municipality vehicle drove caused a burst pipe outside my house because the roads are not properly tarred. Water was gushing out. That same month my bill came R6000. I think it was from that burst pipe.""".* **(Focus Group #1)**

> *"Sometimes the municipality takes very long to repair leaks. This makes me think that it's not a problem if water is leaking and getting wasted".* **(Focus Group #3)**

> *"I feel like I am always using less water, but I do not know why my bill comes high. Then I cannot pay".* **(Focus Group #4)**

Nevertheless, one of the participants exhibited deep appreciation towards the importance of saving water. While narrating the benefits of having water, the participant noted the following:

> *I spent most of my life not having a tap inside my house. I used to collect water from a standpipe. Therefore, now that I have a tap inside my home, I value water. I try to save every drop."* **(Focus Group #1)**

In addition, the above participant blamed what she believed was a "culture of free provision" for poor water behaviour in the area.

> *Some people got free things, houses, water. They do not know what it is like to walk far distance to a standpipe to collect and carry water back to their homes."* **(Focus Group #1)**

Echoing similar sentiments, some of the participants voiced concern on the influence of apartheid on peoples' general behaviour.

> *"We come from apartheid regime. Minds not transformed. Free houses, free education, free grant. So, if everything is free it would be very difficult to ask them to be responsible for water".* **(Focus Group #3)**

More so, the lack of development and dearth of infrastructure such as a recreation centre was blamed for the poor water-saving techniques in the area.

> *This area is lacking development. There is no swimming pool, no place for the children to go to when the weather is hot. Now they use hose pipes to water themselves. They walk far distance to use the public pool. So, to them water is not serious, it is something to play. We are not taught how to be responsible. You cannot go to the river to swim its unsafe, so kids fill large containers with water to sit and play."* **(Focus Group #3)**

In summary, participants attributed their high-water bills, due to consumption above the stipulated 9*kl* limit, to burst pipes.

Participants also shared the perception that the municipality had a long response time to fix leaks. Apart from these, the psychological concept of entitlement was also hinted at to influence the culture of irresponsibility towards water usage in the area. The next subtheme, therefore, explores water consumption knowledge amongst the participants.

(b) Subtheme 2: Water consumption knowledge and practice

It has been reported in literature that 40 percent of municipality-supplied water is lost through leaking or burst pipes and dripping taps resulting in an estimated economic loss of more than R7 billion annually in South Africa (Mavundla 2016). Nonetheless, some of the participants suspected that the high cost of their water bill was a direct result of the above-mentioned high-water losses. As such, this influences their decision not to pay for water bills. While there is no physical evidence to support this claim, Shan *et al.* (2015) note that the public may be more receptive to water conservation initiatives if they believed that water agencies are trustworthy. As a consequence, it becomes highly important to know whether the participants could measure how much water they used per day. Although a majority of the participants conceded that they do not know how to measure their daily water consumption, some, however, gave a glimpse of their daily water consumption as well as the number of members in their family.

> *"It's very hard. We use a bucket to bath. But for other things, like cooking and washing the windows, we can't calculate how much we are using."* **(Focus Group #1)**

> *"I think we use a few 25 litres of bucket a day. But I don't know how much we are using."* **(Focus Group #2)**
>
> *"I have a 20-litre bucket which I use for washing dishes. I have another bucket also 20 litres for bating. I use many buckets of water for washing clothes. Altogether there are 8 people in my house.""".* **(Focus Group #2)**
>
> *"I live with my sister and her children. There are 6 of us. We use lots of water. I do not know how much.""".* **(Focus Group #3)**
>
> *"I think it is very little because I am hardly at home. But my kids are at home, and I do not know how much they are using. We do not talk about how much water we use.""".* **(Focus Group #4)**

The above quotes suggest that the participants could not accurately estimate their daily water consumption. As such, it is sufficient to assume that they cannot justify their high-water bill to burst pipes. Given that they believed that water wastage was a result of burst pipes outside their properties, it was expedient to know who they reported the leaks to. The councillor, municipality, and the owner of the premises were mentioned as some of the people to whom leaks were reported to. Some indicated that they called the councillor first because of difficulties in getting the municipality to respond timeously. This is reflected in the statements below:

> *"Sometimes I call the municipality, but they take a full day to come.""".* **(Focus Group #3)**
>
> *"I call the municipality. Sometimes they come same day or next day. I'm not sure why they take long. They tell us we are in queue."* **(Focus Group #4)**

Another concern noted for the failure to report leaks to the municipality was attributed to some apathy that exists particularly for those who are renting the property.

> *"…. sometimes people are wary of phoning the municipality if they are renting the house. Because it is not their property, they may feel it does not concern me. The same can be said for people walking on the street and see a leak. They feel it's none of my business. It is the municipality's job."* **(Focus Group #1)**

Participants who indicated that they reported leaks to the owner of the property further lamented on the delay in response times to fix the leak.

> *"I am renting. I call the landlord. But she takes very long to come and fix the leak. Maybe she can only come weekend."* **(Focus Group #3)**

"Sometime the owner tells me he doesn't have money to call a plumber. So, there's nothing I can do except live with the leak until it gets fixed." **(Focus Group #4)**

Apart from the above-mentioned difficulties, some of the participants indicated that the cost of phoning to report the leaks was also a setback. It was further highlighted by some of the participants that the leak reporting telephone number is only toll-free when you phone from a Telkom call box. Unfortunately, they claimed there are no working Telkom call boxes in the area. Furthermore, calling a plumber was not entertained as an option due to the cost of paying from one's own pocket.

Given the economic status of the people residing in the low-cost housing, it was easy to understand the challenge of paying from your own money to make a cellphone call to report leaks.

From the above comments by participants in the focus group discussions, it was apparent that some of the participants faced a challenge calling or reporting water leaks. Given these scenarios, it was prudent to know what measures they undertook to address the water leaks in their houses. It was found that some attempted to fix the leaks by themselves or with the support from their neighbours whilst others opted to call the owner of the property. Some participants pointed out that as a preventive measure they turned off their water meter.

One participant seemed unburdened by the leaks on his property.

"The leaks are small, so we just leave it.". **(Focus Group #2)**

This was of concern given the high economic cost of water leaks. Of particular importance, it has been reported in the literature (Seyoum *et al.* 2017) that small leaks in household premises account for the high numbers of water wastage, as these leaks are often unreported or fixed. Consequently, and as advised by Seyoum *et al.* (2017) the detection, locating and correction of water leakages on time would help in minimising water loss as well as save water and money.

(c) Subtheme 3: Cost of excess water consumption

As shown in Chapter 3, residents in LCH areas are benefactors of the FBWP which provides 9*kl* of water free of charge to indigent households and is implemented through meters. Usage above the FBWP is priced and used as a measure to alert

communities that water is scarce and therefore it has to be conserved (Maphela 2015). A report by van Wilgen and Wannenburgh (2016) concludes that most indigent households in South Africa use above the stipulated 9*kl* and as such, contribute towards a monetary water loss of R602.6 million rand within the eThekwini municipality per year. In order to verify this supposition, the residents were asked whether they pay for the extra water. A mixed reaction emerged from the discussions. For example, while some claim to pay for the extra water, others pointed out that many residents in the area do not pay for the extra cost. They attributed this inability to pay to unemployment.

> *"Lots of people don't pay because they don't have money or are not employed."* **(Focus Group #1)**

> *"I haven't paid for many months, but I still have water".* **(Focus Group #2)**

Some, however, claimed to pay only when they could afford the payment.

> *"Sometimes when I have the money. But it is also a problem because I have to take off from work to go to town to pay it."* **(Focus Group #4)**

In an attempt to recover the high cost of extra water consumption, participants claimed that the municipality used a strategy of restricting water supply or threatening to cut-off supply to homes.

> *"I am staying with my mum in her house. We don't have water for the last 4 years because the municipality cut it. We use the communal tap. We owe money to the municipality. We have to walk far to collect water every day."* **(Focus Group #2)**

However, some participants admitted to paying their bills after receiving a threat of disconnection, thereby deeming this strategy somewhat effective.

> *"My gogo owed a lot of money to the municipality, and they came here and threatened to cut off the water supply. She had to go to town to pay the account. However, I have seen people who owe thousands of rands, and nothing is done to them."* **(Focus Group #3)**

Some participants, however, believed the high-water bills were a technical fault on the part of the municipality.

> *"Some people here they bill comes to R12 000. They say it's a mistake. They do not know why the bill is coming so high. It has to be the municipality's fault."* **(Focus Group #4)**

The above statement may be a contributing factor by most participants in their refusal to pay their bills timeously. The mentioned observation supports the earlier assertion made by Nkosi (2010) that attributes the lack of payment and poor water conservation to distrust in water authority bodies by the public.

> *"One month we are paying R200, next month we are charged R1000."* **(Focus Group #1)**

In response to the above, many participants believed that it is necessary to educate communities on how they are being charged for water.

> *"They need to educate us on how we are charged for water per litre."* **(Focus Group #2)**

From the above narratives, while it can be assumed there is some element of public distrust, it will be premature to attribute it as the sole cause of the excessive water consumption. Particularly, and given the poor water conservation practices, apathy and delay in fixing burst pipes, it could be rightly said that the high-water bills may be attributed to the aforementioned factors. Hence, switching off the meter may be an effective preventive measure to avoid high billing.

> *"Yes, I do. I shut off the meter when I am not needing water because I know if I use extra water, I have to pay for it."*

(d) Subtheme 4: Municipality interventions

In view of the above and the call for the municipality to educate the residents on water billing, it was imperative to know from the participants whether the municipality was helping them in the community with information to help conserve water. The participants were unanimous in their response that there is no help nor information on how to conserve water from the municipality.

While accusing the municipality of lack of concern on the water wastage, one of the participants noted the following:

> *"No, there is no information. We see how long they take to fix the leaks on the roads. We also see how the taxi drivers are wasting water from the communal taps to wash their taxis. So, we feel there is no water problem. If the municipality is not caring for all these things, why should we?"* **(Focus Group #1)**

From the foregoing, one could say that the blame on water wastage and poor water conservation practices in the area is not a sole responsibility of the residents. As can be drawn from the above statement, and consistent with the assertion of Hay *et al*. (2012), the municipality lacks clear strategy programmes on the conservation of water in such areas. This may however be related to the constant burst of pipes as a result of taxi movement in the area.

In addition, it was found that information on water conservation practices is only conducted in schools and not in the community.

Since the prime objective of this study is to suggest ways to promote good water conservation behaviour amongst residents in the LCH areas, it became highly important to ask the participants what could be done to help the community become more water conscious and use lesser water. It emerged that information on water conservation measures was the prominent suggestion made by the majority of the participants.

> *"There is no transformation without information. If we can't inform people, how to use water, how to save water. We need to be responsible. Remember people living in Waterloo are coming from the squatter camps. They became recipients of the RDP houses. To them the issue of services is new. Some of them used to steal electricity. But now it is a location, so we need to be responsible. Information is very important. Our people are not well informed on how to save water. We need to teach our children."* **(Focus Group #2)**

> *"I think the municipality must educated people on how to save water. Remember as human beings we all have a conscious. So, if you teach me something, I will remember it. Language barrier is a concern. There are different levels of education here."* **(Focus Group #4)**

Added to the above suggestions, a few participants were open to the idea of disconnection of water when they reach the free allocated amounts to avoid excess consumption and the challenge of paying for the extra amounts. However, many believed this was not a solution and would prefer advice on how to use within the stipulated FBWP levels.

> *"We'd like the municipality to come and talk to us. I'm aware of the free water when you reach that allowance, they stop water and only next day it's reconnected."*

Bearing in mind that the provision of water is free in these areas, the participating residents were asked what incentives would appeal to them to curb over-consumption of water. The common suggestions included free data, writing off of historical debt, and provision of extra electricity and free installation of water tanks.

6.3 Summary

Data collected from the semi-structured interviews generated three main themes: the challenges facing water resource management within the municipality; the lack of interaction between the community and the municipality; and the factors influencing poor water behaviour within households in LCH areas. From the focus group discussions, the main themes were awareness of the current water scarcity in South Africa and knowledge and practices of water conservation within the community. The next chapter outlines the results of the quantitative phase of this study.

Chapter 7: Results (Quantitative phase)

The previous chapter analysed and presented the qualitative phase of the study which included the semi-structured interviews and focus group discussions. It was highlighted that residents in the LCH areas generally had poor water conservation behaviour. A major part of this was attributed to poor communication and lack of community engagement and education between water authorities and the residents.

This chapter presents data obtained through a questionnaire administered to 304 residents residing in the Waterloo area within the eThekwini district with particular reference to their knowledge, awareness, and attitude towards water conservation. The data collected from the responses was analysed with SPSS (version 25®) in relation to the research objective (chapter 1, section 1.4): *To determine the factors that influence water-use behaviour in low-cost housing areas.*

As highlighted in section 5.6.2., this is the second phase of the mixed methods exploratory sequential design applied in this study and as such, the list of items on the questionnaire (Appendix 6) was formulated from the results of the qualitative phase. Additionally, the advice of Marandu *et al.* (2010); Chang (2013); Dolnicar and Hurlimann (2015); and Ramsey *et al*. (2017) was considered (see section 4.4)

Overall, the structural equation model (SEM) was used to evaluate the predicting factors towards water conservation amongst the respondents in the area.

7.1 Respondents' demographic data

This section summarises the biographical characteristics of the respondents. The respondents are residents of the Waterloo area within the eThekwini municipal region. Table 7-1 displays the gender distribution of the respondents per age group. The Fisher exact tests indicate that the gender of the respondents with respect to age distribution are statistically different ($p>0.05$). The female respondents constitute the majority of those sampled (n=304; 52.3%) with only 159 (47.7%) respondents being male. Regardless of this, and with respect to age distribution, the proportion of females (n=65; 6.3%) within the age distribution of 18-29 years were less than the proportion of males (n=46; 15.1%).

Similarly, males were more within the age distribution of 30-39 (n=50; 16.4%) when compared against the females (n=42; 13.8%). On the other hand, females were more represented within the age distribution of 40-49 years (n=47; 15.5%), 50-59 years (n=23; 7.6%), and 60+ years (n=28; 9.2%), respectively. Overall, more (n=92; 30.3%) of the respondents are within the age distribution of 30-39 years old while the lowest representative within the age distribution is 60+ years (n=34; 11.2%).

Table 7-1: Gender distribution by age group

			Age					Total
			18-29 years	30-39 years	40-49 years	50-59 years	60+	
Gender	Male	Count	46	50	27	16	6	145
		% of Total	15.1%	16.4%	8.9%	5.3%	2.0%	47.7%
	Female	Count	19	42	47	23	28	159
		% of Total	6.3%	13.8%	15.5%	7.6%	9.2%	52.3%
Total		Count	65	92	74	39	34	304
		% of Total	21.4%	30.3%	24.3%	12.8%	11.2%	100.0%

Fisher Exact test= 0.000

The racial profile of the respondents is described in Table 7-2. The majority (n=192; 63.0%) are identified as African, while 88 (28.9%) are identified as Indian, 22 (7.2%) as Coloured, and 3 (1.0%) as White.

Table 7-2: Racial distribution of respondents

		Count	Percent of total
Race	African	192	63.0 %
	Indian	88	28.9 %
	Coloured	22	7.2 %
	White	3	1.0 %
	Total	305	100.0 %

The level of education of the respondents is shown in Figure 7-1. The majority of the respondents had a high school certificate 166 (54.4%) while 16 (5.2%) of the respondents had a university qualification, and 32 (10.5%) had college/certificate qualification. It is also worth mentioning that 51 (16.7%) had only a primary school certificate, while 40 (13.1%) indicated no schooling.

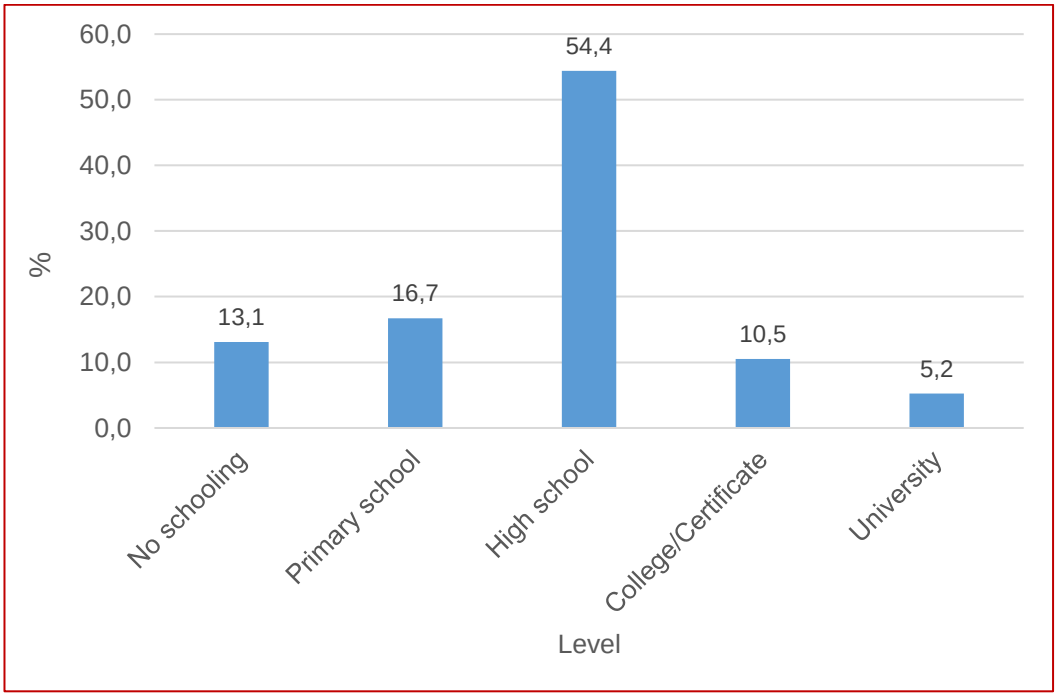


Figure 7-1: Respondents' level of education

Table 7-3 describes the respondent's employment status. The majority were employed (n=183; 60.4%), while 87 (28.7%) are unemployed, 17 (5.6%) were students and 16 (5.3%) were pensioners.

Table 7-3: Employment status of the respondents

		Frequency	Percent of total
Employment status	Employed	183	60.4 %
	Unemployed	87	28.7 %
	Studying	17	5.6 %
	Retired	16	5.3 %
	Total	303	100.0 %
	No response	2	
Total		305	

Table 7-4 describes the housing status of the respondents per the number of years they have lived in the present house. The Fisher exact tests indicate that the respondents' housing status with respect to the number of years lived in the house were statistically different (p>0.05). In terms of their housing status, the majority (n=216; 70.8%) indicated they are renting while 89 (29.2%) of them own the property. The majority had lived in the present house for than 10 years (n=130; 42.6%), whilst 33 (10.8%) had lived in their present house for less than a year.

Table 7-4: Housing status by number of years lived in present house

			Number of years lived in present house				Total
			Less than 1 year	1-5 years	6-10 years	More than 10 years	
Housing status	Owner of property	Count	17	14	11	47	89
		% of Total	5.6%	4.6%	3.6%	15.4%	29.2%
	Renting	Count	16	39	78	83	216
		% of Total	5.2%	12.8%	25.6%	27.2%	70.8%
Total		Count	33	53	89	130	305
		% of Total	10.8%	17.4%	29.2%	42.6%	100.0%

Fisher Exact test= 0.000

The respondent's household monthly income is shown in Table 7-5. Most of the respondents (n=105; 34.4%) earn between R5 000-R10 000 monthly, while 98 (32.1%) indicated that their household income was less than R5 000 per month. In addition, it was found that only 4 (1.3%) of the respondents earn more than R20 000 monthly. A few (n=16; 5.2%) declined to disclose their monthly income.

Table 7-5: Respondents' household monthly income

		Frequency	Percent of total
Income	Less than R5 000	98	32.1 %
	R5 000-R1 0000	105	34.4 %
	R10 000-R20 000	82	26.9 %
	More than R20 000	4	1.3 %
	No response	16	5.2 %
Total		305	100.0 %

7.2 Knowledge of water saving

Before discussing the knowledge of water saving on the part of the respondents, it is appropriate to discuss the reliability of the survey instrument. Reliability is computed by taking several measurements on the same subjects (Kimberlin and Winterstein 2008). A reliability coefficient with a Cronbach's α of 0.70 or higher is considered as "acceptable". The calculated Cronbach's α coefficients were used to determine the internal consistency of the constructs.

As shown in Table 7-6, the Cronbach's α for the eleven items measuring behaviour towards water saving techniques was found to be good at 0.931. Similarly, the Cronbach's α for the seven items measuring water conservation, subjective norms, and attitude was found to be acceptable at 0.781.

Table 7-6: Cronbach's alpha

Focus Area	Sub-section	N of Items	Cronbach's Alpha
Section C	Behaviour towards water saving techniques	11	0.931
Section E	Attitude on water conservation	7	0.781

7.2.1 Knowledge of water saving practices

Knowledge of water conservation was measured by asking the respondents whether they are aware of a number of measures that need to be practiced conserving water (requiring Yes, No, Unsure responses). This is presented in Table 7-7, whereas the level of the practice of this technique (behaviour) was measured on a 5-point Likert scale ranging from Always to Never is presented in Table 7-10.

Table 7-7 displays the percentages of knowledge (awareness) in respect to each water-saving practice. All the respondents (n=305; 100%) affirmed that they were aware that taps had to be tightly closed to avoid dripping. A strong majority of 298 (97.7%) were aware of turning the tap water off during tooth brushing, while 1 (0.3%) was not aware of this technique; and 6 (2.0%) indicated they were unsure. Equally, 302 (99.0%) were aware that leaking pipes had to be repaired or reported to the landlords.

Furthermore, 238 (78.0%) had knowledge that using water in a glass during tooth brushing was a water-saving practice, while 37 (12, 1%) were unsure. In terms of turning the showers off while soaping, 292 (95.7%) knew that turning their showers off while soaping would save water, while 9 (3.0%) indicated they did not have knowledge of this and a small percentage of 3 (1.0%) were unsure.

Similarly, 292 (97.0%) had knowledge that water can be saved when washing a car using a bucket or putting spray nozzle on the end of their hose to prevent the hose from continuously releasing water, whilst a few 3 (1.0%) were not aware and 6 (2.0%) were unsure.

A strong majority of 292 (95.7%) were aware that washing vegetables using water put in a basin or sink rather than under flowing tap water was a water saving technique, while a small percentage 7 (2.3%) did not know, and 6 (2.0%) were unsure. Further to these, the majority (n=297; 97.4%) were aware of the practice of reusing water to water plants and a small number of respondents 6 (2.0%) were unaware. Notwithstanding this, 294 (96.4%) knew that collecting rainwater is a good practice to save water, whilst a few 4 (1.3%) were unaware of this technique. Furthermore, as indicated in the table below 294 (92.1%) stated they were aware of the practice of watering one's garden or plants during evening or night, while a few 7 (2.3%) were unsure.

Regarding flushing 273 (89.5%) were aware of flushing the toilet sparingly after urinating whilst 16 (5.2%) indicated they had no knowledge of this.

Table 7-7: Respondents knowledge of water saving practices

	Knowledge	Yes n (%)	No N (%)	Not sure N (%)
1	Tightly close taps to avoid dripping	305 (100%)	0 (0%)	0 (0%)
2	Turning tap water off during tooth brushing	298 (97.7%)	1 (0.3%)	6 (2.0%)
3	Repairing leaking pipes or reporting them to landlords	302 (99.0%)	3(1.0%)	
4	Use water in a glass during tooth brushing	238 (78.0%)	30 (9.8%)	37 (12.1%)
5	Turning the showers off while soaping	292 (95.7%)	9 (3.0%)	3 (1.0%)
6	Save water when washing a car: by using a bucket or putting spray nozzle on the end of your hose to prevent the hose from continuously releasing water	296 (97.0%)	3 (1.0%)	6 (2.0%)
7	Washing vegetables using water put in a basin or sink rather than under flowing tap water	292 (95.7%)	7 (2.3%)	6 (2.0%)
8	Reusing water: for example, watering plants with used water	297 (97.4%)	6 (2.0%)	2 (0.7%)
9	Collecting rainwater for uses around the house	294 (96.4%)	4 (1.3%)	7 (2.3%)
10	Watering gardens or plants during the evening or night	281 (92.1%)	7 (2.3%)	17 (5.6%)
11	Flush sparingly; for example, after urinating one does not have to do the whole flush.	273 (89.5%)	16 (5.2%)	16 (5.2%)

Table 7-8 describes the relationship between the knowledge of water saving practices and the demographic information (age, race, gender, education, employment status, housing status, and household income) of the respondents. For example, in terms of the statement “Use water in a glass during tooth brushing”, it was found that the knowledge of the respondents differs with respect to their education ($p<0.05$), housing status ($p=0.046$), and household income ($p<0.01$).

With regards to the statement: “Washing vegetable using water put in a basin or sink rather than under flowing tap water”, it was found that the respondents knowledge differs in respect to their education only ($p<0.01$). Regarding the statement: “Reusing water: for example, watering plants with used water”, the knowledge of the respondents differs with their education level ($p=0.049$). Similarly, the knowledge of the respondents differs with respect to their knowledge of “Collecting rainwater for uses around the house ($p<0.01$).

Furthermore, it emerged that the knowledge of the respondents with respect to the statement: “Watering gardens or plants during the evening or night” differs by their education level ($p=0.023$).

More so, the knowledge of the statement: “Flush sparingly, for example after urinating one does not have to do the whole flush” also significantly differs with respect to the respondent’s education level ($p<0.01$).

Overall, and drawing from the above, it is sufficient to assume that the knowledge of water-saving practices amongst the respondents is largely dependent on their education level more than any other demographic factors.

Table 7-8: Relationship between demographic data and knowledge of water saving practices

Do you have knowledge on the following statements to conserve water in your home?		Age	Race	Gender	Education	Employment status	Housing status	Household Income
Tightly close taps to avoid dripping	Chi-square	-	-	-	-	-	-	-
	Df	-	-	-	-	-	-	-
	Sig.	-	-	-	-	-	-	-
Turning tap water off during tooth brushing	Chi-square	5.635	8.222	1.432	1.461	12.999	2.882	9.039
	Df	8	6	2	8	6	2	6
	Sig.	0.737	0.177	0.686	1.000	0.124	0.329	0.112
Repairing leaking pipes or reporting them to landlords	Chi-square	2.095	1.783	0.251	2.537	0.372	2.060	2.710
	Df	4	3	1	4	3	1	3
	Sig.	0.904	0.655	1.000	0.662	1.000	0.205	0.230
Use water in a glass during tooth brushing	Chi-square	9.784	5.008	1.726	19.870	10.574	6.050	21.968
	Df	8	6	2	8	6	2	6
	Sig.	0.281	0.510	0.433	0.012	0.100	0.046	0.004
Turning the showers off while soaping	Chi-square	7.792	4.209	0.303	12.098	9.237	2.278	5.582
	Df	8	6	2	8	6	2	6
	Sig.	0.437	0.448	1.000	0.145	0.146	0.374	0.352
Save water when washing	Chi-square	5.442	4.299	5.607	8.381	8.982	3.821	0.233

a car: by using a bucket or putting spray nozzle on the end of your hose to prevent the hose from continuously releasing water	Df	8	6	2	8	6	2	6
	Sig.	0.753	0.426	0.062	0.353	0.184	0.151	1.000
Washing vegetables using water put in a basin or sink rather than under flowing tap water	Chi-square	5.433	3.757	1.638	27.573	10.466	1.284	3.356
	Df	8	6	2	8	6	2	6
	Sig.	0.733	0.497	0.464	0.004	0.138	0.490	0.624
Reusing water: for example, watering plants with used water	Chi-square	6.491	1.663	4.897	16.814	2.339	3.385	3.830
	Df	8	6	2	8	6	2	6
	Sig.	0.619	0.895	0.069	0.049	0.835	0.203	0.571
Collecting rainwater for uses around the house	Chi-square	7.532	5.000	0.267	31.694	8.438	1.673	3.519
	Df	8	6	2	8	6	2	6
	Sig.	0.480	0.336	0.892	0.001	0.190	0.460	0.617
Watering gardens or plants during the evening or night	Chi-square	5.436	2.196	2.631	18.770	3.312	3.302	4.071
	Df	8	6	2	8	6	2	6
	Sig.	0.727	0.820	0.253	0.023	0.786	0.192	0.601
Flush sparingly; for	Chi-square	12.394	10.507	0.842	25.009	5.738	0.170	1.799

example, after urinating one does not have to do the whole flush	Df	8	6	2	8	6	2	6
	Sig.	0.129	0.109	0.664	0.004	0.409	0.954	0.913

One-way Analysis of variance (ANOVA) was further used to show the differences in the knowledge of the water conservation by the respondent's education level (Table 7-9). The ANOVA test suggests that the level of education of the respondents and their knowledge of water conservation were statistically different ($p<0.01$). The Bonferroni correction indicates knowledge of water conservation was significantly different between the high school and the university education level ($p<0.01$). No significant difference was identified amongst other levels of education ($p>0.05$). Overall, respondents with high school level of education were more knowledgeable on how to always conserve water (1.06±0.1).

Table 7-9: ANOVA test showing the relationship between knowledge and education

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		ANOVA P value	Bonferroni
					Lower Bound	Upper Bound		
No schooling	40	1.1159	.23290	.03683	1.0414	1.1904	0.002	$0.874^{1,5}$
Primary school	51	1.0838	.13341	.01868	1.0463	1.1213		$0.146^{2,5}$
High school	165	1.0556	.11988	.00933	1.0372	1.0741		$0.009^{3,5}$
College/ Certificate	32	1.1364	.23548	.04163	1.0515	1.2213		$1.000^{4,5}$
University	16	1.1989	.24667	.06167	1.0674	1.3303		$0.009^{5,3}$

Superscript numbers indicate significant differences between the sample groups (ANOVA, $P < 0.05$).

7.2.2 Behaviour concerning water saving practices

The behaviour of water saving techniques amongst the respondents is presented in Table 7-10. A strong majority (97.7%) of the respondents indicated they “always” (75.7%) and “very often” (22.0%) make sure that taps in their house do not drip ($p<0.001$). Similarly, (64.8%) indicated they “always” (48.0%) and “very often” (16.8%) turn the tap water off during brushing their teeth ($p<0.001$). Equally important, a high majority (92.7%) indicated they “always” (69.7%) repair their leaking pipes or report them to landlord or municipality ($p<0.001$).

In terms of behaviour towards the statement: “*I use water in a glass during brushing teeth*”, more than half (51.9%) of the respondents indicated they “always” (40.1%) and “very often” (11.8%) use water in a glass during brushing teeth ($p<0.001$). On the item relating to: “*I turn the shower off which soaping*”, (62.9%) indicated “always”, (52.0%) stated “very often”, and (10.9%) indicated that they turned off the shower ($p<0.001$). A majority (76.8%) of the respondents indicated they “always” (61.5%) and “very often” (15.3%) save water when washing their car: by using a bucket or putting a spray nozzle on the end of the hose to prevent the hose from continuously releasing water ($p<0.001$). From existing literature (Jones *et al*. 2011; Datta *et al*. 2017; Garcia *et al*. 2019), noted that one of the factors of high-water consumption may be attributed to activities such as washing of cars. As such, this question was included in the survey to gauge residents’ practices when it came to washing their cars. Given that this is a low-income area, the high response rate for majority of the respondent actually owning a car could also indicate a case of *Social Desirability and Conformity bias where it is* hard for respondents to openly express non-conformity when asked about their behavior, beliefs and opinions. In addition, this is especially true when the respondent believes they may be ridiculed or despised. In such cases, respondents will tend to provide a socially acceptable response - sometime subconsciously - over their true feelings (Johnson and Van de Vijver 2003).

Nevertheless, a significant majority (74.1) indicated they “always” (56.7%) and “very often” (17.4%) wash their vegetables using water put in a bowl or sink rather than under flowing tap water ($p<0.001$). Similarly, (71.0%) indicated “always” (53.8%) and “very often” (17.2%) reuse water, for example, watering plants with used water. Equally, a high majority (75.7%) indicated they “always” (57.0%) and “very often” (18.7%) collect rainwater to use around their houses, for example, washing the yard,

carpets, and watering the garden. Furthermore, (67.7%) indicated they “always” (52.7%) and “very often” (15.0%) water their gardens or plants during the evening or night (p<0.001). Notably, (80.3%) of the respondents indicated they “always” (57.0%) and “very often” (23.3%) flush their toilets sparingly after urinating (p<0.001).

Table 7-10: Respondents behaviour concerning water saving practices

Do you practice the following in your home to save water	n	Likert scale					Mean	Std.	T-test value	*P*-value
		Always	Very often	Sometimes	Rarely	Never				
I make sure that taps in my house do not drip	304	75.7%	22.0%	2.3%	0.0%	0.0%	1.27	0.492	44.858	0.000
I turn the tap water off during brushing my teeth	304	48.0%	16.8%	32.9%	1.3%	1.0%	1.90	0.972	34.167	0.000
I repair leaking pipes or report them to landlord or municipality	304	69.7%	23.0%	6.9%	0.3%	0.0%	1.38	0.628	38.267	0.000
I use water in a glass or cup during brushing my teeth	304	40.1%	11.8%	39.1%	4.6%	4.3%	2.21	1.150	33.523	0.000
I turn the shower off while soaping	304	52.0%	10.9%	33.9%	0.3%	3.0%	1.91	1.065	31.338	0.000
I save water when washing my car: by using a bucket or putting a spray nozzle on the end of your hose to prevent the hose from continuously releasing water	301	61.5%	15.3%	22.9%	0.0%	0.3%	1.62	0.857	32.870	0.000
I wash my vegetables using water put in a bowl or sink rather than under flowing tap water	305	56.7%	17.4%	24.9%	0.0%	1.0%	1.71	0.908	32.920	0.000

I re-use water: for example, watering plants with used water	303	53.8%	17.2%	26.4%	1.0%	1.7%	1.80	0.975	32.041	0.000
I collect rainwater for uses around the house e.g. washing the yard, carpets, watering the garden	305	57.0%	18.7%	21.6%	1.6%	1.0%	1.71	0.927	32.194	0.000
I water my garden or plants during the evening or night	300	52.7%	15.0%	26.3%	2.3%	3.7%	1.89	1.098	29.862	0.000
I flush my toilet sparingly; for example, after urinating one does not have to do the whole flush	305	57.0%	23.3%	15.4%	0.7%	3.6%	1.70	0.996	29.901	0.000

7.2.3 Explaining behaviour towards water saving techniques

Table 7-11 describes the relationship between the behaviour towards water saving practices and the demographic information (age, race, gender, education, employment status, housing status, and household income) of the respondents. In terms of the statement: "*I make sure that taps in my house do not drip*", it was found that the behaviour of the respondents differs with respect to their education ($p<0.01$), and household income ($p<0.01$).

With regards to the statement: "*I turn the tap water off during brushing my teeth*", it was found that the respondents behaviour differs in respect to their age ($p<0.001$), race ($p<0.01$), education ($p<0.001$), employment status ($p=0.042$), housing status ($p=0.028$), household income ($p<0.001$). Regarding the statement: *"I repair leaking pipes or report them to landlord or municipality*" the behaviour of the respondents differs by their race ($p=0.041$), and housing status ($p=0.024$) only. However, the behaviour of the respondents with respect to statement: *"I use water in a glass or cup during brushing my teeth*" differs by their age ($p<0.001$), race ($p<0.001$), education ($p<0.001$), employment status ($p<0.05$), and household income ($p<0.001$).

Furthermore, it emerged that the behaviour of the respondents with respect to the statement: "*I turn the shower off while soaping*" differs by their age ($p<0.05$), race ($p<0.001$), education, ($p<0.001$), and household income ($p<0.001$). More so, the behaviour of respondents with regards to the statement: "*I save water when washing my car: by using a bucket or putting a spray nozzle on the end of your hose to prevent the hose from continuously releasing water*" was found to also differ by age ($p=0.039$), race ($p<0.01$), education ($p<0.01$), and household income ($p<0.001$).

Added to the above, it was found that the behaviour of the respondents with respect to the statement: "*I wash my vegetables using water put in a bowl or sink rather than under flowing water*" significantly differs by their race ($p<0.001$), education ($p<0.001$), employment status ($p=0.023$), and household income ($p<0.001$). Similarly, behaviour towards the statement: "*I re-use water: for example, watering plants with used water*" significantly differs by the respondent's race ($p<0.001$), education ($p<0.001$), employment status ($p<0.05$), and household income ($p<0.001$).

Equally important, it emerged that the behaviour of the respondents towards the statement: "*I collect rainwater for uses around the houses e.g., washing the yard, carpets, watering the garden*", differs by their age ($p=0.029$), race ($p<0.001$), education ($p<0.001$), employment status ($p<0.01$), and household income ($p<0.001$). Nonetheless, the behaviour of the respondents towards the statement: "*I water my garden or plants during the evening or night*" significantly differs by their employment status ($p<0.01$), and household income ($p<0.001$). In addition, the respondent's behaviour towards the statement: *"I flush my toilet sparingly; for example, after urinating one does not have to do the whole flush*" significantly differs by race ($p<0.001$), education ($p<0.001$), and employment status ($p<0.05$).

Overall, behaviour towards water saving techniques amongst the respondents is influenced by their age, race, education, employment status, and household income while gender, and to some extent, the housing status of the respondents, had little or no impact on their behaviour towards water saving techniques.

Table 7-11: Relationship between participant's demographic data and behaviour towards water saving practices

Do you have knowledge on the following statements to conserve water in your home?		Age	Race	Gender	Education	Employment status	Housing status	Household Income
I make sure that taps in my house do not drip	Chi-square	5.457	8.588	0.982	22.184	10.820	5.148	18.944
	Df	8	6	2	8	6	2	6
	Sig.	0.708	0.198	0.612	0.005	0.094	0.076	0.004
I turn the tap water off during brushing my teeth	Chi-square	50.631	34.732	1.963	47.649	21.637	10.847	45.538
	Df	16	12	4	16	12	4	12
	Sig.	0.000	0.001	0.743	0.000	0.042	0.028	0.000
I repair leaking pipes or report them to landlord or municipality	Chi-square	13.488	17.569	6.313	19.643	13.455	9.467	10.719
	Df	12	9	3	12	9	3	9
	Sig.	0.335	0.041	0.097	0.074	0.143	0.024	0.295
I use water in a glass or cup during brushing my teeth	Chi-square	45.908	38.327	8.803	62.156	25.103	9.208	57.392
	Df	16	12	4	16	12	4	12
	Sig.	0.000	0.000	0.066	0.000	0.014	0.056	0.000
I turn the shower off while soaping	Chi-square	30.076	41.184	1.994	53.819	19.770	5.392	63.394
	Df	16	12	4	16	12	4	9
	Sig.	0.018	0.000	0.737	0.000	0.072	0.249	0.000
I save water when washing	Chi-square	21.905	23.986	4.106	36.826	23.216	2.916	56.286

my car: by using a bucket or putting a spray nozzle on the end of your hose to prevent the hose from continuously releasing water	Df	12	9	3	12	9	3	9
	Sig.	0.039	0.004	0.250	0.000	0.006	0.405	0.000
I wash my vegetables using water put in a bowl or sink rather than under flowing tap water	Chi-square	12.051	31.289	2.013	49.693	19.320	5.152	60.217
	Df	12	9	3	12	9	3	12
	Sig.	0.442	0.000	0.570	0.000	0.023	0.161	0.000
I re-use water: for example, watering plants with used water	Chi-square	17.650	41.085	6.097	64.587	25.160	6.273	60.421
	Df	16	12	4	16	12	4	12
	Sig.	0.345	0.000	0.192	0.000	0.014	0.180	0.000
I collect rainwater for uses around the house e.g. washing the yard, carpets, watering the garden	Chi-square	28.254	44.635	3.690	51.498	26.412	5.954	59.802
	Df	16	12	4	16	12	4	12
	Sig.	0.029	0.000	0.450	0.000	0.009	0.203	0.000
I water my garden or plants during the evening or night	Chi-square	21.377	52.267	5.527	50.844	31.401	6.353	47.522
	Df	16	12	4	16	12	4	12
	Sig.	0.164	0.000	0.237	65.944	0.002	0.174	0.000

I flush my toilet sparingly; for example, after urinating one does not have to do the whole flush	Chi-square	25.257	39.830	4.807	25.009	24.170	5.842	1.799
	Df	16	12	4	16	12	4	6
	Sig.	0.065	0.000	0.308	0.000	0.019	0.211	0.913

One-way Analysis of variance (ANOVA) was further used to compare the mean differences in the behaviour towards water conservation by the respondent's demographic information (age, race, education, equipment, and household income).

For the education level, the ANOVA result presented in Table 7-12 shows that there is a significant difference in the behaviour towards water conservation and the respondents' level of education ($p<0.01$). The Bonferroni correction indicates that behaviour of respondents, with a primary school level of education, towards water conservation practices was significantly different from those with a high school education level ($p<0.01$). Similarly, the behaviour of high school level education towards water conservation was significantly different from respondents who indicated no schooling ($p<0.01$). No significant different were measured for those with college/certificate, and university ($p>0.05$) education. Overall, the no schooling (1.42 ± 0.8) respondents were more likely to always conserve water when compared against the high school education level respondents (1.88 ± 0.7).

Table 7-12: ANOVA test showing relationship between education and behaviour towards water conservation

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		ANOVA P value	Bonferroni
					Lower Bound	Upper Bound		
No schooling	39	1.4242	.80352	.12867	1.1638	1.6847	0.002	$1.000^{1,2}$
Primary school	50	1.4327	.61399	.08683	1.2582	1.6072		$0.001^{2,3}$
High school	160	1.8773	.67155	.05309	1.7724	1.9821		$0.003^{3,1}$
College/ Certificate	32	1.8381	.83055	.14682	1.5386	2.1375		$0.103^{4,1}$
University	16	1.6420	.53265	.13316	1.3582	1.9259		$1.000^{5,1}$

Superscript numbers indicate significant differences between the sample groups (ANOVA, $P < 0.05$).

In terms of race, the ANOVA result in Table 7-13 shows that there was a significant difference in the behaviour towards water conservation practices and the respondents' race ($p<0.01$). The Bonferroni correction indicates that behaviours of the African respondents towards water conservation were significantly different from the Coloured and the Indian respondents, respectively ($p<0.001$). No significant difference was measured between the African and White, as well as the White, Indian, and Coloured ($p>0.05$). Overall, the White (1.15±0.3) respondents were more likely to always conserve water when compared to the Africans (1.92±0.7).

Table 7-13: ANOVA test showing relationship between race and water conservation

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		ANOVA P value	Bonferroni test
					Lower Bound	Upper Bound		
African	187	1.9154	.69138	.05056	1.8157	2.0152	0.000	$0.000^{1,3}$
Indian	88	1.4494	.67319	.07176	1.3067	1.5920		$0.000^{1,2}$
Coloured	19	1.2344	.52075	.11947	.9835	1.4854		$1.000^{3,2}$
White	3	1.1515	.26243	.15152	.4996	1.8034		$0.316^{4,1}$

Superscript numbers indicate significant differences between the sample groups (ANOVA, $P < 0.05$).

In terms of age, the ANOVA result in Table 7-14 shows that there was no significant difference in the behaviour towards water conservation practices overall and the respondents age (p>0.05).

Table 7-14: ANOVA test showing relationship between age and behaviour towards water conservation

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		ANOVA P-value
					Lower Bound	Upper Bound	
18-29 years	63	1.6436	.79510	.10017	1.4433	1.8438	0.717
30-39 years	93	1.7136	.68240	.07076	1.5730	1.8541	
40-49 years	71	1.7286	.65312	.07751	1.5740	1.8831	
50-59 years	38	1.8493	.70585	.11450	1.6173	2.0813	
60+	32	1.7727	.82224	.14535	1.4763	2.0692	

In regard to employment status, the ANOVA result in Table 7-15 shows that there was a significant difference in the behaviour towards water conservation practices and the respondents employment status (p<0.01). The Bonferroni correction indicates that behaviours of the employed towards water conservation were significantly different from the retired (p<0.01). Similarly, the behaviours of the unemployed were

statistically different from the retired (p=0.029). No significant difference was measured between the unemployed, employed, and student (p>0.05). Overall, the retired (1.14±0.3) respondents were more likely to always conserve water when compared to the employed (1.8±0.7).

Table 7-15: ANOVA test showing relationship between employment status and behaviour towards water conservation

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		ANOVA P value	Bonferroni
					Lower Bound	Upper Bound		
Employed	181	1.8021	.67774	.05038	1.7027	1.9015	0.005	1.000[1,2]
Unemployed	82	1.6907	.79943	.08828	1.5150	1.8663		0.029[2,4]
Studying	16	1.6875	.78972	.19743	1.2667	2.1083		0.178[3,4]
Retired	16	1.1420	.30418	.07605	.9800	1.3041		0.002[4,1]

Superscript numbers indicate significant differences between the sample groups (ANOVA, $P < 0.05$).

In terms of age, the ANOVA result in Table 7-16 shows that there was no significant difference in the behaviour towards water conservation practices overall and the respondents housing status (p>0.05).

Table 7-16: ANOVA test showing relationship between housing status and behaviour towards water conservation

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		ANOVA P value
					Lower Bound	Upper Bound	
Owner of property	89	1.6486	.67102	.07113	1.5073	1.7900	0.224
Renting	208	1.7592	.73555	.05100	1.6586	1.8597	

For the household income, the ANOVA result in Table 7-17 shows that there was a significant difference in the behaviour towards water conservation and the

respondent's household income ($p<0.01$). The Bonferroni correction indicates that behaviours towards water conservation of respondents with household income of less than R5 000 were significantly different from those who earn between R5000-R10000, and R10 000-R20 000 respectively ($p<0.001$). Overall, the respondents with lower household income were more likely to conserve water (1.37±0.6).

Table 7-17: ANOVA test showing relationship between household income and behaviour towards water conservation

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		ANOVA P value	Bonferroni
					Lower Bound	Upper Bound		
Less than R5 000	95	1.3703	.59646	.06120	1.2488	1.4918	0.000	$0.000^{1,3}$
R5 000-R10 000	101	1.7930	.74602	.07423	1.6457	1.9403		$0.000^{2,1}$
R10 000-R20 000	82	2.0377	.64107	.07079	1.8968	2.1786		$0.087^{3,2}$
More than R20 000	4	1.4091	.81818	.40909	.1072	2.7110		$0.405^{4,2}$

Superscript numbers indicate significant differences between the sample groups (ANOVA, $P < 0.05$).

7.2.4 Differences between knowledge and behaviour concerning water saving practices

The differences between the knowledge of water-saving practices and the actual behaviour towards water saving practices is presented in Table 7-18. It was observed that the proportion of the respondents who had knowledge of water saving practices ranged from 45.9% for "*Use water in a glass during tooth brushing*" to 100% for "*Tightly*

close taps to avoid dripping". On the other hand, it was found that respondents' actual behaviour towards water saving practices ranged from 67.7% for "*Watering gardens or plants during the evening or night*" to 97.7% for "*Tightly close taps to avoid dripping*". Overall, the average mean value measured for knowledge (94.4%) was statistically higher than the actual behaviour (74.1%) towards water saving techniques ($p<0.01$). This reflects a negative gap difference (-20.3) in the knowledge and actual behaviour towards water saving practices.

Table 7-18: Gap differences between knowledge and behaviour towards water saving

		Knowledge (K) (%)	**Behaviour (B) (%)**	**Gap (B-K) %**	***P* value**
1	Tightly close taps to avoid dripping	100	97.7	-2.3	
2	Turning tap water off during tooth brushing	97.7	64.8	-32.9	
3	Repairing leaking pipes or reporting them to landlords	99	92.7	-6.3	
4	Use water in a glass during tooth brushing	78	51.9	-26.1	
5	Turning the showers off while soaping	95.7	62.9	-32.8	
6	Save water when washing a car: by using a bucket or putting spray nozzle on the end of your hose to prevent the hose from continuously releasing water	97	76.8	-20.2	
7	Washing vegetables using water put in a basin or sink rather than under flowing tap water	95.7	74.1	-21.6	
8	Reusing water: for example, watering plants with used water	97.4	71	-26.4	
9	Collecting rainwater for uses around the house	96.4	75.7	-20.7	
10	Watering gardens or plants during the evening or night	92.1	67.7	-24.4	
11	Flush sparingly; for example, after urinating one does not have to do the whole flush.	89.5	80.3	-9.2	0.000

Average score	94.4	74.1	-20.3

Drawing from the above, it can be surmised that having knowledge of water-saving techniques does not translate to the actual behaviour towards water-saving techniques. Nevertheless, the Pearson correlation coefficient in Table 7.19 indicates that the knowledge of water-saving techniques positively correlates ($r=0.644$; $p<0.05$) with actual behaviour towards water-saving technique.

Table 7-19: Pearson Correlation between knowledge and behaviour towards water saving techniques

		Knowledge	Behaviour
Knowledge	Pearson Correlation	1	.644*
	Sig. (2-tailed)		.033
	N	11	11
Behaviour	Pearson Correlation	.644*	1
	Sig. (2-tailed)	.033	
	N	11	11
*. Correlation is significant at the 0.05 level (2-tailed).			

7.3 Awareness of water shortage in SA

The awareness of the water crisis and the need for water conservation practices in SA is presented in Table 7-20. The majority (n=299; 98%) indicated that they are aware that SA is a water scare country. A high proportion of the respondents (n=291; 95.4%) indicated that they know what conservation means. A total of 200 (65.6%) are aware of how much water they use on a daily basis. Similarly, 209 (68.5%) acknowledged that they are familiar with the FBWP, and 187 (61.3%) indicated they know how to read their water meter.

Table 7-20: Respondents awareness of water crisis in South Africa

Indicate your response to the following statements	Responses	
	Yes n (%)	No N (%)
I am aware that South Africa is a water scarce country	299 (98%)	6 (2%)
I know what water conservation means	291 (95.4%)	14 (4.6%)
I am aware of how much water I use a day	200 (65.6%)	105 (34.4%)
I am familiar with the Free Basic Water policy	209 (68.5%)	96 (31.5%)
I know how to read my water meter	187 (61.3)	118 (38.7%)

Figure 7-2 depicts the respondents' awareness concerning water conservation. It can be seen that the majority (98%) are aware that SA is a water scarce country.

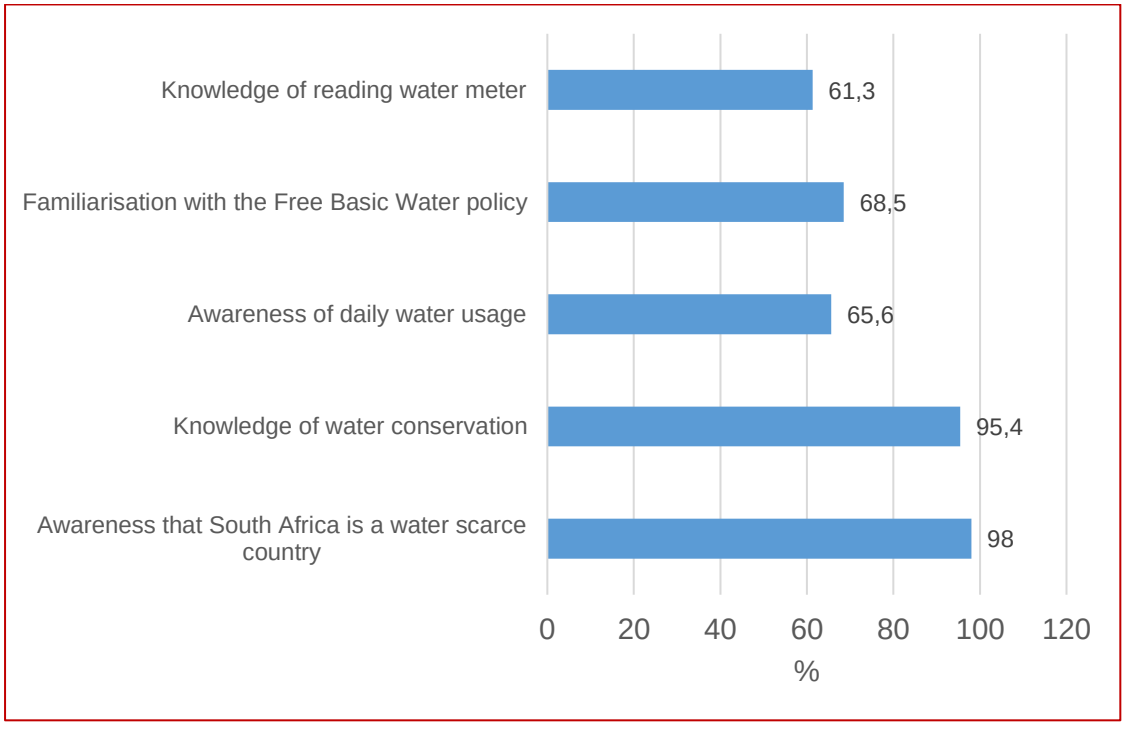


Figure 7-2: Respondents levels of awareness on water-related crisis

7.4 Attitudes, subjective norms, and intentions on water conservation

A pertinent point emerging from the previous section is that the majority of the respondents acknowledged or indicated awareness that SA is a water scarce country. This section presents the analysis of the respondents' answers to the statements measuring attitude, subjective norms, and their intentions on water conservation practices. One sample t-test was performed to determine if the scoring patterns were significantly different per option. The results are summarised below.

7.4.1 Attitude to water conservation

Table 7-21 describes the scoring pattern of the respondents with regards to the statement measuring attitude to water conservation. As indicated by the level of significance, the one sample t-test suggests that the scoring patterns were statistically different ($p<0.01$). This implies that the way the respondents score per variable per option in each of the statements measuring attitude on water conservation were not the same.

While a significant majority (85.9%) were in agreement (strongly agree=73.8%; agree=12.1%) that they do not have the right to use any amount of water whenever and however they want to, a few (11.1%) were in disagreement (disagree=10.8%; strongly disagree=0.3%). Similarly, a majority (84.9%) were in agreement (strongly agree=72.1%; agree=12.8%) that they do not believe the recent rainfall has made up for any previous water shortages in their area whilst a few (8.9%) were in disagreement (disagree=7.9%; strongly disagree=1.0%). Overall, and drawing from average the positive level of agreement, 85.4% of the respondents had good attitudes to water conservation.

Table 7-21: Respondents attitude towards on water conservation

	No	Likert scale					Mean	Std.	T-test	*P*-value
		SA	A	Unsure	D	SD			value	
I don't have the right to use any amount of water whenever and however I want to	305	73.8%	12.1%	3.0%	10.8%	0.3%	1.52	1.000	26.505	0.000
I don't believe the recent rainfall has made up for any previous water shortages in my area	305	72.1%	12.8%	6.2%	7.9%	1.0%	1.53	0.983	27.132	0.000
Likert scale= SA-Strongly Agree; A-Agree; D-Disagree; SD-Strongly Disagree *P<0.01*										

7.4.2 Subjective norms on water conservation

Table 7-22 describes the scoring pattern of the respondents with regards to the statement measuring the influence of subjective norms on water conservation practices. As indicated by the level of significance, the one sample t-test suggests that the scoring patterns were statistically different ($p<0.01$).

This implies that the way the respondents score per variable per option in each of the statements measuring attitude to water conservation were not the same. The majority (97.0%) were in agreement (strongly agree=79.3%; agree=17.7%) that their family members want them to save water. Equally, an overwhelming majority (96.4%) were in agreement (strongly agree=78.6%; agree=17.8%) that their friends want them to save water. In addition, nearly all (99.1%) of the respondents were in agreement that the municipality wants them to save water.

From the average positive level of agreement (97.5%), it is sufficient to assume that the subjective norms (family, friends, and municipality) influence water conservation behaviour.

Table 7-22: Respondents subjective norm influence on water conservation

	No	Likert scale					Mean	Std.	T-test value	*P*-value
		SA	A	Unsure	D	SD				
My family members want me to save water	305	79.3%	17.7%	2.3%	0.7%	0%	1.24	0.520	41.773	0.000
My friends want me to save water	304	78.6%	17.8%	3.3%	0.3%	0%	1.25	0.525	41.627	0.000
The municipality wants me to save water	305	84.3%	14.8%	1.0%	0%	0%	1.17	0.399	51.049	0.000
Likert scale= SA-Strongly Agree; A-Agree; D-Disagree; SD-Strongly Disagree *P<0.01*										

7.4.3 Water conservation intentions

Table 7-23 describes the scoring pattern of the respondents with regards to the statements measuring water conservation intentions. As indicated by the level of significance, the one sample t-test suggests that the scoring patterns were statistically different ($p<0.01$). This implies that the way the respondents score per variable per option in each of the statements measuring water conservation intentions were not the same. It emerged that all (100%) of the respondents were in significant agreement (strongly agree=93.8%; agree=6.2%) that it is important to save water.

Equally, an overwhelming majority (99.3%) indicated (strongly agree=84.9%; agree=14.4%) that they are concerned about the future availability of water. Based on the numbers of positive agreement, it is sufficient to say that there is general consensus amongst the respondents with regards to the importance of water conservation.

Table 7-23: Respondents water conservation intentions

	No	Likert scale					Mean	Std.	T-test value	*P*-value
		SA	A	Unsure	D	SD				
It is important to save water	305	93.8%	6.2%	0%	0%	0%	1.06	0.242	76.634	0.000
I am concerned about the future availability of water	305	84.9%	14.4%	0.7%	0%	0%	1.16	0.382	52.862	0.000
I don't believe the recent rainfall has made up for any previous water shortages in my area	305	72.1%	12.8%	6.2%	7.9%	1.0%	1.53	0.983	27.132	0.000
Likert scale= SA-Strongly Agree; A-Agree; D-Disagree; SD-Strongly Disagree *P<0.01*										

7.4.4 Behaviour change towards water conservation

Part of the inquiry of this study was to influence the change in behaviour towards water conservation practices. This section aimed to determine the use of incentives as a motivating factor to change the respondents' current water conservation behaviour.

As shown in Table 7-24, the majority (n=304; 99.7%) indicated that installing a portable water tank, such as Jojo water tanks, free of charge to collect rainwater will encourage them to use water more sparingly as well as pay their water accounts timeously.

Other notable incentives proposed in this study to encourage behaviour change include: the municipality agreeing to write-off previous water debt (n=291; 96%), free airtime and data (n=269; 88/5%), and a certain amount of electricity (apart from the already stipulated free amount) offered to them free of charge (n=264; 87.1%). As shown, a very high majority of respondents were open to all the proposed incentives.

Table 7-24: Respondents responses towards behaviour change through incentives

Which of these incentives will encourage you to use water more sparingly and pay your water account timeously	Responses	
	Yes n (%)	No n (%)
Free airtime and data	269 (88.5%)	35 (11.5%)
Certain amount of electricity free of charge	264 (87.1%)	39 (12.9%)
The municipality agreeing to write-off previous water debt	291 (96%)	12 (4.0%)
Installing a water can tank free of charge to collect rainwater	304 (99.7%)	1(0.3%)

Figure 7-3 further shows the percentage of respondents favouring each incentive proposed in this study. A strong majority (99.7%) indicated their preference for the installation of a water tank, installed free of charge, to collect rainwater.

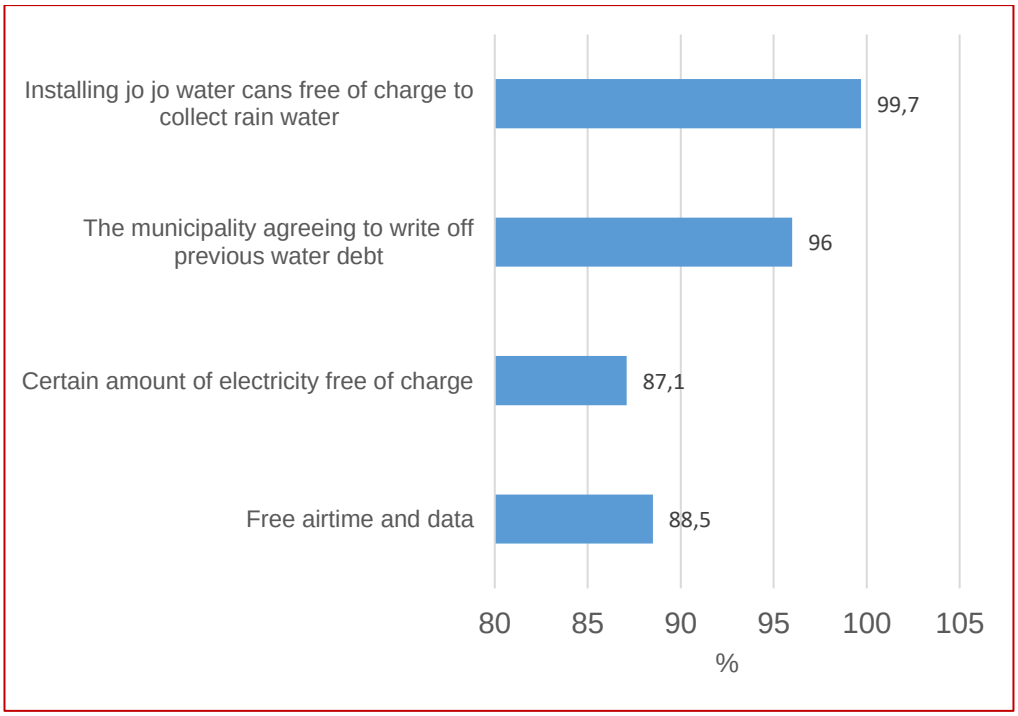


Figure 7-3: Respondents rating of behaviour change through incentives

7.5 Predictors of water conservation

Part of the inquiry in this study was to determine the predictors of water conservation. As a consequence, factors like subjective norms ("*My family members want me to save water; My friends want me to save water; The municipality wants me to save water"*), and attitude to water usage ("*I do not have right to use any amount of water whenever and however I want to; I do not believe the recent rainfall has made up for any previous water shortages in my area"*), were measured as the independent variable to predict water conservation ("*It is important to save water; I am concerned about the future availability of water in my area"*).

The multiple regression analysis of water conservation predictors is displayed in Table 7-25. Both the f-test and the t-test showed revealed a significant difference in the model. The regression coefficient ($r=0.551$; $p<0.01$) suggests a strong causal relationship in the predicted model, while the beta coefficients for subjective norms (0.475) indicate a strong predictor. The coefficient of 0.146, however, indicates a weak predictor for the attitude. Nonetheless, both subjective norms and attitude were positive which indicate that a strong relationship exists between the two predictors and the predicted (intentions on water conservation).

Equally essential, the R^2 values measured suggests that there is a strong explanatory power (30%) for the predictors in the model. Moreover, it can be seen that both subjective norms and attitude significantly contributed to water conservation prediction.

Overall, beta coefficient measured for subjective norms (0.475) was stronger when compared against attitude (0.146) in explaining water conservation.

Table 7-25: Multiple regression on predictors of water conservation

Predictor	F-value	P-value	R	Beta coefficients	R Square	t-value	P-value	Predicted
Subjective norms	65.661	0.000	0.551	0.475	0.304	17.745	0.000	Intention on water conservation
Attitude				0.146				

7.5.1 The relationship between the predictors on water conservation and incentive towards behaviour change

The relationship between the perceived predictors (subjective norms, and attitude), water conservation intentions, and the use of incentives to change the behaviour towards water conservation are shown in Table 7-26.

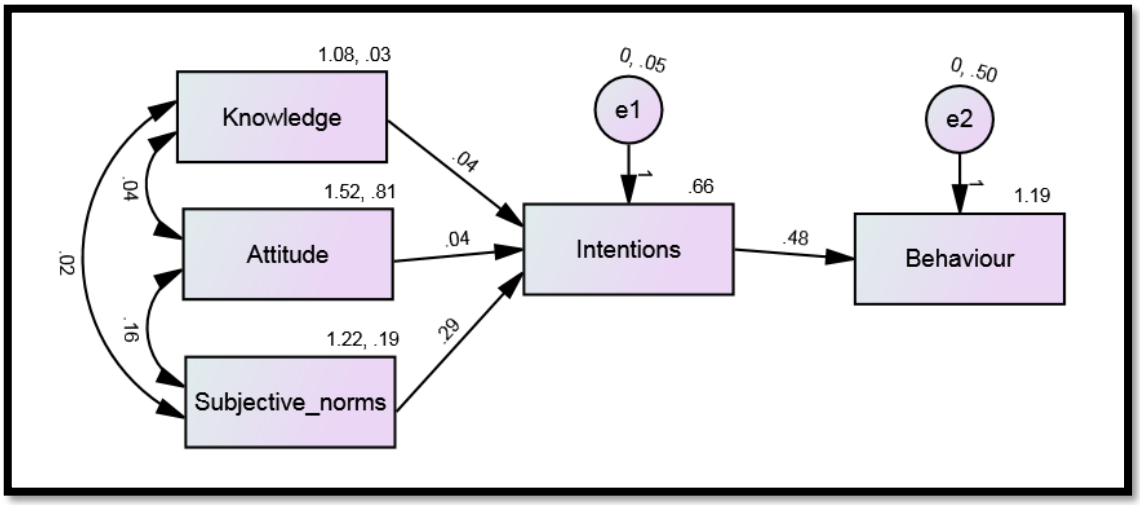
Expectedly, subjective norms correlate significantly with intention to conserve water ($r=0.535$; $p<0.001$). Equally attitude correlates also with the intention to conserve water ($r=0.342$; $p<0.001$), and intentions correlate with intention to conserve water ($r=0.367$; $p<0.001$).

Table 7-26: Relationship between perceived predictors, intentions, and incentives

		Intentions	Attitude	Subjective norms	Incentive
Intentions	Pearson Correlation	1	.342**	.535**	.367**
	Sig. (2-tailed)		.000	.000	.000
	N	305	305	304	302
Attitude	Pearson Correlation	.342**	1	.411**	.264**
	Sig. (2-tailed)	.000		.000	.000
	N	305	305	304	302
Subjective norms	Pearson Correlation	.535**	.411**	1	.416**
	Sig. (2-tailed)	.000	.000		.000
	N	304	304	304	301
Incentive	Pearson Correlation	.367**	.264**	.416**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	302	302	301	302
**. Correlation is significant at the 0.01 level (2-tailed).					

7.5.2 Structural Equation model

Structural equation model (SEM) was further computed using Amos (SPSS version 26). As depicted in Figure1, the path analysis revealed a good fit in the model. The Chi-Square goodness of fit =12.180; df=3, p<0.001, TLI=0.787, CFI=0.957, and RMESA=0.082. Consistent with the multiple regression analysis, the SEM image visibly confirmed that subjective norms were the strongest contributor to water conservation intentions. The path analysis also revealed that water conservation intentions was a strong predictor to water conservation behaviour.



Chi square = 0.00, df =0 P-value = 1.0000, RMSEA = 0.000

Figure 7-4: SEM analysis of the predictors of water conservation

7.6 Summary

The data presented in this chapter shows there is a gap between knowledge and behaviour towards water conservation practices by respondents selected from the Waterloo low-cost housing area. Based on the analysis it was found that the level of knowledge is not equal to the level of actual behaviour practiced to conserve water. Whilst the knowledge of water conservation is mainly influenced by the respondents' level of education, their behaviour by contrast, appears to be influenced by their race, age, education, household income and employment level. In addition, it was shown that subjective norms and attitudes are predictors of the intention to conserve water. The results indicate that the use of incentives could change the behaviour of the

respondents towards water conservation practices. The next chapter will provide the discussion from the findings in Chapter 6 and 7.

Chapter 8: Discussion of the findings

Water authorities globally are faced with the task of ensuring that there is sufficient water to meet demand in the wake of drought, population growth and the threat of reduced supply as a result of climate change. In SA, the challenges are exacerbated due to aged infrastructure, leaks and high-water consumption at a domestic level. More so, many communities, particularly in low-income areas, owe large amounts of money to municipalities due to surpassing the agreed amounts of water as stipulated in the FBWP. In fact, the department of Water and Sanitation has expressed concern that South Africans are not saving water. Water conservation thus becomes an important strategy for water management. This can be achieved by determining the behaviour of domestic water consumers. According to Reddy *et al.* (2017) behavioural sciences can advance conservation by systematically identifying behavioural barriers to conservation and identifying how to best overcome them. With this in mind, this study's aim was to develop a strategic intervention in the form of a behavioural model to assist the eThekwini municipality in its efforts to assist inhabitants in low-cost housing areas to use water more consciously and adhere to the stipulated amount.

The research objectives undertaken in this study were:

Objective 1: To compare the South African approach to water resource management with Brazil, Singapore, Australia and India.

Objective 2: To determine the factors that influence water-use behaviour in low-cost housing areas by:

- Examining inhabitant's knowledge towards water conservation
- Determining inhabitant's levels of attitude towards water conservation.

Objective 3: To develop a behavioural method towards water conservation and preservation in low-cost housing areas by applying the Nudge Theory and the TRA as a foundation to identify ways of reducing water consumption.

8.1 Water resource management strategies in SA and other countries within the global south

Mekonnen and Hoekstra (2016) warn that freshwater scarcity is imminent and as such is posing a threat to the sustainable development of human society. The annual report by the World Economic Forum cited in Bennett *et al.* (2017) identified the main factors behind the global water crisis, as rapid population growth, urbanisation and the changing water consumption and concomitant growth of irrigated agriculture. According to McGrane, Allan and Roy (2018), the above factors pose a threat to sustainable and economic development particularly in water-stressed regions. Moreover, countries in the global south such as Brazil, India, Australia, and Singapore are faced with enormous challenges to meet the water demands of her citizens, and SA is no exception. Given this concern, government policies, institutional frameworks, and water conservation efforts were reviewed in this study. The objective was to determine whether SA is able to build on the experiences from other countries with similar water resources concerns in an effort to improve its own existing strategies, approaches and practices. As such, advice from studies in the review is considered towards the development of a community-based water conservation behavioural model for LCH areas. The content analysis method was used to synthesise and analyse the key concepts of each country's water management framework as presented in Figure 2-3. From the resulting analysis three broad concepts emerged.

8.1.1 Water management guidelines.

It was found that all the studied countries followed the IWRM recommendation. This may be attributed to the fact that all the countries identified themselves as being "water-stressed". Even though Singapore experiences the most average annual rainfall (2340 mm), the country is recognized as "water-stressed" due to the lack of land space to store rainwater. More so and comparing the ratio of the population with access to drinking water, India was found to have the lowest percentage (83%), whilst Brazil and South Africa had 93%, respectively. It was found that the legislative approaches for the five countries under study are fairly similar. For example, terms such as *sustainable, inclusive,* and *participatory* are recognised in their respective water management guidelines.

Moreover, South Africa, as with the other countries reviewed, acknowledges the need to incorporate some form of participatory feedback through stakeholder engagement.

Nevertheless, each country appears to be guided by their separate institutionalised legal and policy framework. Interestingly, it was noted that all the countries have undertaken a revision or change to their water legislations since the 1990s. Although changes to the policies of South Africa were driven by the changed political environment, the four other countries - in the face of climate change and rapid population growth - may have understood the need to amend their water decree to protect their water sources. Despite this, the enforcement of the water regulations as a mainly supply-related strategy was considered poor for all the countries except Singapore.

The Acts governing water are similar in South Africa and Australia as there are many shared characteristics. The legislation in South Africa further demonstrates the need for equality but it is more demographic-related and historically marginalised than it is among user sectors. Australian legislation appears to depend primarily on water trade and embraces the fiscal value of water. In the South African context this has to be addressed and requires further scrutiny as emerging black and rural populations are still without fair access to water or have a significant role in decision-making (Butterworth *et al.* 2010). Significantly, as posited by Pahlow, Snowball and Fraser (2015), the challenges with regard to water management in SA is not only due to inadequate rainfall but also mismanagement as a result of political breakdowns.

Brazil has not completely revised its water laws but has chosen to add to it. The need for equality between all the different water-users was one of the main reforms in Brazil's legislation. In addition, the decision-making process undertaken by Brazil at the river basin committee level has been decentralized, compromising representatives of both government and non-government. This may have constituted the struggle of effectively implementing IWRM framework. Coupled with this, and besides having an institutionalised water management framework, there is no clear legislation relating to the development and control of water resources and the establishment of strong and well-funded management agencies to implement laws. Nevertheless, it was found that as the driest populated continent in the world, Australia, has many years of expertise in handling issues related to water scarcity.

As a result, the country has often been regarded as a global leader in water policy innovation. Significantly, Singapore presents the best-case study for water management practice as its holistic water management framework responds to supply

and demand simultaneously. Its Public Utilities Board (PUB) has put in place a well-considered and comprehensive policy on water demand management.

8.1.2 Water pricing mechanism

In terms of the water pricing mechanism, Brazil and India are mainly controlled by the state government and some stakeholders, whilst the South African water pricing system is controlled by a government-owned agency (DWAF). In South Africa, DWAF oversees the activities of all water sector institutions. It is responsible for national resources planning and allocation. Water is sold in bulk to the water board which are responsible for purification and selling the raw water to municipalities across the country. Furthermore, pricing schemes vary across South Africa. Water pricing is often a sensitive subject, especially in developed and poorer countries. While England (2018) claims that water pricing is intended to facilitate conservation efforts amongst users, Bassi (2016) noted that in the absence of an acceptable fiscal model, uncertainties are raised about how water will be supplied to those with limited financial resources. Local governments must, therefore, try to set tariffs based on costs and take into account social equity, financial viability, and environmental sustainability (Republic of South Africa National Treasury 2008. Within the eThekwini municipality, households with a rateable value of less than R250 000 receive a zero-water bill if their consumption is 9 kl or less. Consumption charges are thereafter billed on the scale relevant to their level of service. (eThekwini Municipality 2012).

In India water pricing is a sensitive issue particularly for the poor, especially in the context of equity and meeting minimum needs (Shen and Reddy 2016). For example, any rise in tariffs is politically and socially unacceptable in the absence of regular household water supply.

For effectiveness of water supply and demand, Australia has engaged in water pricing reforms (Poddar, Qureshi and Shi 2014). These reforms are aimed to ensure that costs are efficient in meeting levels of service that customers are willing to pay for.

Singapore adopts a strict pricing policy for water whereby all citizens are accountable for their domestic use (Zhang *et al.* 2017). Pricing of water is set at market rates and is considered a highly effective policy instrument for the government in its efforts to encourage prudent water usage. The water-pricing formula is subjected to increasing

block tariffs which includes a water conservation tax in an effort to promote water conservation behaviour. While it is it reasonably inferred that setting a price will reduce waste of water (to the extent that water is wasted at the household level), it is a challenge to put a price on water when there is provision for free water up to a stipulated limit and a culture of non-payment as the case in South Africa. This study, however, considers the advice provided.

8.1.3 Water management challenges

Each country assessed in this study appears to have a unique challenge related to water management. For Brazil, the mismatch between supply and demand resulted in conflicts among different stakeholders. More so, the country is suffering from a chronic uneven distribution of water resources which is triggered by rapid urbanisation. Contributing further to the chronic water malaise in Brazil is the growing demand for energy, and agriculture uses. In addition, and besides the deteriorating water quality and decaying infrastructure, the wide array of organisational and legal rigidities makes water-using sectors impractical. Moreover, there seems to be an overlapping jurisdiction problem in water conservation management.

In India, the unpredictable climatic condition, the depletion of ground water resources, coupled with the inadequate water conservation strategy tends to compound the water crisis in the country. More worrisome is the high-water wastage attributed to poor infrastructure and high-water losses through leakages. Similarly, and as observed in Brazil and India, South Africa is also faced with uneven distribution of water across the country. This is fueled by poorly maintained infrastructure and leaking pipes which has resulted in prolonged periods of water restrictions. In addition, South Africa's water management faces challenges attributed to the unusually high-water consumption and, according to Nkosi (2010) and Onyenankeya, Caldwell and Okoh (2018) there is growing distrust between citizens and water authority bodies.

Furthermore, and as observed by Loucks and Beek (2017), countries who embarked on infrastructure development by means of significant investments have improved their water resources management and operations. For example, it can be surmised that the practice of water supply and demand management in Singapore and Australia has garnered much attention and admiration in recent years. The management of water demand in both these countries is ranked as one of the best practices from any

industrialised or developing world, irrespective of whether the water resources are operated by public or private sector institutions. As stated by Lim and Lu (2016), Singapore has managed to find a balance in both water quantity and water quality considerations. Water supply and water demand management have been achieved, public and private sector involvement has been developed, and productivity and equity considerations have been achieved.

Alexander and Arblaster (2017) describe Singapore's water management policies as "*science-driven*" and "*innovative*". For example, its UWM offers a set of principles that underpin better coordinated, more responsive, and more sustainable practice. It is an approach that integrates water sources, water use sectors, water services, and water management scales. However, this study found that countries like Brazil, India, and South Africa suffer poor water distribution as a consequence of deteriorating infrastructure. It is highlighted by Crow-Miller *et al.* (2017) that without the suitable infrastructure to store and distribute water and manage flows, water establishments in poorer countries are severely constrained and face the harsh prospects of water scarcity.

Based on the review of these countries' water management frameworks and polices, it is inferred that suitable water-demand management strategies and policies can provide the foundation to increase the existing supply-demand balance in water-stressed countries and provide numerous benefits to all stakeholders. As highlighted in section 3.2.2, whilst South Africa's water challenges are deeply rooted in the historical legacy of the apartheid regime, there are many lessons that can be learnt from the other four countries in the global south, particularly in the areas of public participation and water conservation measures. However, in order to realise this full potential, there must be significant public and private sector investments in research, development and implementation of water conservation techniques.

8.2 Determining the factors influencing water use behaviour in low-cost housing communities

According to a report by Hu *et al.* (2017), effective water demand management should not only require knowledge of how people use water, but also the relationship between the psychological and behavioural aspects of people's water consumption. Accordingly, and as assumed by Seyranian *et al*. (2015), understanding residential water conservation behaviour is a critical step in the design of measures to aid

individuals in developing good water consumption behaviour that is more environmentally friendly. In view of this, this section examines knowledge, attitude and behaviour by inhabitants' living in the LCH towards water conservation. The findings were drawn from both the qualitative (interviews and focus group discussions), and the quantitative (survey analysis) results.

8.2.1 Knowledge and water conservation behaviour

In the quantitative phase, it was found that the knowledge of water conservation techniques (94.4%) was significantly higher than the actual behaviour (74.1%) towards water-saving techniques ($P<0.05$). The gap difference (-20.3%) measured between knowledge of water-saving techniques and actual behaviour towards water-saving techniques may perhaps be attributed to the provision of the 9*kl* of free water under the FBWP policy. Consumption charges are thereafter billed on the scale relevant to their level of service once the free amount of water is exhausted (eThekwini 2012). This study argues that because the first 9*kl* of water was free of charge, householders were not keen to pay for the extra amount of water they consumed thus contributing to the culture of non-payment of water services. This assertion is further supported by the qualitative finding that indigent community members lack social responsibility in the payment of bills leading to a culture of non-payment in the LCH.

Moreover, it also emerged from the qualitative finding that there is a high amount of water consumption and high unaccounted water losses in the area. The consequence of this may have overreaching effects in terms of water sustainability, as it is noted to have both a direct economic cost of unaffordable high bills and a huge monetary loss to the municipality. In fact, studies show that municipalities are struggling to manage FBWP due to administrative and technical capabilities associated with widespread theft and vandalism of monitoring devices on residential properties (Maphela 2015; Larsen *et al.* 2016).

While it is reasonable to agree that access to safe drinking water is a basic human right and highly essential to people's health and wellbeing (Rodina 2016), the finding from the quantitative phase suggests that the efficient use of water resources in Waterloo is a major concern for water utilities and authorities. In support of this, it emerged from the qualitative results that the inhabitants do not have any definite strategy on how to conserve water. Moreover, and contrary to the report that knowledge of water conservation ultimately results in the adoption of sustainable

attitudes and behaviours (Seyranian *et al*. 2015), the negative gap results in Table 7-18, however, suggest that actual knowledge of water-saving techniques does not translate into behaviour towards water-saving techniques.

This finding is also in direct disagreement with the popular notion that people are disinclined to engage in pro-environmental behaviour because of a knowledge deficit (Heeren *et al.* 2016), as it reveals that knowing about water-saving techniques does not translate to actual behaviour towards saving water. This also could be attributed to the fact that although the knowledge of water saving techniques differs with respect to the respondent's level of education (Table 7-8), their actual behaviour is dependent on their age, race, employment status, education, and household income (Table 7-11). This suggests that multiple demographic factors other than knowledge of water saving practices influences actual behaviour towards water conservation. This finding supports the assertion of Kneebone, Fielding and Smith (2018) that water conservation behaviour is influenced by household dynamics such as income status and level of education, amongst other factors.

8.2.2 Demographic factors and water conservation behaviour

In terms of household actual water conservation behaviour, it was found that respondents with lower education had better water conservation behaviour. This is also in agreement with Dieu-Hang *et al.* (2017) and Aprile and Fiorillo (2017) who observe that households with lower education levels engage in more water conservation behaviours and use less water than higher educated households. More so, and consistent with Shan *et al.* (2015), people with higher levels of education contribute to poorer water conservation behaviour which can be attributed to their higher levels of income and more comfortable lifestyle.

Similarly, and corroborating other studies (such as Warner *et al.* 2015; Barata, Castro and Martins-Loução 2017; Gill and Lang 2018), it was found that households with lower-income levels have better water conservation behaviour. On the contrary, the early study by Lam (2006) found that higher income households have stronger intentions to install water efficient appliances which suggests a good water conservation behaviour. The differences in these studies may be related to the culture and historical depravity, particularly in the context of SA. For example, the focus group discussions revealed that some residents that have never had water in their house,

cherish water and demonstrate intentions to conserve water whilst those who could afford paying water bills are less concerned about their water usage.

Moreover, and as argued by Seyranian *et al.* (2015) higher income households are also more likely to be engaged in careless use of water and are less cognisant of the water bill. In addition, several other studies (Russell and Fielding 2010; Willis *et al.* 2013; Xue *et al.* 2017) have found that higher income correlates with higher water consumption.

Further to the above, and in contrast to the report of Watson (2017) that older householders consume less water, it was found in the quantitative phase of the study that younger respondents had better water conservation behaviour when compared to the older ones. Dean, Fielding and Newton (2016) however, point out that the findings related to age are less clear. The authors argued that it may be stage of life rather than age that determines water use. In this study it was found that retired respondents have better water conservation behaviour than those employed; whilst Beal, Makki and Stewart (2012) found that retired or having teenage children may increase water use. The contradictory findings between this present study and that of Beal *et al*. (2012) reinforces the lack of clarity on the influence of age on water conservation behaviour.

Additionally, while this study found no differences in the pattern of water conservation behaviour amongst genders, other related studies (Davies *et al.* 2014; Tong *et al*. 2017) claim that females generally exhibit better water conservation behaviour than males. On the other hand, this study found that race also plays a crucial role in water conservation behaviour. It emerged that White respondents have a better water conservation behaviour than other racial group (Blacks, Indian, and Coloured). This could, however, be attributed to the historical divide and apartheid water laws which denied access to water to non-White South Africans. Hence, the introduction of democracy and new water laws may have created a culture of entitlement, thus contributing to poor water behaviour.

8.2.3 Awareness and water conservation behaviour

Furthermore, and drawing from the quantitative finding, although a majority of the inhabitants claimed to be aware that SA is a water scarce country, nonetheless, some had no knowledge of their daily water consumption (Table 7-20). This was also evident

in the focus group discussions which revealed that inhabitants had no knowledge of the amount of daily water consumed nor how to read their water meter.

Consequently, community councillors called for more communication and education programmes to educate individuals on ways to preserve water and calculate their consumption of water. This resonates with Onyenankeya and Salawu (2018) that people who are aware of their water situations are more likely to develop the appropriate water conservation behaviour.

Several studies (Inman and Jeffrey 2006; Fielding *et al.* 2012; Ramsey *et al.* 2017) report that the choice to engage in water conservation is dependent on contextual factors which include water pricing, household characteristics, the level of inconvenience, practicality of practices, and attitude and subjective norms of the household. Significantly, the quantitative finding in this study evidently showed that both subjective norms and attitude significantly predict water behaviour. Hence, it is reasonable to assume that no single attribute could successfully predict the complexity of human behaviour. As such, and according to the opinion of Reddy and his co-workers, a systematic understanding of human behaviour and the underlying mechanism is highly imperative (Reddy *et al.* 2017).

8.2.4 Subjective norms and attitude and water conservation behaviour

Early studies have shown that the personal beliefs were most likely to play an important role in decisions relating to water conservation (Marandu *et al*. 2010; Untaru *et al.* 2016), the regression coefficient evidently confirmed that subjective norms perform better than attitude in explaining behaviour towards water conservation (Table 7-25). This could be attributed to the concept of collectivism formed amongst social groups. For example, Chang (2013) argues that the water conservation behaviour of the older members in the family can serve as an example for the rest of the family. However, Fielding *et al.* (2016) in their study, found that attitude is a better variable than subjective norms in explaining water conservation behaviour. The difference between these studies may be associated with other factors that could potentially moderate behaviour, such as difference in culture, situation factors, and type of behaviour (Marandu *et al*. 2010). Resonating further, Reddy *et al.* (2017) notes that the factors that influence human behaviour are complex. Understanding these complexities will be of particular importance in formulating measures that would

invariably encourage the doctrine and practice of water conservation amongst the Waterloo residents.

Reddy *et al.* (2017) resonates with the claim made by Bennett *et al.* (2017) that a better understanding of the human or social dimension of environmental issues can improve conservation.

Overall, this section provides an explicit insight on factors influencing water conservation behaviour amongst respondents living in the Waterloo low-cost housing area. The findings showed that the two explanatory factors namely: attitude and subjective norms were statistically significant predictors of water conservation behaviour. It can be inferred that the conceptualisation of water conservation behaviour as a function of attitude and subjective norm may be appropriate in the context of the Waterloo area. This may help municipalities develop more effective and sustainable water conservation approaches in these communities. Furthermore, knowing and understanding the behaviour of water consumers in such areas where there is high consumption, can enable a more proactive approach to water demand management. This may in fact serve as the building block towards the development of sustainable intervention plans that can lead to a significant decrease in domestic water consumption.

8.3 Community-based behavioural model for water conservation in low-cost housing

One of the pivotal goals of the research is to contribute to the existing body of knowledge and identify water conservation strategies in the form of a behavioural model that could assist the municipality in reducing high water losses and consumption in the LCH areas. This section examines the value of recognising the use of incentives and nudging as a tool for behavioural change towards water conservation in indigent communities with high water consumption and low revenue generation.

The preceding section indicated that subjective norms and attitudes are a critical predictor towards water conservation in the Waterloo area. Various other factors such as knowledge of daily water consumption, and ability to read water meters were mentioned to be an essential component, particularly in terms of enforcing behavioural change amongst residents in the area. Given the complexity of human behaviour, it is critical that there is alignment between water management policies and that of the community needs.

As reported in the study, whilst the current water management system in SA is able to meet current demand, it is however not sustainable to meet the future demands of water. More concerning is the argument that the FBWP is no longer functional in LCH areas due to the high non-revenue water losses. Moreover, and corroborating with Ramírez *et al*. (2019), despite progressive water policies, there still remains an inability by the government to effectively manage and control water resources in vulnerable communities. The consequence is that the looming water crisis is expected to have implications on food security and health. The developed framework takes this into consideration by providing guidelines on the best approach the municipality could adopt in reducing the high-water consumption, wastages and revenue losses in the area.

The features of the framework are consolidated from a variety of sources that include policies and guidelines, research papers, semi-structured interviews, focus group discussions, and the questionnaire. These served as a point of departure in the development of the proposed framework as shown in Figure 8-1.

The next section outlines the framework description and usage.

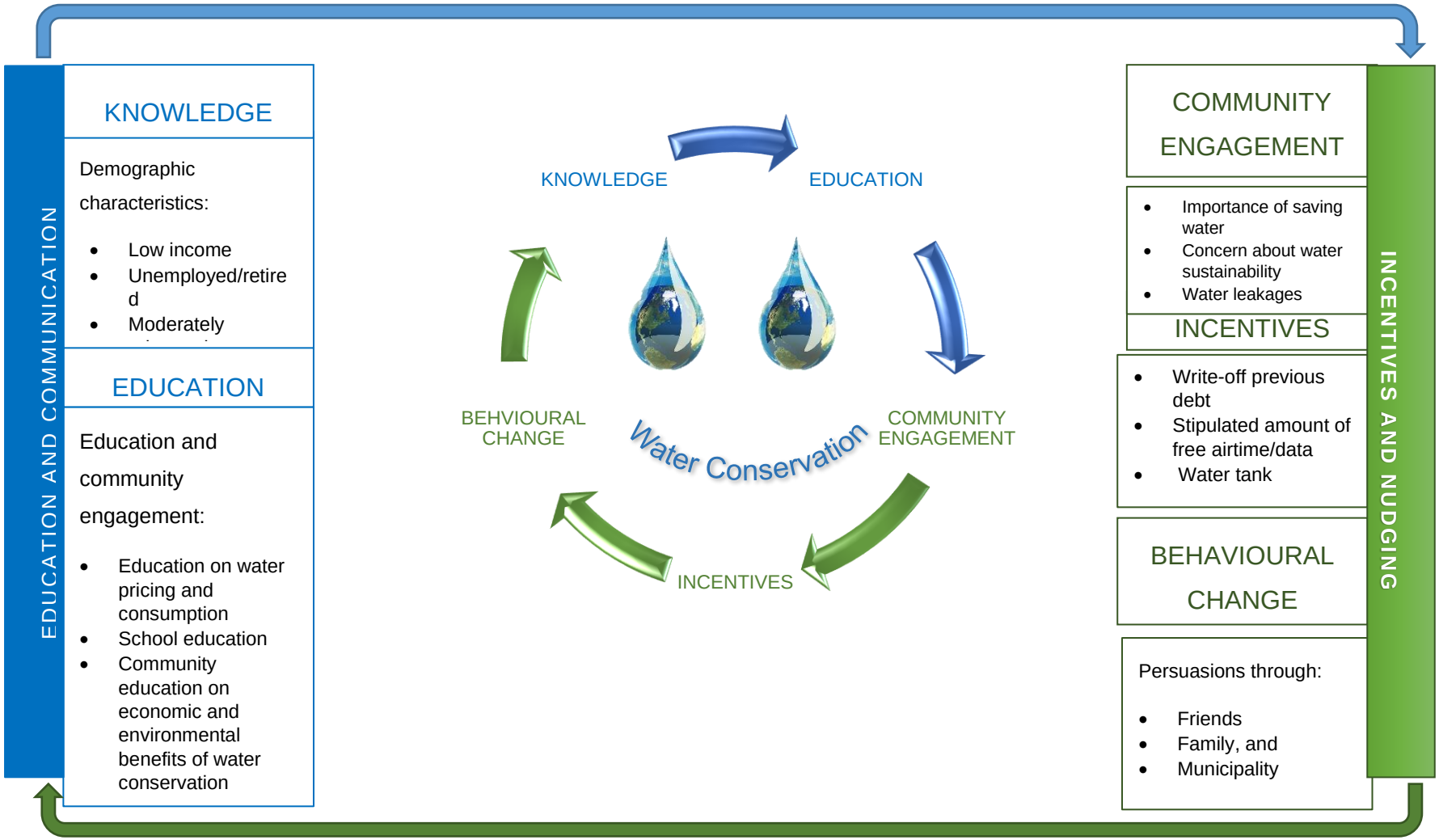


Figure 8-1: Community-based water conservation model for LCH areas (developed by the Researcher)

8.3.1 Education on water pricing and consumption

While water pricing mechanisms and implementation of water restrictions have been reported in the literature to enforce water conservation behaviour (Terrebonne 2005; Zhao *et al.* 2016; England 2018), the findings from this study suggest that such a measure may not work among the LCH areas. Decisions on prices require both equity and efficiency considerations. Homes with low-incomes face problems of affordability as prices rise. In order to address these concerns, Al Mamun *et al.* (2018) suggest that vulnerable communities be part of the engagement with water authorities when it relates to price structures as this may help minimise the impact on their low-income households. More so, as mentioned in this study, measures such as water pricing and water restriction are short-term and could lead to unrest and conflicts in the community. Such presumed conflict from water restrictions has reportedly resulted in casualties in cities such as Cape Town (Parks *et al.* 2019). More so, the demographic characteristics of the LCH area such as Waterloo, which are mainly unemployed/retired, low-income earners, and the moderately educated, suggest that water affordability may be a big issue. Moreover, and corroborating with Nkosi (2017), there is a culture of non-payment and distrust in water authority bodies which has contributed towards poor water behaviour. Equally important, and as argued by Koop, Van Dorssen and Brouwer (2019), the feasibility of water pricing may be limited when affordability issues limit access to domestic water.

While the FBWP policy indicates that consumption above the stipulated amount will be billed for the extra consumption, this study found that the majority of the respondents in the survey could not accurately calculate their daily water consumption. As such, they are not able to easily use water within the FBWP limits. Furthermore, as a majority of the respondents found it challenging to read their water meters, the framework begins with the proposed education and community engagement component (Figure 8-1) as a means to address this challenge. The proposition by Tom *et al.* (2011) that the use of data loggers attached to household water meters to track water data every 10 seconds and provide households with detailed reports of the amount of water used per water future, may be useful. This is in agreement with Chang (2015) who believes that a link between resident's water consumption behaviour and water-related problems would lead to more frugal use of water.

Previous studies (Lowe, Lynch and Lowe 2015; Mini, Hogue and Pincetl 2015; Stavenhagen *et al*. 2018) indicate that households that accurately estimate their water consumption have the best water saving practices. Other research (Safari *et al.* 2017) suggests that householders who know about their daily water consumption significantly reduce their water consumption.

8.3.2 School level education

Another important concern that emerged from the study was that working parents with children are not convincingly certain if their children practice water conservation behaviour in their absence. Hence, it becomes highly important to educate children on the importance of water conservation. According to views shared by some of the experts during the semi-interviews, this could be achieved by the integration of water conservation into the school curriculum. This resonates with the initiatives that educational interventions involving children in and out of the classroom could be effective in influencing water behaviour for children (Thompson *et al.* 2011; Safari *et al.* 2017). Moreover, other scholars (such as Seyranian *et al*. 2015) report that extensive environmental efforts such as a 40-hour educational programme positively influenced students' water attitude and behaviour. Thus, and in agreement with the views of Xiong *et al.* (2016) that school-based education programmes, together with widespread campaigns with particular emphasis on the current water situation in South Africa, could help achieve a change in water conservation behaviour in the community. This is also in line with Zhan, He and So (2019) that school children are much more interested in applying what they have learned, and thus active participation can be viewed as a way to promote and cultivate life-long environmentally responsible behaviour.

8.3.3 Environmental and economic importance of water conservation

Apart from school education, community education and engagement are also a notable suggestion that emerged from this study. It was found that educating people through programmes around water conservation is fundamental and crucial towards behavioural change. However, it emerged from the study that the municipality has hardly engaged with the people. There is a widespread claim amongst the people that the only time they hear from the water authorities is when water restriction is being implemented.

More so, a majority of the people were informed about the current water situation in South Africa through the television which indicates a lack of direct engagement by the water authorities. This, perhaps, might have contributed towards the poor water conservation behaviour found among the residents. Given this concern, and in agreement with Seyranian *et al.* (2015), an outreach programme in the LCH that mainly promotes water conservation is paramount to reduce water conservation in the area. This programme should inform individuals about water shortages and encourage them to conserve water by outlining specific water saving tips. Of particular importance, and corroborating with Seyranian *et al.* (2015), communication of conservation messages may encourage behavioural changes that result in sustainable water conservation. According to the recent study by Addo, Thoms and Parsons (2019), the most effective water conservation outcomes may be achieved through persuasion message framing that influences the casual mechanisms of behaviour for behavioural and attitudinal change among water consumers. Koop, Van Dorssen and Brouwer (2019) suggest ways of framing and content of messages for household water-conservation behaviour should follow. In their report, it is suggested that households may receive information about water scarcity and specific water-saving strategies (e.g., use of dual-flush toilets) to conserve water.

More importantly, the language of communication should be indigenous to the community. This is also reflected in the study where participants had expressed the difficulty of understanding the language of communication used by the municipality. Therefore, the use of indigenous language will promote a sense of inclusivity and shared social identity. This supports several experimental studies which show that communication that frames social identity with high levels of inclusive language helps to promote positive proclivities toward pro-environmental initiatives (Landon *et al.* 2018; Zhuang, Lapinski and Peng 2018). This may help explain why social normative groups, like family and friends, influence the participant's water conservation behaviour. Moreover, and as observed by Seyranian *et al.* (2015), inclusive language helps to define and characterise a particular social identity. In this regard, the family and friends may be engaged to help construct the value of inclusivity.

Equally useful, and as hinted by De Leeuw *et al.* (2015), it is important to know information about why protecting the environment is important and to develop necessary skills or knowledge about how to carry out pro-environmental behaviour.

In agreement with the aforementioned authors, participants indicated pro-environmental conservation importance of saving water such as reducing energy required to process and deliver water which could help in reducing pollution and in conserving fuel resources. Other notable pro-environmental suggestions mentioned include saving water for future recreational purposes. Bennett *et al.* (2017) claims that a better understanding of human or social dimensions of environmental issues will improve conservation. Moreover, it has become widely recognised that engaging with the human dimensions of conservation and environmental management is needed to produce robust and effective conservation policies, actions and outcomes (van Vliet and Kok 2015; Guerrero *et al.* 2018).

8.3.4 Economic incentive to conserve water

According to the suggestion of Bennett *et al.* (2017), conservation policy and practice can and should be guided by the best available information and adequate conceptual frameworks. While several theories and ideas on the best way to reduce water conservation have been proposed in the literature (Datta *et al.* 2015; Farley and Bremer 2017), the practicality of many of these theories may be elusive in the context of South Africa. For example, while water pricing and restriction have reportedly worked in other countries (Koop *et al.* 2015), this present study has exhaustively argued on its demerit in the LCH. From a historical context, and apart from further marginalizing the people, it will no doubt create a culture of unrest and conflicts.

Furthermore, as argued by Reddy *et al*. (2017), most of the proposed strategies in literature are restrictive since they do not encourage voluntary individual behavioural change. They are more of a demand-approach strategy. Given the drawbacks of some of these water conservation strategies, this study has proposed a community-based model through the use of incentives and nudging to influence individual behavioural change. According to Reddy *et al.* (2017), the primary approaches used to encourage conservation behaviour are organized into three categories namely: promoting awareness and concern; incentivising behaviour, and nudging behaviour.

While the use of awareness and incentives are premised on the theory of reasoning, nudging, on the other hand, relies primarily on intuition (Reddy *et al.* 2017).

Of particular interest to the eThekwini municipality, this study found that awareness alone may not adequately address behavioural change. Notably, while most

respondents are well aware of the country's water situation, their current behavior does not reflect this knowledge. This finding is consistent with previous studies (Schultz 2014; Schultz *et al*. 2015), which suggests that information on its own is not as successful in stimulating water conservation. Equally, while a majority of the respondents indicated interest in incentives like free airtime, a certain amount of electricity given free of charge, and municipality agreeing to write-off water debt (Figure 7-3), Frederiks, Stenner and Hobman (2015) warn that the use of such measures may only motivate behavioural change for those individuals who have the least to lose or most to gain. Moreover, and according to an early study by Gneezy, Meier and Rey-Biel (2011), low financial incentives maybe counter-productive, as this may invariably communicate to the water user that the behaviour is not valuable which could result in decreases in conservation. In addition, and in agreement with Allcott and Taubinsky (2015), incentives may also fail due to the fact that the water user is unaware of the potential benefits of saving water.

As is stated earlier in this study, and in line with other studies, nudging the community may be an ideal approach towards behavioural change. According to the seminal report of Thaler and Sunstein (2008), nudging makes little changes to the decision context without restricting choices or substantially changing economic incentives, thus promoting pro-conservation behaviour. As highlighted in their report, nudges work by making the desired behaviour easier, simpler, more engaging, or more intuitive. Schultz *et al.* (2011) observe that installing trash bins, for example, decreases littering by making disposing trash in the bin easier than littering waste. Interestingly, this study found that nearly all the respondents agreed that installing water harvesting facilities such as a JoJo water tank could influence positive water conservation behaviour.

Accordingly, and drawing from the above, it is sufficient to assume that the combination of theory of reasoning (awareness and incentives) and nudging could provide an effective intervention that can promote behaviour change in the LCH. This would not only influence positive behaviour but also will help residents use the amount of stipulated water as per FBWP guidelines. Significantly, the TRA was premised on changing water consumption through knowledge (education and communication), whereas the nudge was centred on the provision of a JoJo tank in place of water pipping in the area. This led to the departure for the next section to highlights the cost benefit exercise of installing JoJo tank in the area.

8.4 An indicative costing exercise

A suggestion which emerged from the nudge theory concept as applied in the study regarding how to promote water conservation in the low-income communities, was the installation of water tanks as an alternative to piped water. An indicative exercise was therefore carried out to evaluate and compare the cost and benefits associated with the installation of a water tank for a hypothesised low-cost housing area, consisting of 1 000 units, against the current practice of installed piping. Each household will be provided a 10*l* capacity water tank free of charge and it will be installed at the cost of the municipality. The municipality will fill each tank with the free water allocation on a monthly basis. If households need water above the allocation, they will need to purchase it from the municipality. Thus, there is an economic incentive for households to economise on water usage above the free allocation.

Table 8-1 indicates the estimated municipal capital costs (provision and installation of a water tank) and current cost (filling the tanks and other operational costs) at R17, 4 million. The benefits are in the form of saved costs, particularly that of installing piping systems and reduced water loss (through leaking pipes) and wastage (through excessive use). Apart from this, there are further benefits associated with saving the costs of water billing and meter installation as well as the cost of infrastructure maintenance. The cost of filling the tanks (and inclusive of operational costs) and the benefits is calculated on a per annum basis.

Table 8-1: Cost and benefit analysis for installing a water tank

Costs	Unit cost (Rands)	Total cost for 1000 household units (millions of Rands)
Cost of tank	12 285.00[1]	12.3
Cost of installation	3 000.00[2]	3,0
Cost of filling 10,000l tank and other operational costs	178.98[3]	2,1
Grand total		**17,4**

Benefits	Unit cost (Rands)	Total cost for 1000 household units (millions of Rands)
Saved cost of Installation of pipes	2 500.00[4]	5,0
Saved cost of water loss and wastage	750,00[5]	0,75
Saved cost of Infrastructure maintenance[5]	450,00[6]	0,45
Estimated cost of billing and meter reading	100,00[7]	1,0

Source

[1] Appendix 7

[2] Estimated by tank installer

[3] eThekwini Municipality 2019a

[4] eThekwini Municipality 2016

[5] Singh 2019

[6] eThekwini Municipality 2019b

[7] Estimated by researcher

From this exercise, it can be seen that provision of water tanks which are filled by the municipality according to the free water allocation may provide a feasible and financially positive alternative to a piped water supply.

8.5 Theoretical contribution of this study

Part of this study's aim was to develop a community-based model for water conservation in a low- cost housing setting within the eThekwini municipality. Studies suggest that by understanding psychological factors such as attitude, beliefs, and social norms, affecting water consumption, water bodies can apply more effective and workable water conservation strategies. This study was guided by the TRA and the nudge theory. While the TRA aids in understanding the influence of subject norms and attitudes in water conservation behaviour, the nudge theory, by contrast, gently encourages and or reshapes existing choices of water conservation methods available to the people by the government. As such, the theoretical contribution of this study proposes a behaviour change model by integrating the elements of both theories in order to develop a community-based model.

From the model proposed in this study, it was shown that the knowledge of water conservation, education, community engagement, and the use of incentives are critical in influencing behaviour change towards water conservation. In terms of knowledge, this study found that participants with lower education levels and low-income householders have better knowledge of water conservation practices. This implies that higher income earners, and educated participants had no time to practice effective water conservation measures. Hence, education through community engagement is proposed in this study. Areas of educational interest should focus on water leakages, consumption knowledge, and water sustainability.

Furthermore, incentives were highly recommended as a tool for behavioural change. Whilst efforts towards water conservation are more of a demand-approach strategy, it is assumed that the use of incentives and nudging may influence individual behavioural change. However, caution must be applied in the use of incentives to influence behaviour change. According to Frederiks *et al*. (2015) the use of such measures may only motivate behavioural change for those individuals who have the least to lose or most to gain. Besides, such measure may not be sustainable in the long term for the municipality given the high costs of data and electricity in the country.

Another recommendation arising from this study is nudging the community towards behavioural change. As noted by Thaler and Sunstein (2008), nudging makes little changes to the decision context without restricting choices or substantially changing economic incentives, thus promoting pro-conservation behaviour. In this context,

nudging can be achieved by the installation of water tanks in the community to monitor and minimize the consumption of water. It is acknowledged that the municipality would have to provide frequent refills of the tanks just as the city has an obligation to maintain the infrastructure so that homes can get a continuous supply.

Moreover, it is worth emphasising that the installation of water tanks doesn't negate the responsibility of the municipality in supplying water. However, the challenges caused by burst pipes can be minimized by this initiative to effectively monitor the water consumption in this area.

8.6 Summary

In summary, this chapter has developed a community-based model to reduce water consumption in the LCH. The study has found that awareness of the current water situation itself may not motivate good water use behaviour, which suggests that the knowledge deficit model may not be applicable in the community. As such, a combination approach of theory of reasoned action (awareness and incentives) together with nudging was proposed as a strategic intervention measure. The chapter suggests that residents will be willing to engage in water conservation if they are aware of their daily water consumption, and if some measure of the price mechanism is applied. The next chapter will provide the conclusion and recommendation drawn from the study.

Chapter 9: Conclusion and recommendations

This study aimed to develop a strategic intervention in the form of a behavioural model to assist the eThekwini municipality in its efforts to promote water conservation by recipients of FBWP. The Waterloo low-cost housing area was used as a setting for the study. A mixed method strategy using a two-phased approach was adopted. Data collection was done through semi-structured interviews, focus group discussions and questionnaires. Purposeful sampling was used to seek relevant information and advice from experts. Convenience sampling was used to gather information from inhabitants of the Waterloo low-cost housing area. This chapter concludes the study and draws on the discussion of the aforementioned techniques to provide recommendations and propose directions for future research.

9.1 Revisiting the study objectives

The study's three objectives and associated findings can now be revisited:

Objective 1: To compare the South African approach to water resource management with Brazil, Singapore, Australia and India.

Objective 1 has been met. The study found that South Africa may be limited, compared to other selected countries, in terms of innovative approaches towards effective water management and conservation measures in regard to future water demand. Preliminary data, derived from the literature review, was presented in Chapter 2. It served as a means to examine whether South Africa can adopt ideas and strategies from similar water-stressed countries with related water resource problems in an effort to develop its existing methods and practices based on their experiences. This objective has been achieved in this study.

Objective 2: To determine the factors that influence water-use behaviour in low-cost housing areas by:

- **Examining inhabitant's knowledge towards water conservation**
- **Determining inhabitant's levels of attitude towards water conservation.**

This objective has been met. Semi-structured interviews were conducted with the area councillors, community leaders, academia, and eThekwini representatives.

The interviews highlighted the challenges surrounding interaction between individuals, communities and the municipality at a local level. By understanding the reasons that influence the demand for water in poor communities, community consciousness about their water situation and their willingness to use it more consciously, one can begin to develop the appropriate strategies for implementing rational use of water for this part of the population.

Significantly, the focus group discussions stressed the need for more engagement and dialogue between all stakeholders involved in water management in LCH areas. More importantly, such an engagement will help communities to feel part of the solution as a way forward in helping them use water within the amounts stipulated in FBWP. Therefore, this objective of the study has been met.

Significantly, the survey conducted in this study pointed to a negative gap between knowledge and behaviour towards water conservation. While the knowledge of water conservation is mainly influenced by the respondent's level of education, their behaviour by contrast, appears to be influenced by their race, age, education, household income and employment level. To support this conclusion, the findings showed subjective norms and attitude are predictors of the intention to conserve water.

> **Objective 3: To develop a behavioural method towards water conservation and preservation in low-cost housing areas by applying the Nudge theory and the Theory of reasoned action as a foundation to identify ways to reducing water consumption.**

This objective has been met. This study developed a community-based behavioural model for water conservation in LCH areas which recognises the value of using incentives as a nudging tool. The proposed framework offers guidelines on the best approach the municipality could adopt in reducing wastages and decreasing future loss of revenue.

Overall, this study showed that water authorities responsible for water management policies within low-cost housing areas in the eThekwini municipality, need to establish the appropriate communication strategies aimed at changing behaviour in water usage, focus on changing water user attitudes, as well as pay attention to factors emanating from the social environment.

The community-based behavioural model developed in this study identifies factors such as education and community engagement on water consumption, pricing and the importance of water conservation for economic and social development. More so, an important aspect of the proposed model provides for the use of incentives as nudging tools. It can therefore be argued that the study has achieved all of its objectives as set out in Chapter 1 section 1.4, namely:

1. To compare the South African approach to water resource management with Brazil, Singapore, Australia and India.
2. To determine the factors that influence water-use behaviour in low-cost housing areas by:
    - Examining inhabitant's knowledge towards water conservation
    - Determining inhabitant's levels of attitude towards water conservation.
3. To develop a behavioural method towards water conservation and preservation in low-cost housing areas by applying the Nudge Theory and the Theory of reasoned action as a foundation to identify ways to reducing water consumption.

9.2 Recommendations

South Africa does not have a framework in place for the regulation and monitoring of water conservation behaviour in LCH areas. The model proposed in this study (Figure 8.1) addresses this limitation and can be adopted for any LCH area within the country. In addition, the community-based water conservation behavioural model in LCH areas may potentially lay a sound foundation for common demand-management approaches in the developed world, such as marketing and awareness initiatives that, if implemented effectively, can help reduce overall domestic water demands. Therefore, the following recommendations are made:

- There should be school and community-based educational programmes to teach:
    a. Water-pricing
    b. Water conservation practices
    c. Meter-reading
- Water authorities should consider allocating the stipulated amounts of free water into installed water tanks mounted onto the property to curb any excess

usage. In light of this recommendation, the fact that a majority of the respondents identified water tanks as an ideal incentive, supports this recommendation. A cost analysis found that such a measure is also more economical in the long-term than the current piping infrastructure.

Significantly, this research is further relevant in the midst of the COVID-19 global outbreak which demonstrates the importance of water supply and its efficient usage. The application of the Nudge theory to mitigate COVID-19 has been hindered by several non-behavioural barriers namely the limited availability of water and soap for efficient hygiene practices.

References

Abansi, C. L., Hall, R. A. and Siason, I. M. 2018. Water demand management and improving access to water. In: *Water Policy in the Philippines*. New York: Springer, 233-259.

Abell, R., Vigerstol, K., Higgins, J., Kang, S., Karres, N., Lehner, B., Sridhar, A. and Chapin, E. 2019. Freshwater biodiversity conservation through source water protection: quantifying the potential and addressing the challenges. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 29 (7): 1022-1038.

Abu-Mahfouz, A. M., Hamam, Y., Page, P. R., Adedeji, K. B., Anele, A. O. and Todini, E. 2019. Real-time dynamic hydraulic model of water distribution networks. *Water*, 11 (3): 470.

ActionAid South Africa. 2016. *Severe drought in South Africa* (online). Available: https://www.actionaidusa.org/work/severe-drought-southern-africa/ (Accessed 15 July 2019).

Adams, E.A. and Zulu, L.C. 2015. Participants or customers in water governance? Community-public partnerships for peri-urban water supply. *Geoforum*, 65: 112-124.

Adams, E.A., Sambu, D. and Smiley, S.L. 2019. Urban water supply in Sub-Saharan Africa: historical and emerging policies and institutional arrangements. *International Journal of Water Resources Development*, 35 (2): 240-263.

Addo, I. B., Thoms, M. C. and Parsons, M. 2019. The influence of water-conservation messages on reducing household water use. *Applied Water Science*, 9 (5): 126.

Addo, I.B., Thoms, M.C. and Parsons, M. 2018. Household water use and conservation behavior: A meta-analysis. *Water Resources Research*, 54 (10): 8381-8400.

Agarwal, R. and Goyal, D. 2017. Water: the elixir of life in Ayurveda. *Environment Conservation Journal*, 18 (1/2): 75-78.

Agri SA. 2016. A raindrop in the drought (online). Available: http://www.nstf.org.za/wp-content/uploads/2016/06/Agri-SA-Drought-Report_CS4.pdf (Accessed 27 August 2018).

Ahluwalia, I. J. 2016. Challenges of urbanisation in India. In: *Contemporary issues in development economics*. Springer, 163-177.

Ahn, J. and Back, K.J. 2018. Influence of brand relationship on customer attitude toward integrated resort brands: a cognitive, affective, and conative perspective. *Journal of Travel & Tourism Marketing*, 35(4): 449-460.

Ajzen, I. 2012. Martin Fishbein's legacy: The reasoned action approach. *The Annals of the American Academy of Political and Social Science*, *640*(1): 11-27.

Ajzen, I. 2015. The theory of planned behaviour is alive and well, and not ready to retire: a commentary on Sniehotta, Presseau, and Araújo-Soares. *Health psychology review*, 9 (2): 131-137.

Akhmouch, A. and Clavreul, D. 2016. Stakeholder engagement for inclusive water governance: "Practicing what we preach" with the OECD water governance initiative. *Water*, 8 (5): 1-17.

Al Mamun, A., Mohamad, M. R., Yaacob, M. R. B. and Mohiuddin, M. 2018. Intention and behavior towards green consumption among low-income households. *Journal of Environmental Management*, 227: 73-86.

Albarracín, D., Kumkale, G.T. and Poyner-Del Vento, P. 2017. How people can become persuaded by weak messages presented by credible communicators: not all sleeper effects are created equal. *Journal of Experimental Social Psychology*, 68: 171-180.

Alegre, H., Baptista, J. M., Cabrera Jr, E., Cubillo, F., Duarte, P., Hirner, W., Merkel, W. and Parena, R. 2016. *Performance indicators for water supply services*. IWA publishing.

Alexander, L. V. and Arblaster, J. M. 2017. Historical and projected trends in temperature and precipitation extremes in Australia in observations and CMIP5. *Weather and Climate Extremes*, 15: 34-56.

Alexandra, J. 2018. Evolving governance and contested water reforms in Australia's Murray Darling Basin. *Water*, 10(2):113.

Aliyu, A. K., Modu, B. and Tan, C. W. 2018. A review of renewable energy development in Africa: a focus in South Africa, Egypt and Nigeria. *Renewable and Sustainable Energy Reviews*, 81: 2502-2518.

Allcott, H. and Taubinsky, D. 2015. Evaluating behaviorally motivated policy: experimental evidence from the lightbulb market. *American Economic Review*, 105 (8): 2501-2538.

Allen, A., Dávila, J. D. and Hofmann, P. 2006. The peri-urban water poor: citizens or consumers? *Environment and Urbanization*, 18 (2): 333-351.

Allouche, J. 2016. The birth and spread of IWRM-A case study of global policy diffusion and translation. *Water Alternatives*, 9 (3): 412.

Almagro, A., Oliveira, P. T. S., Nearing, M. A. and Hagemann, S. 2017. Projected climate change impacts in rainfall erosivity over Brazil. *Scientific reports*, 7 (1): 1-12.

Al-Saidi, M. 2017. Conflicts and security in integrated water resources management. *Environmental Science & Policy*, 73: 38-44.

Al-Washali, T. M., Sharma, S. K. and Kennedy, M. D. 2018. Alternative method for nonrevenue water component assessment. *J. Water Resoure Planning Management*, 144 (5): 04018017.

Alzahrani, K., Hall-Phillips, A. and Zeng, A. Z. 2019. Applying the theory of reasoned action to understanding consumers' intention to adopt hybrid electric vehicles in Saudi Arabia. *Transportation*, 46 (1): 199-215.

Amrose, S., Burt, Z. and Ray, I. 2015. Safe drinking water for low-income regions. *Annual Review of Environment and Resources*, 40: 203-231.

Amy, G., Ghaffour, N., Li, Z., Francis, L., Linares, R. V., Missimer, T. and Lattemann, S. 2017. Membrane-based seawater desalination: present and future prospects. *Desalination*, 401: 16-21.

Andrews, J.C. and Shimp, T.A. 2017. *Advertising, promotion, and other aspects of integrated marketing communications*. Nelson Education. UK: Cengage Learning Ltd.

Antwi, E. K., Boakye-Danquah, J., Gyekye, K. A., Barimah, A. O., Botchwey, I. and Ametepe, R. 2018. Examining farm management practices and implications for food crop

production in semi-arid Ghana. In: *Strategies for building resilience against climate and ecosystem changes in Sub-Saharan Africa*. Springer, 265-289.

Aprile, M. C. and Fiorillo, D. 2017. Water conservation behavior and environmental concerns: evidence from a representative sample of Italian individuals. *Journal of Cleaner Production*, 159: 119-129.

Arain, M., Campbell, M. J., Cooper, C. L. and Lancaster, G. A. 2010. What is a pilot or feasibility study? A review of current practice and editorial policy. *BMC medical research methodology*, 10(1): 67. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2912920/ (Accessed 15 June 2018)

Araral, E. and Wu, X. 2016. Comparing water resources management in China and India: policy design, institutional structure and governance. *Water Policy*, 18 (S1): 1-13.

Arfanuzzaman, M. and Rahman, A.A. 2017. Sustainable water demand management in the face of rapid urbanization and ground water depletion for social–ecological resilience building. *Global Ecology and Conservation*, 10: 9-22.

Argent, R. M., Smith, A. B. and Dharssi, I. 2016. Water resources implications of near-real time national soil moisture assessment. In: Proceedings of *37th Hydrology & Water Resources Symposium 2016: Water, Infrastructure and the Environment*. Engineers Australia, 525.

Armenia, S., Carvalho, H., Franco, E.F., Medaglia, C.M., Nonino, F., Pompei, A. and Dos Santos, J.R. 2018. Understanding the root causes of water scarcity through system dynamics: the Italian case of the Bracciano Lake. *Cocreating responsible futures in the digital age: Exploring New Paths towards Economic*, 79.

Arno, A. and Thomas, S. 2016. The efficacy of nudge theory strategies in influencing adult dietary behaviour: a systematic review and meta-analysis. *BMC Public Health* 16**:** 1-11.

Aronson, J. 1995. A pragmatic view of thematic analysis. *The qualitative report*, 2 (1): 1-3.

Arora, M., Raspall, F., Cheah, L. and Silva, A. 2019. Residential building material stocks and component-level circularity: the case of Singapore. *Journal of cleaner production*, 216: 239-248.

Arsham, H. 2005. Algorithms for sensitivity information in discrete-event systems simulation. *Simulation Practice and Theory*, 6 (1): 1-22.

Ashoori, N., Dzombak, D. A. and Small, M. J. 2016. Modeling the effects of conservation, demographics, price, and climate on urban water demand in Los Angeles, California. *Water Resources Management*, 30 (14): 5247-5262.

Ateş, A.E. and Dursun, R. 2019. A Study on Improving Water Saving Awareness among Primary School Students. *International Journal of Environmental Research and Technology*, 2 (2): 27-29.

Attari, S. Z., Poinsatte-Jones, K. and Hinton, K. 2017. Perceptions of water systems. *Judgment and Decision Making*, 12 (3): 314.

Awareness campaign to reduce water loss in city. 2017. Available: http://www.durban.gov.za/Resource_Centre/Press_Releases/Pages/Awareness-Campaign-to-Reduce-Water-Loss-in-the-City.aspx (Accessed 29 August 2018).

Aziz, S., Husin, M. and Hussin, N. 2017. Intention to family Takaful adoption: a review theory and empirical work. *International Journal of Organizational Leadership*, 6: 373-384.

Aziz, S., Husin, M. and Hussin, N. 2017. Intention to family Takaful adoption: A review theory and empirical work. *International Journal of Organizational Leadership*, 6: 373-384.

Azzara, C.V. 2010. *Questionnaire design for business research: beyond linear thinking-an interactive approach*. London: Tate Publishing.

Babar Hassan, M. S., Nadeem, M. A., Hassan, I., Muneer, M. A. and Rasheed, M. R. 2018. Efficacy of pesticide seed treatments against wheat aphid and its effect on coccinellid predator and crop yield.

Babbie, E. 1998. *The practice of social research.* New York: Wadsworth.

Babbie, E. and Mouton, J. 2001. *The practice of social science research*. Belmont, CA: Wadsworth.

Babbie, E. and Mouton, J. 2006. Content analysis. In: *The practice of social research.* Cape Town: Oxford Press, 304-15.

Baddeley, M. 2018. *Behavioural economics and finance*. New York: Routledge.

Bakker, K. 2013. Constructing 'public'water: the World Bank, urban water supply, and the biopolitics of development. *Environment and Planning D: Society and Space*, 31 (2): 280-300.

Balooni, K. and Venkatachalam, L. 2016. Managing water for sustainable development: An Indian perspective. *IIM Kozhikode Society & Management Review*, 5 (1): 7-13.

Banister, P., Burman, E., Parker, I., Taylor, M. and Tindall, C. 1994. *Quality methods in Psychology.* London: Buckingham: Open University Press.

Barata, R., Castro, P. and Martins-Loução, M. A. 2017. How to promote conservation behaviours: the combined role of environmental education and commitment. *Environmental Education Research*, 23 (9): 1322-1334.

Barbosa, A. and Brusca, I. 2015. Governance structures and their impact on tariff levels of Brazilian water and sanitation corporations. *Utilities Policy*, 34: 94-105.

Barbosa, M. C., Alam, K. and Mushtaq, S. 2016. Water policy implementation in the state of São Paulo, Brazil: key challenges and opportunities. *Environmental Science & Policy*, 60: 11-18.

Barbosa, M. C., Mushtaq, S. and Alam, K. 2017. Integrated water resources management: are river basin committees in Brazil enabling effective stakeholder interaction? *Environmental Science & Policy*, 76: 1-11.

Barlow, M. and Clarke, T. 2017. *Blue gold: the battle against corporate theft of the world's water*. London: Routledge.

Barnhardt, R. and Oscar Kawagley, A. 2005. Indigenous knowledge systems and Alaska native ways of knowing. *Anthropology & education quarterly*, 36 (1): 8-23.

Bassi, N. 2016. Groundwater depletion in India: potential of alternative approaches and policy instruments. In: Narain, V and Narayanamoorthy, A. *Indian Water Policy at the Crossroads: Resources, Technology and Reforms*. Switzerland: Springer, 35-48.

Baumgartner, T. and Pahl-Wostl, C. 2013. UN–Water and its role in global water governance. *Ecology and Society*, 18(3): 1-17.

Beal, C., Makki, A. and Stewart, R. 2012. Identifying the drivers of water consumption: a summary of results from the South East Queensland residential end use study. In: Proceedings of *Science Forum and Stakeholder Engagement: Building Linkages, Collaboration and Science Quality*. 19-20.

Beal, C.D., Gurung, T.R. and Stewart, R.A. 2016. Demand-side management for supply-side efficiency: modeling tailored strategies for reducing peak residential water demand. *Sustainable Production and Consumption*, 6: 1-11.

Beck, T. L., Rodina, E., Luker, L. and Harris, L. 2016. Institutional and policy mapping of the water sector in South Africa. Vancouver, Canada: Program on Water Governance and University of British Columbia. Available: https://open.library.ubc.ca/cIRcle/collections/facultyresearchandpublications/52383/items/1.0366056 (Accessed 12 May 2019).

Benartzi, S., Beshears, J., Milkman, K. L., Sunstein, C. R., Thaler, R. H., Shankar, M., Tucker-Ray, W., Congdon, W. J. and Galing, S. 2017. Should governments invest more in nudging? *Psychological Science*, 28 (8): 1041-1055.

Béné, C., Barange, M., Subasinghe, R., Pinstrup-Andersen, P., Merino, G., Hemre, G.I. and Williams, M. 2015. Feeding 9 billion by 2050–putting fish back on the menu. *Food Security*, 7 (2): 261-274.

Bennett, N. J., Roth, R., Klain, S. C., Chan, K., Christie, P., Clark, D. A., Cullman, G., Curran, D., Durbin, T. J. and Epstein, G. 2017. Conservation social science: understanding and integrating human dimensions to improve conservation. *Biological Conservation*, 205: 93-108.

Benson, D., Gain, A. K. and Rouillard, J. J. 2015. Water governance in a comparative perspective: From IWRM to a'nexus' approach? *Water Alternatives*, 8 (1): 756-773.

Bhaduri, A., Bogardi, J., Siddiqi, A., Voigt, H., Vörösmarty, C., Pahl-Wostl, C., Bunn, S. E., Shrivastava, P., Lawford, R. and Foster, S. 2016. Achieving sustainable development goals from a water perspective. *Frontiers in Environmental Science*, 64 (4) 1-13.

Bhagwan, J., Wegelin, W. and Siqalaba, Z. 2013. Benchmarking of non-revenue water: experiences from South Africa. *Benchmarking* (online), Available: http://www.wrp.co.za/about/articles /benchmarking-non-revenue-waterexperiences-south-africa (Accessed 28 February 2018).

Bharathi, H., Manjappa, S., Suresh, T. and Suresh, B. 2016. Evaluation of water quality index of water bodies Channarayapatna taluk, Karnataka region, India. *International Journal of Applied Sciences and Biotechnology*, 4 (4): 475-482.

Bhargava, S. and Loewenstein, G. 2015. Behavioral economics and public policy 102: Beyond nudging. *American Economic Review*, 105 (5): 396-401.

Bhat, S. A., Zahid, A. T., Sheikh, B. A. and Parrey, S. H. 2017. Environmental education in India: An approach to sustainable development. *FIIB Business Review*, 6 (1): 14-21.

Bhave, A.G., Conway, D., Dessai, S. and Stainforth, D.A. 2018. Water resource planning under future climate and socioeconomic uncertainty in the Cauvery River Basin in Karnataka, India. *Water resources research*, 54 (2): 708-728.

Biggs, E. M., Bruce, E., Boruff, B., Duncan, J. M., Horsley, J., Pauli, N., McNeill, K., Neef, A., Van Ogtrop, F. and Curnow, J. 2015. Sustainable development and the water–energy–food nexus: a perspective on livelihoods. *Environmental Science & Policy*, 54: 389-397.

Birhanu, B. Z. and Tabo, R. 2016. Shallow wells, the untapped resource with a potential to improve agriculture and food security in southern Mali. *Agriculture & Food Security*, 5 (1): 1-13.

Black, M. 2016. *The atlas of water: mapping the world's most critical resource*. California: Univ. of California Press.

Blackstone, A. 2018. Principles of sociological inquiry: qualitative and quantitative methods. Available: https://openlibrary-repo.ecampusontario.ca/xmlui/bitstream/handle/123456789/296/Principles%20of%20Sociological%20Inquiry.pdf?sequence=1&isAllowed=y (Accessed 14 June 2019).

Blanche, M.T., Blanche, M.J.T., Durrheim, K. and Painter, D. eds. 2006. *Research in practice: applied methods for the social sciences*. Durban: Juta and Company Ltd.

Bond, P. 2017. 10 South African commoning of medicines and water beyond human rights rhetoric. In: Westra, R., Albritton. R. and Jeong. S. eds. *Varieties of Alternative Economic Systems: Practical Utopias for an Age of Global Crisis and Austerity.* United Kingdom: Taylor and Francis, 157-180

Boulay, A.M., Bare, J., De Camillis, C., Döll, P., Gassert, F., Gerten, D., Humbert, S., Inaba, A., Itsubo, N., Lemoine, Y. and Margni, M. 2015. Consensus building on the development of a stress-based indicator for LCA-based impact assessment of water consumption: outcome of the expert workshops. *The International Journal of Life Cycle Assessment*, 20 (5): 577-583.

Brace, I. 2018. *Questionnaire design: how to plan, structure and write survey material for effective market research*. London: Kogan page publishers.

Bradshaw, C., Atkinson, S. and Doody, O. 2017. Employing a qualitative description approach in health care research. *Global qualitative nursing research*, 4: 2333393617742282.

Brannen, J., 2017. Combining qualitative and quantitative approaches: an overview. In: *Mixing methods: Qualitative and quantitative research.* New York: Routledge, 3-37.

Brauman, K.A., Richter, B.D., Postel, S., Malsy, M. and Flörke, M. 2016. Water depletion: an improved metric for incorporating seasonal and dry-year water scarcity into water risk assessments. *Elem Sci Anth*, 4: 1-12.

Breach, P. A. and Simonovic, S. P. 2018. Wastewater treatment energy recovery potential for adaptation to global change: an integrated assessment. *Environmental Management*, 61 (4): 624-636.

Brears, R. C. 2016. *Urban water security*. John Wiley & Sons.

Brick, K., De Martino, S. and Visser, M. 2018. *Behavioural nudges for water conservation: experimental evidence from Cape Town* (online). Available: https://efdinitiative.org/sites/default/files/epru_water_study.pdf (Accessed 21 February 2021).

Broers, V. J., De Breucker, C., Van den Broucke, S. and Luminet, O. 2017. A systematic review and meta-analysis of the effectiveness of nudging to increase fruit and vegetable choice. *The European Journal of Public Health*, 27 (5): 912-920.

Brown, A. and Matlock, M.D. 2017. A review of water scarcity indices and methodologies (online). Available: https://efdinitiative.org/sites/default/files/epru_water_study.pdf (Accessed 3 March 2021).

Brown, J. D. 2015. Statistics Corner. Questions and answers about language testing statistics. Characteristics of sound quantitative research. *Shiken research bulletin*, 19 (2): 24-28.

Browne, A.L., Jack, T. and Hitchings, R. 2019. 'Already existing'sustainability experiments: Lessons on water demand, cleanliness practices and climate adaptation from the UK camping music festival. *Geoforum*, 103: 16-25.

Bryman, A., 2016. *Social research methods*. 5th ed. Oxford: Oxford university press.

Budds, J. and McGranahan, G. 2003. Are the debates on water privatization missing the point? Experiences from Africa, Asia and Latin America. *Environment and urbanization*, 15 (2): 87-114.

Butler, A. 2017. *Contemporary South Africa*. United Kingdom: McMillan Education.

Butterworth, J., Warner, J., Moriarty, P., Smits, S. and Batchelor, C. 2010. Finding practical approaches to integrated water resources management. *Water alternatives*, 3 (1): 68-81.

Bwapwa, J. K. 2018. Review on main issues causing deterioration of water quality and water scarcity: case study of South Africa. *Environmental Management and Sustainable Development*, 7 (3): 14-34.

Byrnes, J. 2013. A short institutional and regulatory history of the Australian urban water sector. *Utilities Policy*, 24: 11-19.

Cabinet Office (2012) Applying behavioural insights to reduce fraud, error and debt. London: Cabinet Office. (Online). Available:

Camos, D., Bacon, R., Estache, A. and Mahgoub Hamid, M. 2017. *Shedding light on electricity utilities in the Middle East and North Africa: Insights from a performance diagnostic*. Washington: The World Bank.

Campisano, A., Butler, D., Ward, S., Burns, M. J., Friedler, E., DeBusk, K., Fisher-Jeffes, L. N., Ghisi, E., Rahman, A. and Furumai, H. 2017. Urban rainwater harvesting systems: research, implementation and future perspectives. *Water Research*, 115: 195-209.

Carrao, H., Naumann, G. and Barbosa, P. 2016. Mapping global patterns of drought risk: an empirical framework based on sub-national estimates of hazard, exposure and vulnerability. *Global Environmental Change*, 39: 108-124.

Chakraborti, T. and Chakraborty, M. 2018. Water-sharing saga between Singapore and Malaysia: a historical discord revisited. *Asian Politics & Policy*, 10 (1): 36-55.

Chang, G. 2013. Factors influencing water conservation behavior among urban residents in China's arid areas. *Water policy*, 15 (5): 691-704.

Chatterji, M., Arlosoroff, S. and Guha, G. 2017. *Conflict management of water resources*. 1st ed. London: Routledge.

Check, J. and Schutt, R. K. 2012. Survey research. In: *Research methods in education.* London: Sage, 159-185.

Cheeseman, J. 2016. Food security in the face of salinity, drought, climate change, and population growth. In: *Halophytes for food security in dry lands*. Cambridge: Academic Press, 111-123.

Chern, L. 2017. Nudging towards social change: the application of psychology and behavioral economics in promoting responsible consumption. Senior thesis, Claremont McKenna College.

Chikozho, C., Danga, L. and Saruchera, D. 2017. Articulating the history and major departure points evident in post-apartheid South African national water policy and law. *Physics and Chemistry of the Earth, Parts A/B/C*, 100: 270-277.

Chowns, E. 2015. Is community management an efficient and effective model of public service delivery? Lessons from the rural water supply sector in Malawi. *Public Administration and Development*, 35 (4): 263-276

Chuah, C. J., Ho, B. H. and Chow, W. T. 2018. Trans-boundary variations of urban drought vulnerability and its impact on water resource management in Singapore and Johor, Malaysia. *Environmental Research Letters*, 13 (7): e074011.

Chuma, W., Bosch, T. and Wasserman, H., 2017. The media, civil society and democracy in South Africa: state of the Nation Address 2015. *Communicatio*, 43 (2): 93-108.

Chung, A. and Rimal, R.N. 2016. Social norms: A review. *Review of Communication Research*, 4: 1-28.

Clark, C. 2016. Trans-jurisdictional water governance and implementing the human right to water in South Africa. In *Trans-jurisdictional Water Law and Governance.* London: Routledge, 294-312.

Closas, A., Schuring, M. and Rodriguez, D. 2012. *Integrated urban water management: lessons and recommendations from regional experiences in Latin America, Central Asia, and Africa* (No. 75043). The World Bank (online). Available: http://documents.worldbank.org/curated/en/999601468276884552/pdf/750430WPS0Box30Africa0high00PUBLIC0.pdf (Accessed 25 February 2020).

Cohen, D. A. 2016. The rationed city: The politics of water, housing, and land use in drought-parched São Paulo. *Public Culture*, 28 (2 (79)): 261-289.

Cohen, D. and Crabtree, B. 2008. *Semi-structured interviews. Qualitative research guidelines project* (online). Available: http//www.qualres.org/HomeSemi-3629.html (Accessed 15 January 2019).

Cohen, L., Manion, L., Morrison, K. and Morrison, R.B. 2007. *Research methods in education.* New York: Routledge.

Collins, S. M., Mbullo Owuor, P., Miller, J. D., Boateng, G. O., Wekesa, P., Onono, M. and Young, S. L. 2019. 'I know how stressful it is to lack water!'Exploring the lived experiences of household water insecurity among pregnant and postpartum women in western Kenya. *Global public health*, 14 (5): 649-662.

Collis, J. and Hussey, R. 2009. Business research: a practical guide for undergraduate and postgraduate students. 3rd ed. United Kingdom: Palgrave Macmillan.

Cominola, A., Giuliani, M., Piga, D., Castelletti, A. and Rizzoli, A.E. 2015. Benefits and challenges of using smart meters for advancing residential water demand modeling and management: A review. *Environmental Modelling & Software*, 72: 198-214.

Connor, R. 2015. *The United Nations world water development report 2015: water for a sustainable world*. UNESCO publishing.

Cook, H. F. 2017. *The protection and conservation of water resources*. Wiley Online Library.

Cookey, P. E., Darnsawasdi, R. and Ratanachai, C. 2016. Critical analysis of water governance challenges of Songkhla Lake Basin, Thailand. *Lakes & Reservoirs: Research & Management*, 21 (4): 293-314.

Cooper, E. J. 2017. To nudge or not to nudge: promoting environmentally beneficial behaviours. Senior thesis, Bard College.

Cosgrove, W.J. and Loucks, D.P. 2015. Water management: current and future challenges and research directions. *Water Resources Research*, 51 (6): 4823-4839.

Couzens, E. 2015. Avoiding Mazibuko: Water security and constitutional rights in Southern African case law. *Potchefstroom Electronic Law Journal/Potchefstroomse Elektroniese Regsblad*, 18 (4): 1162-1186.

Creswell, J.W. 2008. *Planning, conducting, and evaluating quantitative and qualitative research.* 4th ed. Boston: Pearson.

Creswell, J.W. 2009. *Research design: Qualitative, quantitative and mixed methods Approaches*. 3rd ed. London: SAGE Publications.

Creswell, J.W. 2009. *Research design: Qualitative and mixed methods approaches*. London and Thousand Oaks: Sage Publications.

Creswell, J. W. 2013. *Qualitative inquiry and research design*. 3rd ed. California: SAGE Publications.

Creswell, J. W. and Plano-Clark, V. L. 2011. *Designing and conducting mixed methods research*. 2nd ed. California: Sage publications.

Creswell, J.W. and Creswell, J.D. 2017. *Research design: qualitative, quantitative, and mixed methods approaches*. London: Sage publications.

Creswell, J.W., Plano Clark, V.L., Gutmann, M.L. and Hanson, W.E., 2003. Advanced mixed methods research designs. *Handbook of mixed methods in social and behavioral research*, 209: 240.

Cronin, A. A., Prakash, A., Priya, S. and Coates, S. 2014. Water in India: situation and prospects. *Water Policy*, 16 (3): 425-441.

Crow-Miller, B., Webber, M. and Molle, F. 2017. The (re) turn to infrastructure for water management? Online. Available: http://www.water-alternatives.org/index.php/alldoc/articles/vol10/v10issue2/351-a10-2-1/file (Accessed 19 May 2018).

Dabelko, G. D. and Parker, M. 2018. Afterword: From backdraft to boomerang. In: *Water, Climate Change and the Boomerang Effect*. Routledge, 180-183.

Dalin, C., Wada, Y., Kastner, T. and Puma, M.J. 2017. Groundwater depletion embedded in international food trade. *Nature*, 543 (7647): 700.

Damkjaer, S. and Taylor, R. 2017. The measurement of water scarcity: defining a meaningful indicator. *Ambio*, 46 (5): 513-531.

Datta, S., Miranda, J. J., Zoratto, L., Calvo-González, O., Darling, M. and Lorenzana, K. 2015. *A behavioral approach to water conservation: evidence from Costa Rica*. the World Bank. Online. Available: https://openknowledge.worldbank.org/bitstream/handle/10986/22156/A0behavioral0a0ence0from0Costa0Rica.pdf?sequence=1 (Accessed 21 January 2020).

Datta, S., Miranda, J. J., Zoratto, L., Calvo-González, O., Darling, M. and Lorenzana, K. 2015. *A behavioral approach to water conservation: evidence from Costa Rica*. Washington: The World Bank.

Davies, T.E., Pettorelli, N., Creswell, W. and Fazey, I.R. 2014. Who are the poor? measuring wealth inequality to aid understanding of socioeconomic contexts for conservation: a case-study from the Solomon Islands. *Environmental conservation*, 41 (4): 357-366.

De Leeuw, A., Valois, P., Ajzen, I. and Schmidt, P. 2015. Using the theory of planned behavior to identify key beliefs underlying pro-environmental behavior in high-school students: Implications for educational interventions. *Journal of environmental psychology*, 42: 128-138.

De Vaus, D. and de Vaus, D. 2013. *Surveys in social research*. London: Routledge.

De Vos, A. S. 2005. *Scientific theory and professional research*. In: De Vos, A. ed. *Research at Grassroots: For the Social Sciences and Human Service Professions.* 3rd ed. Pretoria: Van Schaik.

Dean, A. J., Fielding, K. S. and Newton, F. J. 2016. Community knowledge about water: who has better knowledge and is this associated with water-related behaviors and support for water-related policies? *PloS one*, 11 (7): 1-18.

del Saz-Salazar, S., García-Rubio, M.A., González-Gómez, F. and Picazo-Tadeo, A.J. 2016. Managing water resources under conditions of scarcity: on consumers' willingness to pay for improving water supply infrastructure. *Water resources management*, 30 (5): 723-1738.

DeNicola, E., Aburizaiza, O.S., Siddique, A., Khwaja, H. and Carpenter, D.O. 2015. Climate change and water scarcity: the case of Saudi Arabia. *Annals of global health*, 81 (3): 342-353.

Denscombe, M. 2012. *Research proposals: A practical guide: a practical guide*. United Kingdom: McGraw-Hill Education.

Department of Water and Sanitation. 2018. (online) Available:https://www.dws.gov.za/National%20Water%20and%20Sanitation%20Mas

ter%20Plan/Documents/Volume%201%20(Printed%20version%20).pdf (Accessed 15 February 2021).

Development, U. N. C. o. E. 1992. *The Dublin statement on water and sustainable development*: UNCED Rio de Janeiro. (online). Available: http://www.wmo.int/pages/prog/hwrp/documents/english/icwedece.html (Acceessed12 August 2019).

Diamond, R.E. and Jack, S. 2018. Evaporation and abstraction determined from stable isotopes during normal flow on the Gariep River, South Africa. *Journal of hydrology*, 559: 569-584.

Dianoux, C., Heitz-Spahn, S., Siadou-Martin, B., Thevenot, G. and Yildiz, H., 2019. Nudge: A relevant communication tool adapted for agile innovation. *Journal of Innovation Economics Management*, (1): 7-27.

Dieu-Hang, T., Grafton, R. Q., Martínez-Espiñeira, R. and Garcia-Valiñas, M. 2017. Household adoption of energy and water-efficient appliances: an analysis of attitudes, labelling and complementary green behaviours in selected OECD countries. *Journal of Environmental Management*, 197: 140-150.

Dilling, L., Daly, M.E., Kenney, D.A., Klein, R., Miller, K., Ray, A.J., Travis, W.R. and Wilhelmi, O. 2018. Drought in urban water systems: learning lessons for climate adaptive capacity. *Climate Risk Manag*. 23: 32–42.

Dillon, P. and Arshad, M. 2016. Managed aquifer recharge in integrated water resource management. In: *Integrated groundwater management*. Springer, Cham, 435-452.

Dongallo Jr, J.O., Picardo, R.L., Bacarisas, J.P. and Napoles, J.C., 2017. Assessing cognition, health behaviour, reasoned action, and planned behaviour on HIV/AIDS among openly homosexual men. *University of the Visayas-Journal of Research*, 11 (1): 19-30.

Donnenfeld, Z., Crookes, C. and Hedden, S. 2018. A delicate balance: water scarcity in South Africa. *ISS Southern Africa Report*, 2018 (13): 1-24.

Dörnyei, Z. 2007. *Research methods in applied linguistics*. Oxford: Oxford University Press

Dotse, L. N. A. 2016. Exploring the relationship between water scarcity on food and nutritional security in rural households in the Nqgeleni location, Eastern Cape. PhD thesis, University of Witwatersrand.

Dow, K. and Downing, T. E. 2016. *The atlas of climate change: mapping the world's greatest challenge*. Univ of California Press.

Du Plessis, A. 2017. South Africa's water availability and use. In: *Freshwater Challenges of South Africa and its Upper Vaal River*. New York: Springer, 65-76.

Du Plessis, A. 2019. Current and future water scarcity and stress. In: *Water as an Inescapable Risk.* New York*:* Springer, 13-25.

Du Toit, J., Wagner, C. and Fletcher, L. 2017. Socio-spatial factors affecting household recycling in townhouses in Pretoria, South Africa. *Sustainability*, 9 (11): 2033.

DWAF (Department of Water Affairs and Forestry). 1997. White paper on national water policy for South Africa (online). Available: https://www.ircwash.org/resources/white-paper-national-water-policy-south-africa (Accessed 21 February 2018).

DWAF. 2007. Free Basic Water. Online. Available: http://webcache.googleusercontent.com/search?q=cache:QHISC9bB3dwJ:ws.dwa.gov.za/wspd/UserControls/DownloadImportFiles.aspx%3FFileID%3D151+&cd=1&hl=en&ct=clnk&gl=za (Accessed 28 January 2021).

Edokpayi, J. N., Enitan, A. M., Mutileni, N. and Odiyo, J. O. 2018. Evaluation of water quality and human risk assessment due to heavy metals in groundwater around Muledane area of Vhembe District, Limpopo Province, South Africa. *Chemistry Central Journal*, 12 (1): 2-16

England, M. I. 2018. India's water policy response to climate change. *Water International*, 43 (4): 512-530.

Ercumen, A., Arnold, B. F., Kumpel, E., Burt, Z., Ray, I., Nelson, K. and Colford Jr, J. M. 2015. Upgrading a piped water supply from intermittent to continuous delivery and association with waterborne illness: a matched cohort study in urban India. *PLoS medicine*, 12 (10): 1-24.

eThekwini Municipality. 2009. Budget Speech by the mayor. Online. Available: http://www.durban.gov.za/Documents/City_Government/Treasury_Budget/eThekwini%20Budget%2008-09.pdf (Accessed 28 February 2021).

eThekwini Municipality Water Services Development Plan. 2012. Online. Available: http://www.durban.gov.za/City_Services/water_sanitation/Policies_Plans_Guidelines/Documents/WSDP2012_Approved.pdf (Accessed 28 February 2021).

eThekwini water and sanitation. 2012. Online. Available:http://www.durban.gov.za/Resource_Centre/Policies/Documents/Policies%20and%20Practices%20for%20Water%20Sanitation.pdf (Accessed 28 February 2021).

eThekwini Municipality. 2015. Water leaks to cost Durban dear. *Iol*. 11 March. Available: https://www.iol.co.za/news/south-africa/kwazulu-natal/water-leaks-to-cost-durban-dear-1830327 (Accessed 15 August 2017).

eThekwini Municipality. 2016. Report of human settlements and Infrastructure: Meeting of the eThekwini council held on 06 December 2016 (online). Available: http://www.durban.gov.za/Online_Tools/Council%20Minutes%20and%20Decisions/Council%202017/Council%20Minutes%202017/Minutes%20-%20Council%20-%202017-02-23.pdf (Accessed 12 February 2020).

.eThekwini Municipality. 2019.. Medium term revenue and expenditure framework 2019/2020 to 2021/2022. Available: http://www.durban.gov.za/Resource_Centre/reports/Documents/MediumTermRevenueandExpenditureFramework2019_2020to2021_2022.pdf (Accessed 25 November 2019).

eThekwini Municipality. 2019b. Water tariffs 2018 – 2019. Available: http://www.durban.gov.za/Resource_Centre/Services_Tariffs/Water%20Tariffs/Forms/AllItems.aspx (Accessed 30 June 2019)

Fan, L., Liu, G., Wang, F., Ritsema, C. J. and Geissen, V. 2014. Domestic water consumption under intermittent and continuous modes of water supply. *Water Resources Management*, 28 (3): 853-865.

Farley, K. A. and Bremer, L. L. 2017. “Water is life”: local perceptions of páramo grasslands and land management strategies associated with payment for ecosystem services. *Annals of the American Association of Geographers*, 107 (2): 371-381.

Fearnside, P. M. 2016. Environmental and social impacts of hydroelectric dams in Brazilian Amazonia: implications for the aluminum industry. *World Development*, 77: 48-65.

Feike, T. and Henseler, M. 2017. Multiple policy instruments for sustainable water management in crop production-a modeling study for the Chinese Aksu-Tarim region. *Ecological Economics*, 135: 42-54.

Fielding, K. S., Russell, S., Spinks, A. and Mankad, A. 2012. Determinants of household water conservation: the role of demographic, infrastructure, behavior, and psychosocial variables. *Water Resources Research*, 48 (10)

Fishbein, M. and Ajzen, I. 2011. *Predicting and changing behavior: the reasoned action approach*. United Kingdom: Taylor and Francis.

Fisher-Jeffes, L., Carden, K. and Armitage, N. 2017. A water sensitive urban design framework for South Africa. *Town and Regional Planning*, 71 (1): 1-10.

Flick, U. 2015. *Introducing research methodology: a beginner's guide to doing a research project*. 2nd ed. California: Sage publication.

Förster, J. J., Downsborough, L. and Chomba, M. J. 2017. When policy hits practice: structure, agency, and power in South African water governance. *Society & Natural Resources*, 30 (4): 521-536.

Franca, E. B., de Azeredo Passos, V. M., Malta, D. C., Duncan, B. B., Ribeiro, A. L. P., Guimaraes, M. D., Abreu, D. M., Vasconcelos, A. M. N., Carneiro, M. and Teixeira, R. 2017. Cause-specific mortality for 249 causes in Brazil and states during 1990–2015: a systematic analysis for the global burden of disease study 2015. *Population health metrics*, 15 (1): 1-17.

Francés, G. E., Quevauviller, P., González, E. S. M. and Amelin, E. V. 2017. Climate change policy and water resources in the EU and Spain. A closer look into the Water Framework Directive. *Environmental Science & Policy*, 69: 1-12.

Francis, A. 2015. *Jordan's refugee crisis* (Vol. 21). Washington, DC: Carnegie Endowment for International Peace (online). Available: https://carnegieendowment.org/files/CP_247_Francis_Jordan_final.pdf (Accessed 17 June 2018).

Frederiks, E. R., Stenner, K. and Hobman, E. V. 2015. Household energy use: applying behavioural economics to understand consumer decision-making and behaviour. *Renewable and Sustainable Energy Reviews*, 41: 1385-1394.

Fuller, M. 2019. *South Africa’s main freshwater resources* (image). Available: https://www.xlab.earth/2019/08/23/understanding-south-african-water-quality/ (Accessed 17 December 2019).

Fullerton Jr, T. M., Ceballos, A. and Walke, A. G. 2016. Short-term forecasting analysis for municipal water demand. *Journal-American Water Works Association*, 108 (1): E27-E38.

Funke, N., Nortje, K., Meissner, R., Steyn, M. and Ntombela, C. 2019. An analysis of international and South African discourses and perspectives on water security. In:

Understanding Water Security at Local Government Level in South Africa. New York: Springer, 45-71.

Furlong, C., Brotchie, R., Considine, R., Finlayson, G. and Guthrie, L. 2017. Key concepts for integrated urban water management infrastructure planning: lessons from Melbourne. *Utilities Policy*, 45: 84-96.

Furlong, C., Gan, K. and De Silva, S. 2016. Governance of integrated urban water management in Melbourne, Australia. *Utilities Policy*, 43: 48-58.

Gaddis, E., Grellier, J., Grobicki, A., Hay, R., Mirumachi, N., Mukhtarov, F. and Rast, W. 2019. *Freshwater policy*. 7: 400-422.

Gain, A. K., Giupponi, C. and Wada, Y. 2016. Measuring global water security towards sustainable development goals. *Environmental Research Letters*, 11 (12): 124015.

Gallagher, K. M. and Updegraff, J. A. 2012. Health message framing effects on attitudes, intentions, and behavior: a meta-analytic review. *Annals of behavioral medicine*, 43 (1): 101-116.

García, M. M. and Bodin, Ö. 2019. Participatory water basin councils in Peru and Brazil: expert discourses as means and barriers to inclusion. *Global Environmental Change*, 55: 139-148.

Garcia, J., Salfer, L.R., Kalbusch, A. and Henning, E., 2019. Identifying the drivers of water consumption in single-family households in Joinville, Southern Brazil. *Water*, 11(10): 1990.

Gebrehiwot, K. A. and Gebrewahid, M. G. 2016. The need for agricultural water management in sub-Saharan Africa. *Journal of Water Resource and Protection*, 8 (09): 835.

Ghauri, P., and K. Gronhaug. 2005. *Research Methods in business research*. Harlow: Prentice Hall.

Ghazouani, W., Molle, F., Swelam, A., Rap, E. and Abdo, A. 2015. *Understanding farmers' adaptation to water scarcity: a case study from the western Nile Delta, Egypt* (160): IWMI.

Gianfrate, V., Piccardo, C., Longo, D. and Giachetta, A. 2017. Rethinking social housing: Behavioural patterns and technological innovations. *Sustainable cities and society*, 33: 02-112.

Gibb, B. C. 2016. Weird and wonderful water. *Nature chemistry*, 8 (8): 733-734.

Gill, C. and Lang, C. 2018. Learn to conserve: The effects of in-school energy education on at-home electricity consumption. *Energy Policy*, 118: 88-96.

Gilpin, R. 2018. *The challenge of global capitalism: The world economy in the 21st century*. New Jersey: Princeton University Press.

Glass, S. 2017. Twisting the tap: Water scarcity and conflict in the Euphrates-Tigris River Basin. Available: https://digitalcollections.sit.edu/cgi/viewcontent.cgi?article=3621&context=isp_collection (Accessed 09 February 2018)

Glavan, M., Železnikar, Š., Velthof, G., Boekhold, S., Langaas, S. and Pintar, M. 2019. How to enhance the role of science in European Union policy making and implementation: the case of agricultural impacts on drinking water quality. *Water*, 11 (3): 492.

Gleick, P.H. 2018. Transitions to freshwater sustainability. *Proceedings of the National Academy of Sciences*, 115 (36): 8863-8871.

Gneezy, U., Meier, S. and Rey-Biel, P. 2011. When and why incentives (don't) work to modify behavior. *Journal of Economic Perspectives*, 25 (4): 191-210.

Goepel, N., M. Rossini Rahme, and F. Svanhall. 2015. *Strategic recommendations for the design of nudges towards a sustainable society.* Sweden: Blekinge Tekniska Högskola.

Goh, X. P., Radhakrishnan, M., Zevenbergen, C. and Pathirana, A. 2017. Effectiveness of runoff control legislation and active, beautiful, clean (ABC) waters design features in Singapore. *Water*, 9 (8): 627.

Gold, G.J. 2011. *Review of predicting and changing behavior: the reasoned action approach: by M. Fishbein and I. Ajzen*. New York, NY: Psychology Press, Taylor & Francis Group, page 382-385.

Gosling, S. N. and Arnell, N. W. 2016. A global assessment of the impact of climate change on water scarcity. *Climatic Change*, 134 (3): 371-385.

Gostin, L.O. and Friedman, E.A., 2017. Global health: a pivotal moment of opportunity and peril. *Health Affairs*, 36 (1): 159-165.

Govender, I. G. 2016. Monitoring and evaluating service delivery as a wicked problem in South Africa. *Journal of Human Ecology*, 55 (1-2): 21-34.

Grafton, R.Q., McLindin, M., Hussey, K., Wyrwoll, P., Wichelns, D., Ringler, C., Garrick, D., Pittock, J., Wheeler, S., Orr, S. and Matthews, N. 2016. Responding to global challenges in food, energy, environment and water: risks and options assessment for decision-making. *Asia & the Pacific Policy Studies*, 3 (2): 275-299.

Griffin, R.C. 2016. Water resource economics: The analysis of scarcity, policies, and projects. *Journal of Economics*. 91 (2): 203-207.

Grubb, M., Koch, M., Thomson, K., Sullivan, F. and Munson, A. 2019. *The 'Earth Summit' agreements: A guide and assessment: An analysis of the Rio'92 UN conference on environment and eevelopment*. New York: Routledge

Guba, E. G. and Lincoln, Y. S. 1989. *Fourth generation evaluation*. California: SAGE Publication.

Gude, V. G. 2016. Desalination and sustainability–an appraisal and current perspective. *Water Research*, 89: 87-106.

Gumbi, N. and Rangongo, M.F., 2018. Factors that Hinder Effective Management and the Supply of Clean Potable Water at eThekwini Municipality in KwaZulu-Natal. International Conference on Public Administration and Development Alternatives, 04-06 July 2018, Stellenbosch University, Saldahna Bay, South Africa. (online). Available: http://ulspace.ul.ac.za/bitstream/handle/10386/2249/gumbi_factors_2018.pdf?sequence=1&isAllowed=y (Accessed 28 February 2021).

Guerrero, A. M., Bennett, N. J., Wilson, K. A., Carter, N., Gill, D., Mills, M., Ives, C. D., Selinske, M. J., Larrosa, C. and Bekessy, S. 2018. Achieving the promise of integration in social-ecological research. *Ecology and Society*, 23 (3).

Hafner, R. J., Elmes, D. and Read, D. 2019. Promoting behavioural change to reduce thermal energy demand in households: a review. *Renewable and Sustainable Energy Reviews*, 102: 205-214.

Haggar, M.S. 2019. The reasoned action approach and the theories of reasoned action and planned behaviour. In: Dunn, D.S. ed. *Oxford Bibliographies in Psychology*. New York: Oxford University Press, 1-29.

Hanak, E. 2011. *Managing California's water: from conflict to reconciliation*. San Franscisco: Public Policy Institute of California.

Hansen, P. G. 2016. The definition of nudge and libertarian paternalism: does the hand fit the glove? *European Journal of Risk Regulation*, 7 (1): 155-174.

Hansla, A., Gamble, A., Juliusson and Gärling, T. 2008. The relationships between awareness of consequences, environmental concern, and value orientations, J. Environ. Psychol., 28 (1): 1-9.

Harrison, I.J., Green, P.A., Farrell, T.A., Juffe-Bignoli, D., Sáenz, L. and Vörösmarty, C.J. 2016. Protected areas and freshwater provisioning: a global assessment of freshwater provision, threats and management strategies to support human water security. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 26: 103-120.

Hay, E.R., Riemann, K., Van Zyl, G. and Thompson, I. 2012. Ensuring water supply for all towns and villages in the Eastern Cape and Western Cape Provinces of South Africa. *Water SA*, 38 (3): 437-444.

Hazelton, D. G. 2019. WC/WDM cost recovery: free basic water and cost recovery challenges. *Water&Sanitation Africa*, 14 (3): 47-50.

Heeren, A. J., Singh, A. S., Zwickle, A., Koontz, T. M., Slagle, K. M. and McCreery, A. C. 2016. Is sustainability knowledge half the battle? *International Journal of Sustainability in Higher Education*, 17 (5): 613-632.

Hellberg, S. 2014. Water, life and politics: exploring the contested case of eThekwini municipality through a governmentality lens. *Geoforum*, 56: 226-236.

Hellberg, S. 2017. Water for survival, water for pleasure - a biopolitical perspective on the social sustainability of the basic water agenda. *Water Alternatives*, 10 (1): 65.

Hellberg, S. 2018. *The biopolitics of water: governance, scarcity and populations*. New York: Routledge.

Herr, D. 2018. Drop by Drop: Scarcity as the Severance Between Intentions to Save Water and Actual Water-Saving. (Online). Available: http://www.psychology.uct.ac.za/sites/default/files/image_tool/images/117/Logos/thesis/Herr%20-%20Thesis%20_Without%20Appendices%20for%20Vula_.pdf (Accessed 27 February 2021)

Ho, C.-W., Wang, Y.-B. and Yen, N. Y. 2015. Does environmental sustainability play a role in the adoption of smart card technology at universities in Taiwan: an integration of TAM and TRA? *Sustainability*, 7 (8): 10994-11009.

Hoekstra, A. Y., Buurman, J. and van Ginkel, K. C. 2018. Urban water security: a review. *Environmental Research Letters*, 13 (5): 053002.

Holland, R.A., Scott, K.A., Flörke, M., Brown, G., Ewers, R.M., Farmer, E., Kapos, V., Muggeridge, A., Scharlemann, J.P., Taylor, G. and Barrett, J. 2015. Global impacts of

energy demand on the freshwater resources of nations. *Proceedings of the National Academy of Sciences*, 112 (48): E6707-E6716.

Hove, J., D'Ambruoso, L., Mabetha, D., Van Der Merwe, M., Byass, P., Kahn, K., Khosa, S., Witter, S. and Twine, R. 2019. 'Water is life': developing community participation for clean water in rural South Africa. *BMJ global health*, 4 (3)

Hox, J.J. and Boeije, H.R. 2005. Data collection, primary versus secondary. In Kempf-Leonard, K. ed. *Encyclopedia of Social Measurement*. San Diego: Academic Press, 593-599.

https://www.bi.team/wp-content/uploads/2015/07/BIT_Charitable_Giving_Paper-1.pdf (Accessed 13 August 2019).

Hu, S., Yan, D., Guo, S., Cui, Y. and Dong, B. 2017. A survey on energy consumption and energy usage behavior of households and residential building in urban China. *Energy and Buildings*, 148: 366-378.

Huddart, J.E., Thompson, M.S., Woodward, G. and Brooks, S.J. 2016. Citizen science: from detecting pollution to evaluating ecological restoration. *Wiley Interdisciplinary Reviews: Water*, 3 (3): 287-300.

Hurlimann, A. and Dolnicar, S. 2010. Acceptance of water alternatives in Australia–2009. *Water Science and Technology*, 61 (8): 2137-2142.

Hurlimann, A. and Dolnicar, S. 2016. Public acceptance and perceptions of alternative water sources: a comparative study in nine locations. *International Journal of Water Resources Development*, 32 (4): 650-673.

Infrastructure News. 2019*. Department of Water to rethink war on leaks programme* (online). Available: https://infrastructurenews.co.za/2019/02/14/department-of-water-to-rethink-war-onleaks-programme/ . (Accessed 12 Jun. 2019).

Inman, D. and Jeffrey, P. 2006. A review of residential water conservation tool performance and influences on implementation effectiveness. *Urban Water Journal*, 3 (3): 127-143.

Irvine, K., Chua, L. and Eikass, H. S. 2014. The four national taps of Singapore: a holistic approach to water resources management from drainage to drinking water. *Journal of water management modeling*: 1-11.

Isidiho, A.O. and Sabran, M.S.B. 2016. Evaluating the top-bottom and bottom-up community development approaches: mixed method approach as alternative for rural un-educated communities in developing countries. *Mediterranean Journal of Social Sciences*, 7 (4): 266-273.

Ivankova, N. V., Creswell, J. W. and Stick, S. L. 2006. Using mixed-methods sequential explanatory design: from theory to practice. *Field methods*, 18(1): 3-20.

Jacobs-Mata, I.M., De Wet, B., Banoo, I., Meissner, R., De Lange, W.J. and Strydom, W.F. 2018. Understanding residential water-use behaviour in urban South Africa. *Alive2green* (online). Available: https://researchspace.csir.co.za/dspace/bitstream/handle/10204/10139/Jacobs-Mata_20578_2018.pdf?sequence=1 (Accessed 16 February 2019).

Jafta, J., Tshiqi, A.J., Cameron, J. and Froneman, J. 2017. *City of Tshwane Metropolitan Municipality v Link Africa (Pty) Ltd and Others* (online). Available: https://collections.concourt.org.za/handle/20.500.12144/3781 (Accessed 12 March 2019).

Jain, S. 2018. Water Scarcity: A global issue. *Journal of Advanced Research in Alternative Energy, Environment and Ecology*, 5 (3): 12-14.

Jensen, O. 2019. Designing effective water policy: capacity and effectiveness of reforms in developing countries. *Policy and Society*, 38 (1): 77-95.

Jiang, Y. 2015. China's water security: current status, emerging challenges and future prospects. *Environmental Science & Policy*, *54*, pp.106-125.

Jimu, I. M. 2008. Community development: a cross-examination of theory and practice using experiences in rural Malawi. *Africa Development*, 33 (2)

Johnson, B. and Christensen, L. 2012. *Educational research: quantitative, qualitative and mixed approaches*. 4th ed. California: SAGE Publications.

Jones, G. 2017. *Profits and sustainability: a history of green entrepreneurship*. Oxford University Press.

Jones, N., Evangelinos, K., Gaganis, P. and Polyzou, E., 2011. Citizens' perceptions on water conservation policies and the role of social capital. *Water Resources Management*, 25(2): 509-522.

Jung, J. Y. and Mellers, B. A. 2016. American attitudes toward nudges. *Judgment & Decision Making*, 11 (1): 62-74.

Kahinda, J. M., Taigbenu, A. and Boroto, R. 2010. Domestic rainwater harvesting as an adaptation measure to climate change in South Africa. *Physics and Chemistry of the Earth, Parts A/B/C*, 35 (13-14): 742-751.

Kanakoudis, V., Tsitsifli, S. and Demetriou, G. 2016. Applying an integrated methodology toward non-revenue water reduction: the case of Nicosia, Cyprus. *Desalination and Water Treatment*, 57 (25): 11447-11461.

Kapangaziwiri, E., Kahinda, J.M., Dzikiti, S., Ramoelo, A., Cho, M., Mathieu, R., Naidoo, M., Seetal, A. and Pienaar, H. 2018. Validation and verification of lawful water use in South Africa: An overview of the process in the KwaZulu-Natal Province. *Physics and Chemistry of the Earth, Parts A/B/C*, 105: 274-282.

Katz, D., Kronrod, A., Grinstein, A. and Nisan, U. 2018. Still waters run deep: comparing assertive and suggestive language in water conservation campaigns. *Water*, 10 (3): 275.

Kayser, G. L., Amjad, U., Dalcanale, F., Bartram, J. and Bentley, M. E. 2015. Drinking water quality governance: a comparative case study of Brazil, Ecuador, and Malawi. *Environmental science & policy*, 48: 186-195.

Kerzner, H. 2017. *Project management: a systems approach to planning, scheduling, and controlling*. 10th ed. New York: John Wiley & Sons.

Khaing, K. K. 2016. Groundwater environment in Yangon, Myanmar. In: *Groundwater Environment in Asian Cities*. Elsevier, 317-335.

Khare, A. 2015. Antecedents to green buying behaviour: a study on consumers in an emerging economy, *Intell. Plan,* 33 (3): 309-329.

Kimberlin, C. L. and Winterstein, A. G. 2008. Validity and reliability of measurement instruments used in research. *American journal of health-system pharmacy*, 65 (23): 2276-2284.

Kincheloe, J.L. and Tobin, K. 2015. The much-exaggerated death of positivism (online). Available: https://www.researchgate.net/profile/Kenneth_Tobin/publication/225745166_The_much_exaggerated_death_of_positivism/links/5dfc4d4ea6fdcc28372ed60b/The-much-exaggerated-death-of-positivism.pdf (Accessed 29 June 2019).

King, A. D., Karoly, D. J. and Henley, B. J. 2017. Australian climate extremes at 1.5 C and 2 C of global warming. *Nature Climate Change*, 7 (6): 412-416.

Klopper, H. 2008. The qualitative research proposal. *Curationis*, 31(4): 62-72.

Kneebone, S., Fielding, K. and Smith, L. 2018. It's what you do and where you do it: perceived similarity in household water saving behaviours. *Journal of Environmental Psychology*, 55: 1-10.

Knodel, J. 1993. The design and analysis of focus group studies: a practical approach. In: *Successful focus groups: Advancing the state of the art.* California: Sage publications, 35-50.

Knox, A.J., de Groot, J.R. and Mohlakoana, N. 2017. Post-apartheid spatial inequalities and the built environment: drivers of energy vulnerability for the urban poor in South Africa. In: *Energy Poverty and Vulnerability*. New York: Routledge, 61-79.

Knüppe, K. and Meissner, R. 2016. Drivers and barriers towards sustainable water and land management in the Olifants-Doorn Water Management Area, South Africa. *Environmental Development*, 20: 3-14.

Koop, S. H. and van Leeuwen, C. J. 2017. The challenges of water, waste and climate change in cities. *Environment, Development and Sustainability*, 19 (2): 385-418.

Koop, S., Van Dorssen, A. and Brouwer, S. 2019. Enhancing domestic water conservation behaviour: a review of empirical studies on influencing tactics. *Journal of Environmental Management*, 247: 867-876.

Kosters, M. and Van der Heijden, J. 2015. From mechanism to virtue: Evaluating Nudge theory. *Evaluation*, 21 (3): 276-291.

Kostigen, T.M. 2014. Could California's drought last 200 years. *National Geographic, 2* (16): 2014.

Kothari, C.R. 2004. *Research methodology: methods and techniques*. New Delhi: New Age International.

Kumar Chaudhary, A., Warner, L.A., Lamm, A.J., Israel, G.D., Rumble, J.N. and Cantrell, R.A. 2017. Using the theory of planned behavior to encourage water conservation among Extension Clients. *Journal of Agricultural Education*, 58(3): 185-202.

Kumar, M. D. 2018. Proposing a solution to India's water crisis: 'paradigm shift'or pushing outdated concepts? *International Journal of Water Resources Development*, 34 (1): 42-50.

Kumar, R. 2019. *Research methodology: a step-by-step guide for beginners*. London: Sage publications.

Kumar, S.V. and Bharat, G.K., 2014. Perspectives on a water resource policy for India. *The Energy and Resource Institute*. (Online) Available: https://www.researchgate.net/profile/Girija_Bharat/publication/281318809_Perspectives_on_a_Water_Resource_Policy_for_India/links/55e1840208ae2fac471dcbb9/Perspectives-on-a-Water-Resource-Policy-for-India.pdf (Accessed 21 November 2019).

Kusena, W., Desai, S., Heinz, B. and Abel, C. 2016. Assessing public participation in water conservation and water demand management in water stressed urban areas: insights from the City of Gweru, Zimbabwe. *Review of Social Sciences*, 1 (8): 30-43.

Lam, S. P. 2006. Predicting intention to save water: theory of planned behavior, response efficacy, vulnerability, and perceived efficiency of alternative solutions 1. *Journal of Applied Social Psychology*, 36 (11): 2803-2824.

Lambert, A., Fantozzi, M. and Thornton, J. 2013. Practical approaches to modeling leakage and pressure management in distribution systems–progress since 2005. In: Proceedings of *12th International Conference on Computing and Control for the Water Industry, CCWI2013*. 2-4.

Landon, A. C., Woodward, R. T., Kyle, G. T. and Kaiser, R. A. 2018. Evaluating the efficacy of an information-based residential outdoor water conservation program. *Journal of Cleaner Production*, 195: 56-65.

Lapworth, D., Nkhuwa, D., Okotto-Okotto, J., Pedley, S., Stuart, M., Tijani, M. and Wright, J. 2017. Urban groundwater quality in sub-Saharan Africa: current status and implications for water security and public health. *Hydrogeology Journal*, 25 (4): 1093-1116.

Larsen, T. A., Hoffmann, S., Lüthi, C., Truffer, B. and Maurer, M. 2016. Emerging solutions to the water challenges of an urbanizing world. *Science*, 352 (6288): 928-933.

Lede, E., Meleady, R. and Seger, C.R, 2019. Optimizing the influence of social norms interventions: Applying social identity insights to motivate residential water conservation. *Journal of Environmental Psychology*, 62: 105-114.

Lee, H. and Tan, T. P. 2016. Singapore's experience with reclaimed water: NEWater. *International Journal of Water Resources Development*, 32 (4): 611-621.

Lee, H.M., Song, H.J., Lee, C.K. and Reisinger, Y. 2019. Formation of festival visitors' environmentally friendly attitudes: cognitive, affective, and conative components. *Current Issues in Tourism*, 22(2): 142-146.

Lehner, M., Mont, O. and Heiskanen, E. 2016. Nudging–a promising tool for sustainable consumption behaviour? *Journal of Cleaner Production*, 134: 166-177.

Leiner, D.J. 2014. Convenience samples from online respondent pools: a case study of the SoSci Panel. *International Journal of Internet Science*, 20 (5): 1-18.

Lester, S. and Rhiney, K. 2018. Going beyond basic access to improved water sources: Towards deriving a water accessibility index. *Habitat International*, 73: 129-140.

Li, H., Xu, C.Y., Beldring, S., Tallaksen, L.M. and Jain, S.K., 2016. Water resources under climate change in Himalayan basins. *Water Resources Management*, 30 (2): 843-859.

Li, P and Qian, H. 2018. Water resources research to support a sustainable China. *International Journal of Water Resources Development*, 34 (3): 327-336

Lim, H. and Lu, X. 2016. Sustainable urban stormwater management in the tropics: an evaluation of Singapore's ABC Waters Program. *Journal of Hydrology*, 538: 842-862.

Lincoln, Y. S. and Guba, E. *G*. 1985*. Naturalistic inquiry. Beverly Hills*: CA: Sage.

Lincoln, Y.S. and Guba, E.G. 1990. Judging the quality of case study reports. *International Journal of Qualitative Studies in Education*, 3 (1): 53-59.

Lindlof, T.R. and Taylor, B.C. 2017. *Qualitative communication research methods*. California: Sage publications.

Liu, B. and Speed, R. 2009. Water resources management in the People's Republic of China. *Water Resources Development*, 25 (2): 193-208.

Liu, J., Liu, Q. and Yang, H. 2016. Assessing water scarcity by simultaneously considering environmental flow requirements, water quantity, and water quality. *Ecological indicators*, 60: 434-441.

Living with Urban Periphery. 2018. Living the urban periphery: understanding investment, infrastructure and economic change in northern eThekwini Municipality, South Africa (online). Available: https://www.wits.ac.za/media/wits-university/research/peripheries/documents/Northern%20eThekwini%20Pamphlet%20PDF%20final.pdf (Accessed 21 January 2019).

Loewenstein, G. and Chater, N. 2017. Putting nudges in perspective. *Behavioural Public Policy*, 1 (1): 26-53.

Lonergan, S.C. 2018. Water and conflict: rhetoric and reality. In: *Environmental conflict*. London: Routledge, 109-124.

Lorz, C., Abbt-Braun, G., Bakker, F., Borges, P., Börnick, H., Fortes, L., Frimmel, F., Gaffron, A., Hebben, N. and Höfer, R. 2012. Challenges of an integrated water resource management for the Distrito Federal, Western Central Brazil: climate, land-use and water resources. *Environmental Earth Sciences*, 65 (5): 1575-1586.

Loucks, D.P. and van Beek, E., 2017. Water resources planning and management: an overview. In: *Water Resource Systems Planning and Management*. New York: Springer, 1-49.

Lourenco, J. S., Ciriolo, E., Almeida, S. R. and Dessart, F. J. 2016. *Behavioural insights applied to policy-country overviews 2016*. Joint Research Centre (Seville site) (online). Available: https://ideas.repec.org/p/ipt/iptwpa/jrc100547.html (accessed 30 March 2019).

Lowe, B., Lynch, D. and Lowe, J. 2015. Reducing household water consumption: a social marketing approach. *Journal of Marketing Management*, 31 (3-4): 378-408.

Lu, L., Deller, D. and Hviid, M. 2019. Price and behavioural signals to encourage household water conservation: Implications for the UK. *Water resources management*, 33 (2): 475-491.

Lu, S., Zhang, X., Bao, H. and Skitmore, M. 2016. Review of social water cycle research in a changing environment. *Renewable and Sustainable Energy Reviews*, 63: 132-140.

Lu, Y., Song, S., Wang, R., Liu, Z., Meng, J., Sweetman, A.J., Jenkins, A., Ferrier, R.C., Li, H., Luo, W. and Wang, T. 2015. Impacts of soil and water pollution on food safety and health risks in China. *Environment international*, 77: 5-15.

Luan, I. O. B. 2010. Singapore water management policies and practices. *International Journal of Water Resources Development*, 26 (1): 65-80.

Lucas, N. P. and Cordery, I. 2019. Effects of heightened price awareness on urban water consumption. *Australasian Journal of Water Resources*, 23 (2): 129-136.

Lune, H. and Berg, B.L. 2016. *Qualitative research methods for the social sciences*. 9th ed. United States: Pearson.

Mabhaudhi, T., Mpandeli, S., Madhlopa, A., Modi, A.T., Backeberg, G. and Nhamo, L. 2016. Southern Africa's water–energy nexus: Towards regional integration and development. *Water*, 8 (6): 235.

Mackey, A. and Gass, S.M. 2015. *Second language research: methodology and design*. New York: Routledge.

Maggioni, E. 2015. Water demand management in times of drought: what matters for water conservation? *Water Resources Research*, 51 (1): 125-139.

Mahlanza, L., Ziervogel, G. and Scott, D. 2016. Water, rights and poverty: an environmental justice approach to analysing water management devices in Cape Town. In: Proceedings of *Urban Forum*. Springer, 363-382.

Mallow, M., Gary, L., Jeng, T., Bongomin Jr, B., Aschkenasy, M. T., Wallis, P., Cranmer, H. H., Debasu, E. and Levine, A. C. 2018. WASH activities at two Ebola treatment units in Sierra Leone. *PloS one*, 13 (5)

Mamathashree, C., Pavithra, A. and Shilpha, S. 2017. Water footprint for sustainable production. *Journal of Pharmacognosy and Phytochemistry*, 6 (5): 2343-2347.

Mamitimin, Y., Feike, T. and Doluschitz, R. 2015. Bayesian network modeling to improve water pricing practices in northwest China. *Water*, 7 (10): 5617-5637.

Mango, N., Siziba, S. and Makate, C. 2017. The impact of adoption of conservation agriculture on smallholder farmers' food security in semi-arid zones of southern Africa. *Agriculture & Food Security*, 6 (1): 32.

Maphela, B. 2015. Critical assessment of South Africa's water policy. PhD thesis, University of Johannesburg. Available: https://ujdigispace.uj.ac.za (Accessed 13 July 2017).

Marandu, E. E., Moeti, N. and Joseph, H. 2010. Predicting residential water conservation using the Theory of Reasoned Action. *Journal of Communication*, 1 (2): 87-100.

Margerum, R. D. and Robinson, C. J. 2015. Collaborative partnerships and the challenges for sustainable water management. *Current Opinion in Environmental Sustainability*, 12: 53-58.

Marques, R. C., Pinto, F. S. and Miranda, J. 2016. *Redrafting water governance: guiding the way to improve the status quo*: Elsevier.

Marshall, G. R. and Alexandra, J. 2016. Institutional path dependence and environmental water recovery in Australia's Murray-Darling basin. *Water Alternatives*, 9 (3)

Marson, M. and Savin, I. 2015. Ensuring sustainable access to drinking water in Sub Saharan Africa: conflict between financial and social objectives. *World Development*, 76: 26-39.

Marston, A. 2014. The scale of informality: community-run water systems in peri-urban Cochabamba, Bolivia. *Water Alternatives*, 7 (1)

Martin, W.E., Ingram, H.M., Laney, N.K. and Griffin, A.H. 2015. *Saving water in a desert city*. New York: Routledge.

Martins Gonçalves, H. and Viegas, A. 2015. Explaining consumer use of renewable energy: determinants and gender and age moderator effects. *Journal of Global Scholars of Marketing Science*, 25 (3): 198-215.

Martos, A., Pacheco-Torres, R., Ordóñez, J. and Jadraque-Gago, E. 2016. Towards successful environmental performance of sustainable cities: intervening sectors. A review. *Renewable and Sustainable Energy Reviews*, 57: 479-495.

Mastrorillo, M., Licker, R., Bohra-Mishra, P., Fagiolo, G., Estes, L. D. and Oppenheimer, M. 2016. The influence of climate variability on internal migration flows in South Africa. *Global Environmental Change*, 39: 155-169.

Mauter, M.S., Zucker, I., Perreault, F., Werber, J.R., Kim, J.H. and Elimelech, M. 2018. The role of nanotechnology in tackling global water challenges. *Nature Sustainability*, 1 (4): 166-175.

Mavundla, N.B. 2016. The effectiveness of local government in water usage in Ezakheni Township. M.Tech, University of the Free State. Available: https://scholar.ufs.ac.za/bitstream/handle/11660/4069/MavundlaNB.pdf?sequence=1&isAllowed=y (Accessed 21 June 2018).

Maxwell, J.A. 2012. *Qualitative research design: an interactive approach.* London: Sage publications.

Mazzeo, S.E., Bean, M.K., Palmberg, A.A., Simpson, C.C., Thacker, L.R., Dunne Stewart, M. and Gow, R.W. 2017. A pilot intervention targeting dietary intake in school cafeterias. *Health Behavior and Policy Review*, 4 (3): 256-264.

McGoldrick, T. A. 2018. A theological argument for water as a human right: The Bolivian Pachamama/Mother Earth Encounter with Catholic Social Thought. *Journal of Catholic Social Thought*, 15 (1): 109-137.

McGrane, S. J., Allan, G. J. and Roy, G. 2018. Water as an economic resource and the impacts of climate change on the hydrosphere, regional economies and Scotland. *Fraser of Allander Economic Commentary*, 42 (4): 53-74.

McKenzie-Mohr, D. and Schultz, P.W. 2014. Choosing effective behavior change tools. *Social Marketing Quarterly*, 20 (1): 35-46.

Mean annual runoff. *Oxford Reference.* Retrieved 9 Nov. 2019 (online). Available: https://www.oxfordreference.com/view/10.1093/oi/authority.20110810105355688.

Mehta, L., Movik, S., Bolding, A., Derman, B. and Manzungu, E. 2017. Introduction-flows and practices: the politics of integrated water resources management (IWRM) in eastern and Southern Africa. In: *Flows and Practices: The Politics of Integrated Water Resources Management in Eastern and Southern Africa*. African Books Collective, 1-29.

Meissner, R., Funke, N., Nortje, K., Jacobs-Mata, I., Moyo, E., Steyn, M., Shadung, J., Masangane, W. and Nohayi, N. 2018. Water security at local government level in South Africa: a qualitative interview-based analysis. *The Lancet Planetary Health*, 2: S17.

Meissner, R., Steyn, M., Jacobs-Mata, I., Moyo, E., Shadung, J., Nohayi, N. and Mngadi, T., 2019. The perceived state of water security in the Sekhukhune District Municipality and the eThekwini Metropolitan Municipality. In *Understanding Water Security at Local Government Level in South Africa*. Palgrave Pivot, Cham.

Mekonnen, M. M. and Hoekstra, A. Y. 2016. Four billion people facing severe water scarcity. *Science advances*, 2 (2): e1500323.

Mertler, C.A. 2018. *Introduction to educational research*. California: Sage Publications.

Michie, S., Carey, R.N., Johnston, M., Rothman, A.J., De Bruin, M., Kelly, M.P. and Connell, L.E. 2018. From theory-inspired to theory-based interventions: A protocol for developing and testing a methodology for linking behaviour change techniques to theoretical mechanisms of action. *Annals of Behavioral Medicine*, 52 (6): 501-512.

Milimo, J. T. 2017. *The poor of Zambia speak Who would ever listen to the poor?* Zambia: Zambia Social Investment Fund.

Milman, A. and Polsky, C. 2016. Policy frameworks influencing outdoor water-use restrictions. *JAWRA Journal of the American Water Resources Association*, 52 (3): 605-619.

Mini, C., Hogue, T. S. and Pincetl, S. 2015. The effectiveness of water conservation measures on summer residential water use in Los Angeles, California. *Resources, Conservation and Recycling*, 94: 136-145.

Mkhwanazi, L.M., Mbatha, M.W. and Khulekani, M. 2019. Perception of community members on the provision of low-cost housing in Kwa-Dlangezwa Area, KwaZulu-Natal, South Africa. *Journal of Public administration*, 1: 7.

Mont, O., Lehner, M. and Heiskanen, E. 2017. *Nudging a tool for sustainable behaviour?* The Swedish Environmental Protection Agency (online). Available: https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6643-7.pdf?pid=14232 (Accessed 15 July 2019).

Montambeault, F. 2016. Participatory citizenship in the making? The multiple citizenship trajectories of participatory budgeting participants in Brazil. *Journal of Civil Society*, 12 (3): 282-298.

Montano, D.E. and Kasprzyk, D. 2015. Theory of reasoned action, theory of planned behaviour, and the integrated behavioural model. *Health behaviour: Theory, research and practice*, 1: 95-124.

Morgan, D.L. 1998. Practical strategies for combining qualitative and quantitative methods: applications to health research. *Qualitative health research*, 8 (3): 362-376.

Morse, J. M. and Niehaus, L. 2009. *Principles and procedures of mixed methods design*. Walnut Creek: Left Coast Press.

Moura, L.R.C., Souki, G.Q., Veiga, R.R., Cunha, N.R. and Fontes, S.T. 2017. Beliefs, attitudes, subjective rules and perceived control about water saving behaviour. *Mediterranean Journal of Social Sciences.* 8 (4*):* 77-85

Mpofu, M. and Hlatywayo, C.K. 2015. Training and development as a tool for improving basic service delivery; the case of a selected municipality. *Journal of Economics, Finance and Administrative Science*, 20 (39): 133-136.

Mugambiwa, S. S. and Tirivangasi, H. M. 2017. Climate change: a threat towards achieving'Sustainable Development Goal number two'(end hunger, achieve food security and improved nutrition and promote sustainable agriculture) in South Africa. *Jàmbá: Journal of Disaster Risk Studies*, 9 (1): 1-6.

Mukherjee, A. ed., 2018. *Groundwater of South Asia*. New York: Springer

Munasinghe, M. 2019. *Water supply and environmental management*. Routledge.

Münscher, R., Vetter, M. and Scheuerle, T. 2016. A review and taxonomy of choice architecture techniques. *Journal of Behavioral Decision Making*, 29 (5): 511-524

Musavengane, R. and Leonard, L. 2019. When race and social equity matters in nature conservation in post-apartheid South Africa. *Conservation & Society*, 17 (2): 135-146.

Myers, M.D., 2019. *Qualitative research in business and management*. California: Sage Publications Limited.

Na, J., Yang, H., Bae, S. and Lim, K.M. 2014. Analysis of statistical methods currently used in toxicology journals. *Toxicological research*, 30 (3): 185-191.

Nadlifatin, R., Lin, S.-C., Rachmaniati, Y. P., Persada, S. F. and Razif, M. 2016. A pro-environmental reasoned action model for measuring citizens' intentions regarding ecolabel product usage. *Sustainability*, 8 (11): 1165.

Namugize, J.N., Jewitt, G. and Graham, M. 2018. Effects of land use and land cover changes on water quality in the uMngeni river catchment, South Africa. *Physics and Chemistry of the Earth, Parts A/B/C*, 105: 247-264.

Nardi, P.M. 2018. *Doing survey research: a guide to quantitative methods*. New York: Routledge.

National Framework for Municipal Indigent Policies (2005). Online. Available:

https://www.westerncape.gov.za/text/2012/11/national_framework_for_municipal_indigent_policies.pdf (Accessed 12 January 2021).

Nayar, A. 2017. Nudging urban water conservation: evidence from India on the effect of behavior economics on water consumption. *European Journal of Research in Social Sciences Vol*, 5 (4)

Nayar, A. and Kanaka, S. 2017. A comparative study on water conservation through behavioral economics-based nudging: evidence from Indian City. A nudge in time can save nine. *International Journal of Business and Social Science*, 8 (12)

Nechifor, V. and Winning, M. 2018. Global economic and food security impacts of demand-driven water scarcity—alternative water management options for a thirsty world. *Water*, 10 (10):1442.

Nel, N., Jacobs, H. E., Loubser, C. and Du Plessis, K. J. 2017. Supplementary household water sources to augment potable municipal supply in South Africa. *Water SA*, 43 (4): 553-562.

Ng, P. J. H. 2018. Singapore: Transforming water scarcity into a virtue. In: *Assessing global water megatrends*. New York: Springer, 179-186.

Nguyen, H. V. and Lobo, A. 2017. Encouraging Vietnamese household recycling behavior: Insights and implications. *Sustainability*, 9 (2): 179.

Nguyen, T. N., Lobo, A. and Greenland, S. 2017. Energy efficient household appliances in emerging markets: the influence of consumers' values and knowledge on their attitudes and purchase behaviour. *International Journal of Consumer Studies*, 41 (2): 167-177.

Nickum, J. E. 2019. *Metropolitan water uses conflicts in Asia and the Pacific*. Routledge.

Nielsen, A. S. E., Sand, H., Sørensen, P., Knutsson, M., Martinsson, P., Persson, E. and Wollbrant, C. 2017. *Nudging and pro-environmental behaviour*. Denmark: Nordisk Ministerråd.

Njiraini, G.W., Thiam, D.R. and Coggan, A., 2017. The analysis of transaction costs in water policy implementation in South Africa: trends, determinants and economic implications. *Water Economics and Policy*, 3 (01): 1650020.

Nkosi, I. M. 2010. Investigation on water management options for Mamarwan mine. PhD thesis, University of Pretoria.

Nkosi, M., Mathivha, F.I. and Odiyo, J.O. 2021. Impact of Land Management on Water Resources, a South African Context. *Sustainability*, 13(2): 701.

Nkosi, N. 2017. Evaluation of public participation and poverty alleviation programmes: the case of the City of Johannesburg (CoJ). PhD thesis, North-West University.

Nobre, C. A., Marengo, J. A., Seluchi, M. E., Cuartas, L. A. and Alves, L. M. 2016. Some characteristics and impacts of the drought and water crisis in Southeastern Brazil during 2014 and 2015. *Journal of Water Resource and Protection*, 8 (2): 252-262.

Odendaal, N. 2019. *Water shedding can be avoided, says Sisulu* (video online). Available: https://www.polity.org.za/article/water-shedding-can-be-avoided-says-sisulu-2019-10-28 (Accessed 26 October 2019).

O'Donnell, E. L. and Talbot-Jones, J. 2018. Creating legal rights for rivers. *Ecology and Society*, 23 (1): 1-10.

Ololade, O. O., Esterhuyse, S. and Levine, A. D. 2017. The water-energy-food nexus from a South African perspective. *Water-Energy-Food Nexus: Principles and Practices*, 229: 129.

Onyenankeya, K. and Salawu, A. 2018. Negotiating water conservation communication through indigenous media. *Communitas*, 23: 178-193.

Onyenankeya, K. U. 2017. Development communication for water conservation in rural and peri-urban communities: a study of three district municipalities in Eastern Cape, South Africa. PhD thesis, University of Fort Hare.

Onyenankeya, K., Caldwell, M. and Okoh, A. I. 2018. Sustainable water use and the nexus of behavioural intentions: the case of four South African communities. *Water and Environment Journal*, 32 (2): 285-291.

Opare, S. 2011. Sustaining water supply through a phased community management approach: Lessons from Ghana's "oats" water supply scheme. *Environment, Development and Sustainability*, 13: 1021-1042.

Organization, W. H. 2019. Safer water, better health. (online). Available: https://apps.who.int/iris/bitstream/handle/10665/329905/9789241516891-eng.pdf?ua=1 (Accessed 17 May 2019).

Otkin, J.A., Anderson, M.C., Hain, C., Svoboda, M., Johnson, D., Mueller, R., Tadesse, T., Wardlow, B. and Brown, J. 2016. Assessing the evolution of soil moisture and vegetation conditions during the 2012 United States flash drought. *Agricultural and forest meteorology*, 218: 230-242.

Oullier, O., Cialdini, R., Thaler, R. H. and Mullainathan, S. 2010. Improving public health prevention with a nudge. *Economic Perspectives*, 6 (2): 117-136.

Oyekale, A. S. 2017. Access to safe drinking water, sanitation, and under 5 diarrhea morbidity in South Africa. *Annals of Tropical Medicine and Public Health*, 10 (1): 187.

Ozturk, I. 2015. Sustainability in the food-energy-water nexus: evidence from BRICS (Brazil, the Russian Federation, India, China, and South Africa) countries. *Energy*, 93: 999-1010.

Ozturk, I., 2017. The dynamic relationship between agricultural sustainability and food-energy-water poverty in a panel of selected Sub-Saharan African Countries. *Energy Policy*, 107: 289-299.

Pahlow, M., Snowball, J. and Fraser, G. 2015. Water footprint assessment to inform water management and policy making in South Africa. *Water SA*, 41 (3): 300-313.

Pahl-Wostl, C. 2017. An evolutionary perspective on water governance: from understanding to transformation. *Water Resources Management*, 31 (10): 2917-2932.

Pahl-Wostl, C., Vörösmarty, C., Bhaduri, A., Bogardi, J., Rockström, J. and Alcamo, J. 2013. Towards a sustainable water future: shaping the next decade of global water research. *Current Opinion in Environmental Sustainability*, 5 (6): 708-714.

Palanaippan, M., Gleick, P. H., Allen, L., Cohen, M. J., Christian-Smith, J. and Smith, C. 2017. *Clearing the waters: a focus on water quality solutions*. Nairobi: United Nations Environment Programme.

Palanichamy, R.B. 2019. *How does a flood-prone city run out of water? Inside Chennai's "Day Zero" crisis.* Available: https://www.wri.org/blog/2019/06/how-does-flood-prone-city-run-out-water-inside-chennai-day-zero-crisis (Accessed 24 November 2019).

Pan, M.L. 2016. *Preparing literature reviews: qualitative and quantitative approaches*. United Kingdom: Taylor and Francis.

Pandey, S., Pandey, S.K. and Miller, L. 2017. Measuring innovativeness of public organizations: using natural language processing techniques in computer-aided textual analysis. *International Public Management Journal*, 20 (1): 78-107.

Papas, M. 2018. Supporting sustainable water management: insights from Australia's reform journey and future directions for the Murray–Darling Basin. *Water*, 10 (11): 1649.

Parfitt, J., 2005. Questionnaire design and sampling. In: Flowerdew, R. and Martin. D. ed. *Methods in human geography: A guide for students doing a research project.* England: Pearson, 78-106.

Parks, R., Mclaren, M., Toumi, R. and Rivett, U. 2019. Experiences and lessons in managing water from Cape Town (online). Available: https://www.researchgate.net/profile/Robbie_Parks/publication/336681159_Experiences_and_lessons_in_managing_water_from_Cape_Town/links/5dacd493a6fdccc99d925eec/Experiences-and-lessons-in-managing-water-from-Cape-Town.pdf (Accessed 19 November 2019).

Pascoe, S., Brincat, S. and Croucher, A. 2019. The discourses of climate change science: scientific reporting, climate negotiations and the case of Papua New Guinea. *Global Environmental Change*, 54: 78-87.

Pasquini, L., Ziervogel, G., Cowling, R. M. and Shearing, C. 2015. What enables local governments to mainstream climate change adaptation? lessons learned from two municipal case studies in the Western Cape, South Africa. *Climate and Development*, 7 (1): 60-70.

Patton, M. 1990. *Qualitative evaluation and research methods*. 2nd ed. California: SAGE Publications.

Paul, J., Modi, A. and Patel, J. 2016. Predicting green product consumption using theory of planned behavior and reasoned action. *Journal of retailing and consumer services*, 29: 123-134.

Pedro-Monzonís, M., Solera, A., Ferrer, J., Estrela, T. and Paredes-Arquiola, J. 2015. A review of water scarcity and drought indexes in water resources planning and management. *Journal of Hydrology*, 527: 482-493.

Pekel, J.F., Cottam, A., Gorelick, N. and Belward, A.S. 2016. High-resolution mapping of global surface water and its long-term changes. *Nature*, 540 (7633): 418-422.

Peuckert, J. 2016. Urban water innovation systems in newly industrialized countries: case studies of Brazil, China, India and South Africa. In: *Innovation Systems and Capabilities in Developing Regions*. Routledge, 143-174.

Phellas, C.N., Bloch, A. and Seale, C. 2011. Structured methods: interviews, questionnaires and observation. *Researching society and culture*, 3: 1-12.

Phipps, M. and Brace-Govan, J. 2011. From right to responsibility: sustainable change in water consumption. *Journal of Public Policy & Marketing*, 30 (2): 203-219.

Pienaar, A., Brent, A. C., Musango, J. K. and De Kock, I. H. 2017. Water resource infrastructure implications of a green economy transition in the Western Cape Province of South Africa: a system dynamics approach. *South African Journal of Industrial Engineering*, 28 (2): 78-94.

Pilaj, H. 2017. The choice architecture of sustainable and responsible investment: nudging investors toward ethical decision-making. *Journal of business ethics*, 140(4): 743-753.

Poddar, R., Qureshi, M. E. and Shi, T. 2014. A comparison of water policies for sustainable irrigation management: the case of India and Australia. *Water Resources Management*, 28 (4): 1079-1094.

Porter, M. E. and Kramer, M. R. 2019. Creating shared value. In: Lenssen, G. and Smith, N. eds. *Managing sustainable business*. Dordrecht: Springer, 323-346.

Projected water resources in 2007 and 2050 (image). Available: www.fewresources.org/water-scarcity-issues-were-running-out-of-water.html (Accessed 12 July 2017).

Rahi, S. 2017. Research design and methods: A systematic review of research paradigms, sampling issues and instruments development. *International Journal of Economics and Management Sciences*, (6) 2: 1-5.

Ramírez, R. R., De Clercq, W. and Jackson, M. N. 2019. Human Water Governance: A social innovation model to reduce the inequalities of water services in South African informal settlements. In: *New Paths of Entrepreneurship Development*. Springer, 231-255.

Ramsey, E., Berglund, E. Z. and Goyal, R. 2017. The impact of demographic factors, beliefs, and social influences on residential water consumption and implications for non-price policies in Urban India. *Water*, 9 (11): 844-865.

Ramulongo, L., Nethengwe, N. and Musyoki, A. 2017. The nature of urban household water demand and consumption in Makhado Local Municipality: a case study of Makhado Newtown. *Procedia Environmental Sciences*, 37: 182-194.

Rana, M. and Guleria, V. 2018. Water Scarcity in India: A Threat to Sustainable Management of Water. *ESSENCE Int. J. Env. Rehab. Conserv*. IX (1): 35-44.

Rasul, G. and Sharma, B. 2016. The nexus approach to water–energy–food security: an option for adaptation to climate change. *Climate Policy*, 16 (6): 682-702.

Rebonato, R. 2012. *Taking liberties: A critical examination of libertarian paternalism*. United Kingdom: Palgrave Macmillan.

Reddy, S. M., Montambault, J., Masuda, Y. J., Keenan, E., Butler, W., Fisher, J. R., Asah, S. T. and Gneezy, A. 2017. Advancing conservation by understanding and influencing human behavior. *Conservation Letters*, 10 (2): 248-256.

Reddy, S.M., Montambault, J., Masuda, Y.J., Keenan, E., Butler, W., Fisher, J.R., Asah, S.T. and Gneezy, A. 2017. Advancing conservation by understanding and influencing human behavior. *Conservation Letters*, 10 (2): 248-256.

Reddy, V. R. 2016. Regulatory instruments and demand management of water: potential and prospects. In: *Indian Water Policy at the Crossroads: Resources, Technology and Reforms*. Springer, 153-178.

Reese, G., Loew, K. and Steffgen, G. 2014. A towel less: social norms enhance pro-environmental behavior in hotels. *The Journal of Social Psychology*, 154 (2): 97-100.

Ridoutt, B.G. and Pfister, S. 2010. A revised approach to water footprinting to make transparent the impacts of consumption and production on global freshwater scarcity. *Global Environmental Change*, 20 (1): 13-120.

Ringler, C., Zhu, T., Gruber, S., Treguer, R., Auguste, L. and Addams, L., 2016. Role of water security for agricultural and economic development–concepts and global scenarios. In *Handbook on Water Security*. United Kingdom: Edward Elgar Publishing, 183-200.

Robinson, C. J., Maclean, K., Hill, R., Bock, E. and Rist, P. 2016. Participatory mapping to negotiate indigenous knowledge used to assess environmental risk. *Sustainability Science*, 11 (1): 115-126.

Rodina, L. 2016. Human right to water in Khayelitsha, South Africa–lessons from a 'lived experiences' perspective. *Geoforum*, 72 (2016): 58-66.

Rogoll, J. L. 2017. Shaping hydropolitics in Durban: community activist strategies in Chatsworth. PhD thesis, University of KwaZulu-Natal.

Ronquest-Ross, L.C., Vink, N. and Sigge, G.O. 2015. Food consumption changes in South Africa since 1994. *South African Journal of Science*, 111 (9-10): 1-12.

Roulston, K. 2010. *Reflective interviewing: a guide to theory and practice*. California: Sage.

Ruggeri, K. 2018. Behavioral Insights for Public Policy: Concepts and Cases. London: Routledge.

Russell, S. and Fielding, K. 2010. Water demand management research: a psychological perspective. *Water resources research*, 46 (5): 1-12.

Ryan, J. 2017. To what extent have the policy recommendations of the behavioural insights team been in accordance with nudge theory? Master's thesis, University of Twente.

Safari, Y., Asadi, F., Amiri, N., Motlagh, Z. J., Azari, A., Sharafi, H. and Sharafi, K. 2017. Management of drinking water consumption at home: a case study of knowledge and attitude evaluation-Kermanshah, Iran (2015). *Indian Journal of Public Health Research & Development*, 8 (2): 403-409.

Sahin, O., Bertone, E. and Beal, C.D. 2017. A systems approach for assessing water conservation potential through demand-based water tariffs. *Journal of Cleaner Production*, 148: 773-784.

Salih, A. M. and Abdo, G. M. 2017. Water Conservation in the Arab region. In: *Water, Energy & Food Sustainability in the Middle East*. Springer, 85-105.

Sandhe, A. and Joshi, A. 2017. Consumers' attitude towards organic food products in Vadodara–an exploratory study. *Pacific Business Review International*, 10 (1): 32-40.

SAPA. 2012. Molewa warns of water crisis. Available: https://www.timeslive.co.za/news/sci-tech/2012-02-28-molewa-warns-of-water-crisis/ (Accessed 26 October 2017).

Sarantakos, S. 1993. Varieties of social research. In: *Social Research*. United Kingdom: Macmillan Education, 29-69.

Sarantakos, S. 2013. Social research. 4th ed. Cape Town: Palgrave Macmillan

Schmitt, T. 2016. Integrated water resources management in Brazil: participatory approaches as a way to resource justice? In: *Fairness and Justice in Natural Resource Politics*. Routledge, 85-101.

Schubert, C. 2017. Green nudges: do they work? Are they ethical? *Ecological Economics*, 132: 329-342.

Schultz, P.W. 2011. Conservation means behavior. *Conservation biology*, 25 (6): 1080-1083.

Schultz, L., Folke, C., Österblom, H. and Olsson, P. 2015. Adaptive governance, ecosystem management, and natural capital. *Proceedings of the National Academy of Sciences*, 112 (24): 7369-7374.

Schultz, P. W. 2014. Strategies for promoting proenvironmental behavior. *European Psychologist*, (Suppl.): 107-117.

Schulz, C. and Loris, A. A. 2017. The paradox of water abundance in Mato Grosso, Brazil. *Sustainability*, 9 (10): 1796.

Schwab, K. ed. 2009. *The Global Competitiveness Report 2009–10*. Geneva: World Economic Forum.

Seago, C. 2016. A comparison of the South African approach to water resources management and planning with four international countries. *Research Report: a comparison of the South African approach to water resources management and planning with four international countries.* (online). Available: http://www.wrc.org.za/wp-content/uploads/mdocs/KV%20341-15.pdf (Accessed 21 June 2018).

Seyoum, S., Alfonso, L., Van Andel, S. J., Koole, W., Groenewegen, A. and Van De Giesen, N. 2017. A Shazam-like household water leakage detection method. *Procedia Engineering*, 186: 452-459.

Seyranian, V., Sinatra, G. M. and Polikoff, M. S. 2015. Comparing communication strategies for reducing residential water consumption. *Journal of Environmental Psychology*, 41: 81-90.

Shackleton, S., Ziervogel, G., Sallu, S., Gill, T. and Tschakert, P. 2015. Why is socially-just climate change adaptation in sub-Saharan Africa so challenging? A review of barriers identified from empirical cases. *Wiley Interdisciplinary Reviews: Climate Change*, 6 (3): 321-344.

Shamim, M.A., Panhwar, I.A. and Iftikhar, S.F. 2019. Water Consumption Behavior: A Review with Global Perspective and Special Reference to Developing Country. *Global Management Journal for Academic & Corporate Studies*, 9 (1): 146-162.

Shan, Y., Yang, L., Perren, K. and Zhang, Y. 2015. Household water consumption: insight from a survey in Greece and Poland. *Procedia Engineering*, 119: 1409-1418.

Shakespeare, T., Fehlberg, M., Slejko, T., Taylor, J., Srbinovska, I. and Bolsin, S. 2019. Successful use of "Choice Architecture" and "Nudge Theory" in a quality improvement initiative of analgesia administration after Caesarean section. *Journal of evaluation in clinical practice*, 25 (1): 125-129

Sheeran, P. and Rivis, A. 2017. Descriptive norms as an additional predictor in the theory of planned behaviour: a meta-analysis. In: *Planned Behaviour*. New York: Routledge, 49-68.

Sheik, N. 2017. Unskilled managers running Durban's failing system. *Sunday Tribune,* 29 October. Available: https://www.iol.co.za/sunday-tribune/news/unskilled-managers-running-durbans-failing-billing-system-11762657 (Accessed 21 November 2017).

Shen, D. and Reddy, V. R. 2016. Water pricing in China and India: a comparative analysis. *Water Policy*, 18 (S1): 103-121.

Shensul, S.L., Schensul, J.J. and LeCompte, M.D. 1999. Essential ethnographic methods 2: observations, interviews and questionnaires, Walnut Creek: Altamira Press.

Shields, K. F., Bain, R. E., Cronk, R., Wright, J. A. and Bartram, J. 2015. Association of supply type with fecal contamination of source water and household stored drinking water in developing countries: a bivariate meta-analysis. *Environmental Health Perspectives*, 123 (12): 1222-1231.

Shiva, V. 2016. *Water wars: Privatization, pollution, and profit*. Canada: North Atlantic Books.

Silanikove, N. and Koluman, N. 2015. Impact of climate change on the dairy industry in temperate zones: predications on the overall negative impact and on the positive role of dairy goats in adaptation to earth warming. *Small Ruminant Research*, 123 (1): 27-34.

Silvestri, G., Wittmayer, J.M., Schipper, K., Kulabako, R., Oduro-Kwarteng, S., Nyenje, P., Komakech, H. and Van Raak, R. 2018. Transition management for improving the sustainability of WASH services in informal settlements in Sub-Saharan Africa—an exploration. *Sustainability*, 10 (11): 4052.

Silveti, D. and Andersson, K. 2019. Challenges of governing off-grid "productive" sanitation in Peri-Urban areas: comparison of case studies in Bolivia and South Africa. *Sustainability*, 11 (12): 3468.

Simonovic, S.P. 2002. World water dynamics: global modeling of water resources. *Journal of Environmental Management*, 66 (3): 249-267.

Singh, O. 2019. Fix those leaks and illegal connections, Nkosazana Dlamini-Zuma tells eThekwini. Available: https://www.timeslive.co.za/news/south-africa/2019-07-31-fix-those-leaks-and-illegal-connections-nkosazana-dlamini-zuma-tells-ethekwini/ (Accessed 18 December 2019).

Singh, S. and Sharma, V.K. 2019. Urban droughts in India: case study of Delhi. In: *Urban Drought*. Singapore: Springer, 155-167.

Smith, M. and Toprakkiran, N. 2019. Behavioural insights, nudge and the choice environment in obesity policy. *Policy Studies*, 40 (2): 173-187.

Sobowale, A. and Ortigara, A. 2017. From MDGs to SDGs: the need for global thinking and local actions in the Nigerian water sector. *Arid Zone Journal of Engineering, Technology and Environment*, 13 (5): 620-629.

Sojamo, S. 2015. Unlocking the "prisoner's dilemma" of corporate water stewardship in South Africa—exploring corporate power and legitimacy of engagement in water management and governance. *Sustainability*, 7 (6): 6893-6918.

Song, F. and Wu, J. 2019. Study of Residential Demand-Side Management. In *Household Energy Consumption in China: 2016 Report.* Singapore: Springer.

Soto Rios, P. C., Deen, T. A., Nagabhatla, N. and Ayala, G. 2018. Explaining water pricing through a water security lens. *Water*, 10 (9): 1173.

Sousa Júnior, W., Baldwin, C., Camkin, J., Fidelman, P., Silva, O., Neto, S. and Smith, T. F. 2016. Water: drought, crisis and governance in Australia and Brazil. *Water*, 8 (11): 493.

Soyapi, C.B. 2017. Water security and the right to water in Southern Africa: An overview. *Potchefstroom Electronic Law Journal/Potchefstroomse Elektroniese Regsblad*, 20(1): 1-9

Sprinthall, R.C., Schmutte, G.T. and Sirois, L., 1991. *Understanding educational research*. New Jersey: Prentice Hall.

Srnka, K.J. and Koeszegi, S.T. 2007. From words to numbers: how to transform qualitative data into meaningful quantitative results. *Schmalenbach Business Review*, 59 (1: 29-57.

Staddon, C. 2016. *Managing Europe's water resources: twenty-first century challenges*. New York: Routledge.

Statistics SA. 2016. Statistical Release P0301. Community Survey. (online). Available at: http://cs2016.statssa.gov.za/wp-content/uploads/2016/07/NT-30-06-2016-RELEASE-for-CS-2016-_ Statistical-releas_1-July-2016.pdf. Accessed 12 February 2021

Stats SA. 2017. General household survey (online). Available: http://www.statssa.gov.za/publications/P0318/P03182017.pdf (Accessed 15 June 2018).

Statistics South Africa. 2017. (online). Available: Available: http://www.statssa.gov.za/publications/P0302/P03022017.pdf. (23 February 2021)

Stavenhagen, M., Buurman, J. and Tortajada, C. 2018. Saving water in cities: assessing policies for residential water demand management in four cities in Europe. *Cities*, 79: 187-195.

Stepping, K. 2016. *Urban sewage in Brazil: drivers of and obstacles to wastewater treatment and reuse. Governing the water-energy-food nexus series* (online). Available: https://www.econstor.eu/bitstream/10419/199489/1/die-dp-2016-26.pdf (Accessed 23 March 2019).

Stigter, T.Y., Varanda, M., Bento, S., Nunes, J.P. and Hugman, R. 2017. Combined assessment of climate change and socio-economic development as drivers of freshwater availability in the south of Portugal. *Water resources management*, 31 (2): 609-628.

Straus, J., Chang, H. and Hong, C.-y. 2016. An exploratory path analysis of attitudes, behaviors and summer water consumption in the Portland Metropolitan Area. *Sustainable Cities and Society*, 23: 68-77.

Strabheim, H. and Beck, S. 2019. Introduction to the handbook of behavioural change and public policy. In: Handbook of behavioural change and public policy. United Kingdom: Edward Elgar Publishing.

Street, R. A. 2016. Unpacking the new proposed regulations for South African traditional health practitioners. *SAMJ: South African Medical Journal*, 106 (4): 325-326.

Suhag, R. 2016. *Overview of groundwater in India, Central Groundwater Board-PRS legislative research report* (online). Available: http://13.127.246.217:8080/xmlui/bitstream/handle/123456789/1785/Case%20study-IA1-GWH.pdf?sequence=1 (Accessed 15 February 2019).

Sultana, F. and Loftus, A. 2015. The human right to water: critiques and condition of possibility. *Wiley Interdisciplinary Reviews: Water*, 2 (2): 97-105.

Sunstein, C. R. 2014. *Why nudge? The politics of libertarian paternalism*. Connecticut: Yale University Press.

Sunstein, C.R. 2017. Default rules are better than active choosing (often). *Trends in cognitive sciences,* 21 (8): 600-606.

Sunstein, C.R. 2019. Which nudges do people like? A national survey. In Handbook of Behavioural Change and Public Policy. United Kingdom: Edward Elgar Publishing.

Supply, W. U. J. W., Programme, S. M. and Organization, W. H. 2015. *Progress on sanitation and drinking water: 2015 update and MDG assessment*. World Health Organization.

Sustainable Development Goals to be achieved by 2030 (image). Available: www.un.org/en/development/desa/population/theme/sdg/index.asp (Accessed 12 May 2018).

Sutherland, C., Scott, D. and Hordijk, M. 2015. Urban water governance for more inclusive development: A reflection on the 'waterscapes' of Durban, South Africa. *The European Journal of Development Research*, 27 (4): 488-504.

Sutherland, C., Hordijk, M., Lewis, B., Meyer, C. and Buthelezi, S. 2014. Water and sanitation provision in eThekwini Municipality: a spatially differentiated approach. *Environment and Urbanization*, 26 (2): 469-488.

Swilling, M., Tavener-Smith, L., Keller, A., Von der Heyde, V. and Wessels, B. 2013. *Rethinking incremental urbanism: co-production of incremental informal settlement upgrading strategies* (online). Available: https://www.researchgate.net/profile/Chris_Harnish2/publication/321343057_Eco-Incremental_Housing_Researching_Typologies_and_Systems_in_Pursuit_of_a_Community- (Accessed 23 March 2018).

Swyngedouw, E. 2006. Power, water and money: exploring the nexus. In: *Human Development Report Office (HDRO)*. New York: United Nations Development Programme (online) Available: http://hdr.undp.org/en/reports/global/hdr2006/papers/Swyngedouw.pdf (Accessed 21 July 2018).

Tahir, M. R. M., Sa'ari, H. and Johare, R. 2017. Illegal street racers' behavior: the proposed theory. *International Journal of Academic Research in Business and Social Sciences*, 7 (7): 2222-6990.

Talbot-Jones, J. and Bennett, J. 2019. Toward a property rights theory of legal rights for rivers. *Ecological Economics*, 164: 106352.

Tan, Y. S. and Kwek, L. J. 2016. Environmental sustainability and sustainable development. In: *50 Years of Environment: Singapore's Journey towards Environmental Sustainability*. Singapore: World Scientific, 247-264.

Taylor, D., Bury, M., Campling, N., Carter, S., Garfied, S., Newbould, J. and Rennie, T. 2007. A review of the use of the Health Belief Model (HBM), the Theory of Reasoned Action (TRA), the Theory of Planned Behaviour (TPB) and the Trans-Theoretical Model (TTM) to study and predict health related behaviour change. *The School of Pharmacy, University of London,* February: 1-27.

Teddlie, C. and Tashakkori, A. 2009. *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences*. California: Sage publications.

Teotónio, C., Fortes, P., Roebeling, P., Rodriguez, M. and Robaina-Alves, M. 2017. Assessing the impacts of climate change on hydropower generation and the power sector in Portugal: a partial equilibrium approach. *Renewable and Sustainable Energy Reviews*, 74: 788-799.

Terrebonne, P. 2005. *Residential water demand management programs: a selected review of literature* (online). Available: https://core.ac.uk/reader/71344530 (Accessed 23 October 2018).

Thakur, R., Harris, G., Thakur, S. And Onwubu, S. 2019. Factors contributing towards high water usage within poor communities in Kwazulu-Natal, South Africa. *WIT Transactions on Ecology and the Environment*, 239: 1-10.

Thaler, R. H. and Benartzi, S. 2004. Save more tomorrow: using behavioral economics to increase employee saving. *Journal of political Economy*, 112 (S1): S164-S187.

Thaler, R. H. and Sunstein, C. R. 2008. Nudge: improving decisions about health. *Wealth, and Happiness*. New Haven: Yale University Press.

The Civil Engineer. 1985. Durban and the 1983/84 water crisis: emergency water supplies. *Civil Engineer in South Africa*. 27, 29-31.

Thomas, V., Azizi, M.A. and Behzad, K. 2016. *Developing transboundary water resources: What perspectives for cooperation between Afghanistan, Iran and Pakistan?* Kabul, Afghanistan: Afghanistan Research and Evaluation Unit (online). Available: https://s3.amazonaws.com/academia.edu.documents/45848971/1607E_Developing_transboundary_water_resources.pdf?response-content- (Accessed 27 August 2018)

Thompson, R. R., Coe, A., Klaver, I. and Dickson, K. 2011. Design and implementation of a research-informed water conservation education program. *Applied Environmental Education & Communication*, 10 (2): 91-104.

Timm, S.N. and Deal, B.M. 2018. Understanding the behavioral influences behind Singapore's water management strategies. *Journal of Environmental Planning and Management*, 61 (10): 1654-1673.

Tissington, K., Dettmann, M., Langford, M., Dugard, J. and Conteh, S. 2008. Water services fault lines: An assessment of South Africa's water and sanitation provision across 15 municipalities. In: *Centre for Applied Legal Studies in Johannesburg, the Centre on Housing Rights and Evictions in Geneva, & the Norwegian Centre for Human Rights at the University of Oslo* (online). Available: https://www.researchgate.net/publication/304803375_Water_Services_Fault_Lines_An_Assessment_of_South_Africa's_Water_and_Sanitation_Provision_Across_15_Municipalities (Accessed 20 January 2020).

Tom, G., Tauchus, G., Williams, J. and Tong, S. 2011. The role of communicative feedback in successful water conservation programs. *Applied Environmental Education & Communication*, 10 (2): 80-90.

Tong, Y., Fan, L. and Niu, H. 2017. Water conservation awareness and practices in households receiving improved water supply: A gender-based analysis. *Journal of cleaner production*, 141: 947-955.

Top 10 countries where people live without access to clean water (image). Available: https://www.sciencenews.org/article/future-will-people-have-enough-water-live (Accessed 28 April 2018).

Tortajada, C. 2014. Water infrastructure as an essential element for human development. *International Journal of Water Resources Development*, 30 (1): 8-19.

Tortajada, C. and Buurman, J. 2017. *Water policy in Singapore* (online). Available: https://thirdworldcentre.org/wp-content/uploads/2017/08/Water-Policy-in-Singapore.pdf (Accessed 6 September 2019).

Tortajada, C., González-Gómez, F., Biswas, A.K. and Buurman, J. 2019. Water demand management strategies for water-scarce cities: The case of Spain. *Sustainable cities and society*, 45: 649-656.

Tularam, G. A. and Murali, K. K. 2015. Water security problems in Asia and longer-term implications for Australia. In: *Sustainable Water Use and Management*. New York: Springer, 119-149.

Tully, S. 2017. A human right to access water. A critique of general comment no. 15. In: *Economic, Social and Cultural Rights. New York:* Routledge, 345-373.

Tuncok, I.K. and Eslamian, S. 2017. Drought management strategies in water-stressed/water-scarce regions. In: *Handbook of Drought and Water Scarcity.* Boca Rotan: CRC Press, 95-152.

Tundisi, J. G. and Tundisi, T. M. 2016. Integrating ecohydrology, water management, and watershed economy: case studies from Brazil. *Ecohydrology & Hydrobiology*, 16 (2): 83-91.

Turner, A., White, S., Chong, J., Dickinson, M., Cooley, H. and Donnelly, K. 2016. Managing drought: Learning from Australia (online). Available: http://www.allianceforwaterefficiency.org/WorkArea/DownloadAsset.aspx?id=9554 (Accessed 1 November 2018).

Turok, I. and Borel-Saladin, J. 2016. Backyard shacks, informality and the urban housing crisis in South Africa: stopgap or prototype solution? *Housing Studies*, 31 (4): 384-409.

Tussupova, K., Hjorth, P. and Berndtsson, R. 2016. Access to drinking water and sanitation in rural Kazakhstan. *International Journal of Environmental Research and Public Health*, 13 (11): 1115.

UNICEF. 2017. *Progress on sanitation and drinking water: 2015 update and MDG assessment*. Geneva: World Health Organization.

Untaru, E.-N., Ispas, A., Candrea, A. N., Luca, M. and Epuran, G. 2016. Predictors of individuals' intention to conserve water in a lodging context: the application of an extended theory of reasoned action. *International Journal of Hospitality Management*, 59: 50-59.

Val, A. L., Bicudo, C. E. d. M., Bicudo, D. d. C., Pujoni, D. G. F., Rosado, F., Spilki, I. d. S. N., Hespanhol, I., Cirilo, J. A., Tundisi, J. G. and Val, P. 2019. Water Quality in Brazil. *Water Quality in the Americas*: 103.

Van den Berg, C. 2015. Drivers of non-revenue water: a cross-national analysis. *Utilities Policy*, 36: 71-78.

Van Deun, H., van Acker, W., Fobé, E. and Brans, M. 2018. Nudging in public policy and public management: a scoping review of the literature. In: Proceedings of *Political Studies Association 68th Annual International Conference.* Cardiff University, 26-28 March 2018. PSA, 1-27.

Van Vliet, M. and Kok, K. 2015. Combining backcasting and exploratory scenarios to develop robust water strategies in face of uncertain futures. *Mitigation and adaptation strategies for global change*, 20 (1): 43-74.

Van Wilgen, B. W. and Wannenburgh, A. 2016. Co-facilitating invasive species control, water conservation and poverty relief: achievements and challenges in South Africa's Working for Water programme. *Current Opinion in Environmental Sustainability*, 19: 7-17.

Varady, R. G., Zuniga-Teran, A. A., Garfin, G. M., Martín, F. and Vicuña, S. 2016. Adaptive management and water security in a global context: definitions, concepts, and examples. *Current opinion in environmental sustainability*, 21: 70-77.

Vaske, J.J., Beaman, J. and Sponarski, C.C. 2017. Rethinking internal consistency in Cronbach's Alpha. *Leisure Sciences*, 39 (2): 163-173.

Veiga, L. B. E. and Magrini, A. 2013. A cross-sectional analysis of Brazil's water pollution control regulation: suggestions based on the USA regulation. *International Journal of Sustainable Development and Planning*, 8 (4): 537-548.

Victor, D. G., Almeida, P. and Wong, L. 2015. *Water management policy in Brazil* (online). Available: https://www.researchgate.net/profile/Paulo_Almeida27/publication/279447246_Water_Management_Policy_in_Brazil/links/5592b80f08ae16f493ee38e1/Water-Management-Policy-in-Brazil.pdf (Accessed 21 October 2019).

Viljoen, G. 2017. South Africa's water crisis: the idea of property as both a cause and solution. *Law, Democracy and Development*, 21 (1): 176-200.

Vogel, C. and Olivier, D., 2019. Re-imagining the potential of effective drought responses in South Africa. *Regional Environmental Change*, 19 (6): 1561-1570.

Vougiouklis, T. 2018. From continuous to ciscrete via V andV bar. *Science & Philosophy*, 6 (2): 37-44.

Wada, Y., Flörke, M., Hanasaki, N., Eisner, S., Fischer, G., Tramberend, S., Satoh, Y., Van Vliet, M., Yillia, P. and Ringler, C. 2016. Modeling global water use for the 21st century: water futures and solutions (WFaS) initiative and its approaches. *Geoscientific Model Development*, 9: 175-222.

Wakode, H. B., Baier, K., Jha, R. and Azzam, R. 2018. Impact of urbanization on groundwater recharge and urban water balance for the city of Hyderabad, India. *International Soil and Water Conservation Research*, 6 (1): 51-62.

Wang, X.-j., Zhang, J.-y., Shahid, S., Guan, E.-h., Wu, Y.-x., Gao, J. and He, R.-m. 2016. Adaptation to climate change impacts on water demand. *Mitigation and Adaptation Strategies for Global Change*, 21 (1): 81-99.

Wanjiru, E. M. and Xia, X. 2015. Energy-water optimization model incorporating rooftop water harvesting for lawn irrigation. *Applied Energy*, 160: 521-531.

Wanjiru, E.M., Zhang, L. and Xia, X. 2016. Model predictive control strategy of energy-water management in urban households. *Applied energy*, 179: 821-831.

Warf, B. 2016. Global geographies of corruption. *GeoJournal*, 81 (5): 657-669.

Warner, L. A., Rumble, J., Martin, E., Lamm, A. J. and Cantrell, R. 2015. The effect of strategic message selection on residents' intent to conserve water in the landscape. *Journal of Agricultural Education*, 56 (4): 59-74.

Warsame, A.M. 2018. Perceived challenges of water scarcity on livestock production and pastoral community resilience in Qardho District, Somalia. Master's Degree, Makere University.

Water UN. 2018. Sustainable development goal 6. *Synthesis report on water and sanitation. New York: United Nations*,

Watson, S. 2017. Consuming water smartly: the significance of sociocultural differences to water-saving initiatives. *Local Environment*, 22 (10): 1237-1251.

Waylen, G. 2018. Nudges for gender equality? What can behaviour change offer gender and politics? *European Journal of Politics and Gender*, 1 (1-2): 167-183.

Weaver, M., O'Keeffe, J., Hamer, N. and Palmer, C. 2017. Water service delivery challenges in a small South African municipality: identifying and exploring key elements and relationships in a complex social-ecological system. *Water SA*, 43 (3): 398-408.

Weitz, N., Strambo, C., Kemp-Benedict, E. and Nilsson, M., 2017. Closing the governance gaps in the water-energy-food nexus: insights from integrative governance. *Global Environmental Change*, 45: 165-173.

Wells, V. K., Babak, T., Gregory-Smith, D., and Manika, D. 2016. The role of generativity and attitudes on employees' home and workplace water and energy saving behaviours. *Tourism Management,* 56: 63-74.

Whitehead, M., Jones, R., Howell, R., Lilley, R. and Pykett, J. 2014. *Nudging all over the world: assessing the global impact of the behavioural sciences on public policy* (online). Available: https://www.research.ed.ac.uk/portal/files/21716133/NudgingAllOvertheWorld.pdf (Accessed 21 June 2018).

Whitehead, M., Jones, R. and Pykett, J. 2019. Nudging around the world: a critical geography of the behaviour change agenda. In: *Handbook of Behavioural Change and Public Policy*. Chelteham: Edward Elgar Publishing.

Wichman, C. J., Taylor, L. O. and Von Haefen, R. H. 2016. Conservation policies: who responds to price and who responds to prescription? *Journal of Environmental Economics and Management*, 79: 114-134.

Williams, J.E., Rummel, S., Lemon, J., Barney, M., Smith, K., Fesenmyer, K. and Schoen, J. 2016. Engaging a community of interest in water quality protection: anglers monitoring wadeable streams. *Journal of Soil and Water Conservation*, 71 (5): 114A-119A.

Willis, R. M., Stewart, R. A., Giurco, D. P., Talebpour, M. R. and Mousavinejad, A. 2013. End use water consumption in households: impact of socio-demographic factors and efficient devices. *Journal of Cleaner Production*, 60: 107-115.

Woodhouse, P. and Muller, M. 2017. Water governance—an historical perspective on current debates. *World Development*, 92: 225-241.

Woodward, E., Jackson, S., Finn, M. and McTaggart, P. M. 2012. Utilising indigenous seasonal knowledge to understand aquatic resource use and inform water resource management in northern Australia. *Ecological Management & Restoration*, 13 (1): 58-64.

World Bank Report. 2016. Brazil may be the owner of 20% of the world's water supply but it is still very thirsty. (online) Available: https://www.worldbank.org/en/news/feature/2016/07/27/how-brazil-managing-water-resources-new-report-scd (Accessed 21 June 2019).

World Health Organisation (WHO). 2017. Global health observatory data. Online. Available:

World water development report 4. 2012. Available: https://www.un.org/waterforlifedecade/scarcity.shtml (Accessed 20 May 2018).

Wunderlich, S.M. and Martinez, N.M. 2018. Conserving natural resources through food loss reduction: production and consumption stages of the food supply chain. *International Soil and Water Conservation Research*, 6 (4): 331-339.

WWAP, U. 2012. *World water assessment programme: the United Nations world water development report 4: managing water under uncertainty and risk*: Paris: UNESCO.

Xiong, Y. J., Hao, X. R., Liao, C. and Zeng, Z. N. 2016. Relationship between water-conservation behavior and water education in Guangzhou, China. *Environmental Earth Sciences*, 75 (1): 1.

Xue, P., Hong, T., Dong, B. and Mak, C. 2017. A preliminary investigation of water usage behavior in single-family homes. In: Proceedings of *Building Simulation*. Springer, 949-962.

Yates, J. S. and Harris, L. M. 2018. Hybrid regulatory landscapes: the human right to water, variegated neoliberal water governance, and policy transfer in Cape Town, South Africa, and Accra, Ghana. *World Development*, 110: 75-87.

Yazdanpanah, M., Feyzabad, F.R., Forouzani, M., Mohammadzadeh, S. and Burton, R.J. 2015. Predicting farmers' water conservation goals and behavior in Iran: a test of social cognitive theory. *Land Use Policy,* 47: 401-407.

Yazdanpanah, M., Forouzani, M., Abdeshahi, A. and Jafari, A. 2016. Investigating the effect of moral norm and self-identity on the intention toward water conservation among Iranian young adults. *Water Policy*, 18 (1): 73-90.

Ye, L., Bose, M. and Pelton, L.E. 2017. How gender identity affects consumer behaviour: overview and historical analysis. *The Journal of Business Diversity*, 17 (4): 9-24.

Yin, R. K. 2013. *Case study research: design and methods*. 5th ed. California: Sage publications.

Zhan, Y., He, R. and So, W. W. M. 2019. Developing elementary school children's water conversation action competence: a case study in China. *International Journal of Early Years Education*, 27 (3): 287-305.

Zhang, D., Gersberg, R. M., Ng, W. J. and Tan, S. K. 2017. Conventional and decentralized urban stormwater management: a comparison through case studies of Singapore and Berlin, Germany. *Urban Water Journal*, 14 (2): 113-124.

Zhao, J., Ni, H., Peng, X., Li, J., Chen, G. and Liu, J. 2016. Impact of water price reform on water conservation and economic growth in China. *Economic Analysis and Policy*, 51: 90-103.

Zhao, M., Velicogna, I. and Kimball, J. S. 2017. A global gridded dataset of grace drought severity index for 2002–14: comparison with pdsi and spei and a case study of the Australia millennium drought. *Journal of Hydrometeorology*, 18 (8): 2117-2129.

Zhuang, J., Lapinski, M. K. and Peng, W. 2018. Crafting messages to promote water conservation: using time-framed messages to boost conservation actions in the United States and China. *Journal of Applied Social Psychology*, 48 (5): 248-256.

Zolli, A. and Healy, A. M. 2012. *Resilience: why things bounce back*. Hachette UK: McGraw-Hill Education.

APPENDIX A: Ethics clearance letter

MANAGEMENT SCIENCES: FACULTY RESEARCH ETHICS COMMITTEE (FREC)

30 May 2019

Student Name: Ms R Thakur
Student No: 19251504
FREC REF: 34/19FREC

Dear Ms R Thakur

DOCTOR OF PHILOSOPHY: PUBLIC ADMINISTRATION

TITLE: REDUCING WATER CONSUMPTION IN LOW -COST HOUSING AREAS IN THE ETHEKWINI MUNICIPALITY

Please be advised that the FREC Committee has reviewed your proposal and the following decision was made: **Approved – Ethics Level 2**

Date of FRC Approval: 29 May 2019

Approval has been granted for a period of two years from the above FRC date, after which you are required to apply for safety monitoring and annual recertification. Please use the form located at the Faculty. This form must be submitted to the FREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the FREC according to the FREC SOP's.
Please note that ANY amendments in the approved proposal require the approval of the FREC as outlined in the FREC SOP's.

Yours sincerely

Prof JP Govender
Chairperson: Faculty Research Ethics Committee

APPENDIX B: Gatekeeper letter

EXECUTIVE COUNCILLOR HU DE BOER

EThekwini Municipality
221 Anton Lembede Street, Durban
Shell House Building, M Floor
Tel: 031 311 3468, Cell: 0833552343
Durbanward35@gmail.com

5 APRIL 2018

To: Durban University of Technology

DOCTORATE STUDY

We hereby grant permission to Mrs Rookmoney Thakur, a doctorate candidate at the Durban University of Technology (DUT) to carry out her study titled: **Reducing water consumption in low cost housing areas in the EThekwini Municipality.**

Thank You

05/04/2018

HEINZ DE BOER
WARD 35 COUNCILLOR
0833552343

DATE

APPENDIX C: Letter of information and consent

LETTER OF INFORMATION

Faculty of Management Sciences

Department of Public Management & Economics

Title of the Research Study: Reducing water consumption in low-cost housing areas in eThekwini municipality

Principal Investigator/s/researcher: Rookmoney Thakur

Co-Investigator/s/supervisor/s: Prof. Geoffrey Harris

Brief Introduction and Purpose of the Study

South Africa is facing a serious water crisis as municipalities across the country are finding it hard to meet water demands. Municipalities within Rustenberg, Majakaneng in Brits, Malamulele in Limpopo, and eTthekwini in Kwazulu-Natal, amongst others, have been trying to mitigate the inadequacy of water supply. According to a water study by the Institute of Security Studies (2017), there is uncertainty with respect to the future demand and supply of water in South Africa. This may result in an unstainable gap between supply and demand for many years. Furthermore, South Africa is losing over 1, 5 billion cubic metres of water a year due to failing infrastructure, such as piping, which has outlived its lifespan. Of concern, South Africa loses more than R7-billion worth of water annually because of leaking taps and pipes. Within poorer areas, the efficient supply and conscientious use of water resources is important, with the former a basic right and the latter an opportunity for research given that the country is in the grips of its worth drought in decades. This study aims to establish insight and knowledge regarding the high-water consumption by inhabitants of low-cost housing (LCH) developments within the eThekwini municipality. Several studies have confirmed that water conservation attitudes and behaviour are closely related. This study asserts that behavioural patterns such as attitude, perception and willingness to pay by the communities has an impact on the management, both supply and infrastructural, of the resource in LCH areas. In order to highlight this supposition, the Waterloo low-cost housing area will be the focus area of study.

Outline of the Procedures:

Responsibilities of the participant: Participants will be asked to avail themselves for either an interview or be part of a focus group. Consultation times will be done at the convenience of participants at venues of mutual suitability.

Inclusion/exclusion criteria: Purposive sample will be used to target potential participants.

Explanation of tools and measurement outcomes: An interview survey method and focus group with no medical involvement of participants. Purposeful sampling will be used to gather pertinent data. Should follow-ups be necessary, this will be done at the convenience of participants?

Risks or Discomforts to the Participant: (Description of foreseeable risks or discomforts to for participants if applicable e.g., Transient muscle pain, VBAI, post-needle soreness, other adverse reactions, etc.) **None**

Benefits: (To the participant and to the researcher/s e.g., publications) Increase body of knowledge on the issue of water management within the EThekwini municipality and gain insight on views and attitudes of inhabitants in LCH developments.

Reason/s because the Participant May Be Withdrawn from the Study: Non-availability of disinterest**. T**here will be no adverse consequences for the participant should they choose to withdraw.

Remuneration: (Will the participant receive any monetary or other types of remuneration?) No

Costs of the Study: (Will the participant be expected to cover any costs towards the study?) No

Confidentiality: (Description of the extent to which confidentiality will be maintained and how will this be maintained?) There is no confidentiality for interviews as participants are experts in their fields. However, confidentiality will be maintained for the focus group sessions.

Research-related Injury: (What will happen should there be a research-related injury or adverse reaction? Will there be any compensation?) No

Persons to Contact in the Event of Any Problems or Queries:

Supervisor,) Please contact the researcher or the Institutional Research Ethics administrator on 031 373 2900. Complaints can be reported to the DVC: TIP, Prof Moyo on 031 373 2382 or dvctip@dut.ac.za.

General:

Potential participants must be assured that participation is voluntary and the approximate number of participants to be included should be disclosed. A copy of the information letter should be issued to participants. The information letter and consent form must be translated and provided in the primary spoken language of the research population e.g., isiZulu.

APPENDIX D: Letter of consent

LETTER OF CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, (Rookmoney Thakur), about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____ _____ _____ _____

Full Name of Participant **Date** **Time** **Signature / Right Thumbprint**

I, _____ (name of researcher) herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

_____ _____ _____

Full Name of Researcher **Date** **Signature**

_____ _____ _____

Full Name of Witness (If applicable) **Date** **Signature**

_____ _____ _____

Full Name of Legal Guardian (If applicable) **Date** **Signature**

APPENDIX E: Semi-structured interview discussion guide

Title: Reducing water consumption in low-cost housing areas in the eThekwini municipality.

Researcher: Rookmoney Thakur

Date:

Time:

Participant:

Introduce myself and the purpose of the interview group. Thank participants for their involvement and time. Outline the ethical considerations and ask for permission to tape record the session. State that the tapes will only be listened by the researcher (myself) and that the tapes will be stored in a secure place.

1. Is the current water management system in the eThekwini municipality feasible, affordable and sustainable?
2. How can one improve the water management system in eThekwini in order to achieve the government strategic development and governance goals?
3. Does a relationship exist between households in LCH and the municipality?
4. Are changes in water management system communicated on a continuous basis to the households in LCH?
5. Do you think the households understand that they are part of the solution to water demand management?
6. Do households report the challenges they experience in their efforts to manage their water demand?
7. Do households know where to report their water management devices when there is a breakdown?
8. Is the level of education in the households significant in understanding the importance of water demand management?
9. What are the attitudes of households towards high water consumption?
10. Does the socio-economic status of a household lay a role in their usage of water?

APPENDIX E: Focus group discussion guide

Title: Reducing water consumption in low-cost housing areas in the eThekwini municipality.

Researcher: Rookmoney Thakur

Date:

Time:

Number of groups:

Number of participants:

Introduce myself and the purpose of the focus group. Thank participants for their involvement. Outline the ethical considerations and ask for permission to tape record the session. State that the tapes will only be listened by the researcher (myself) and that the tapes will be stored in a secure place.

1. Are you aware that there is a drought in the country presently?
2. What are some of the water problems you experiencing in this area?
3. Do you think about the amount of water you use daily?
4. What are some of the saving strategies you use in your house to save water?
5. Do you have any gadgets to reduce the amount of water coming out of the tap?
6. Do you make sure taps are closed correctly?
7. Do you inform the municipality about any leaks on your property?
8. Do you know how much you paying for water every month?
9. Do you feel that the municipality is doing enough to inform you on how to save water?

APPENDIX F: Questionnaire

Questionnaire – Main Study

Dear respondent,

I am conducting research as part of my doctoral studies entitled: **Reducing water consumption in low-cost housing areas within the eThekwini Municipality.**

I will be grateful if you take a few minutes to complete the questionnaire below.

- Your participation is entirely voluntary.
- There are no right or wrong responses.
- The survey is anonymous and confidential.

Section A: Demographic information

Please place an (X) in the appropriate block

1. Age

18 – 29	30 – 39	40 – 49	50 – 59	60 +

2. Race

African	Indian	Coloured	White

3. Gender

Male	Female

4. Education

No schooling	Primary School	High School	College/Certificate	University

5. Employment Status

Employed	Unemployed	Studying	Retired

6. Housing Status

Owner of Property	Renting

7. How long have you lived in your present house?

Less than 1 year	1 – 5 years	6 – 10 years	More than 10 years

8. Household income per month

Less than R5000	R5 000 – R10 000	R10 000 – R20 000	More than R20 000

Section B: Knowledge of water saving practices. P l e a s e tick the desired block

	Do you have knowledge on the following statements to conserve water in your home	**Yes**	**No**	**Not sure**
1.	Tightly close taps to avoid dripping			
2.	Turn tap water off during brushing teeth			
3.	Repair leaking pipes or reporting them to landlords			
4.	Use water in a glass during brushing teeth.			
5.	Turn the shower off while soaping			
6.	Save water when washing a car: by using a bucket or putting a spray nozzle on the end of your hose to prevent the hose from continuously releasing water.			
7.	Washing vegetables using water put in a basin or sink rather than under flowing tap water			
8.	Reusing water: for example, watering plants with used water			
9.	Collecting rainwater for uses around the house			
10.	Watering gardens or plants during the evening or night			
11.	Flush sparingly; for example, after urinating one does not have to do the whole flush.			

Section C: Behaviour towards water saving practices

Please tick the desired block on the 5-point scale to indicate the extent to which you comply with the following statements

Do you practice the following in your home to save water	Always	Very Often	Sometimes	Rarely	Never
1. I make sure that taps in my house do not drip					
2. I turn the tap water off during brushing my teeth					
3. I repair leaking pipes or report them to landlord or municipality					
4. I use water in a glass or cup during brushing my teeth					
5. I turn the shower off while soaping					
6. I save water when washing my car: by using a bucket or putting a spray nozzle on the end of your hose to prevent the hose from continuously releasing water					
7. I wash my vegetables using water put in a bowl or sink rather than under flowing tap water					
8. I re-use water: for example, watering plants with used water					
9. I collect rainwater for uses around the house e.g., washing the yard, carpets, watering the garden					
10. I water my garden or plants during the evening or night					
11. I flush my toilet sparingly; for example, after urinating one does not have to do the whole flush.					

Section D: Awareness

Please tick the appropriate block

Indicate your response to the following statements	Yes	No
1. I am aware that South Africa is a water scarce country		
2. I know what water conservation means		
3. I am aware of how much water I use a day		
4. I am familiar with the Free Basic Water Policy		
5. I know how to read my water meter		

Section E: Attitude on water conservation Please tick the appropriate block

Do you agree or disagree on the following statements?	Strongly Agree	Agree	Unsure	Disagree	Strongly Disagree
1. It is important to save water					
2. I am concerned about the future availability of water in my area					
3. I don't have the right to use any amount of water whenever and however I want to					
4. I don't believe the recent rainfall has made up for any previous water shortages in my area					
5. My family members want me to save water					
6. My friends want me to save water					
7. The municipality wants me to save water					

Section F: Behaviour change through incentives Please tick the appropriate block

	Which of these incentives will encourage you to use water more sparingly and pay your water account timeously	Yes	No
1.	Free airtime and data		
2.	Certain amount of electricity free of charge		
3.	The municipality agreeing to write off previous water debt		
4.	Installing water tank free of charge to collect rainwater		

Thank you for your participation and time.

APPENDIX G: Cost estimate of 10 000 litre water tank

ADVANTAGES OF A SINGLE RAINBOW RESERVOIRS TANK OVER THE INSTALLATION OF A ONE OR A NUMBER OF PLASTIC TANKS?

There are several reasons why a single Aluzinc steel, water storage tank from ***Rainbow Reservoirs*** is preferable over one or a number of polyethylene plastic tanks making up the same volume:

COST

The material cost of a single ***Rainbow Reservoirs*** tank is less than the fewest number of plastic tanks making up a similar volume.

Example (Feb 2020):

Vessel	**Capacity (litres)**	**Approximate Cost (ZAR)**
Rainbow Reservoirs Tank Model HT115/2	52 000	61,700.00***
2 x 20,000l + 1 x 10,000l plastic vertical tanks	50 000	88,235.00

**10,000l JoJo cost: R12, 285.00*

*** 20,000l JoJo cost: R37, 975.00*

****excludes (optional) installation costs*

Plastic tanks depreciate in value more rapidly than steel water tanks.

SPACE

A lack of adequate space is often an important factor when installing liquid or water storage systems. When space is restricted, the installation of a single ***Rainbow Reservoirs*** tank requires much less ground area than an array of smaller tanks making up the same volume.

Example:

Vessel	**Capacity (litres)**	**Surface area (m^2)**
Rainbow Reservoirs Tank Model HT115/6	156 000	22,57
Eight x 20,000 litre plastic vertical tanks	160 000	58,32

DURABILITY

Plastic tanks are far more susceptible to UV radiation and heat from the sun than steel tanks. This results in deterioration of the plastic over time causing the tanks to become brittle and susceptible to cracking. Steel water tanks do not crack over time.

Zinc / Aluminum alloy-coated steel or Aluzinc® steel is composed of 55% aluminum, 43.5% zinc and 1.5% silicon which provides a superior corrosion coating for steel. These components are combined in an alloy which, when used to coat steel, extend the life of the steel core by 4 times more than that of galvanized coated steel used in similar conditions and considerably more than that of plastic tanks.

TEMPERATURE VARIANCE

In areas that are prone to extreme temperatures, a large body of water stored in a large water tank is far more resistant to extreme temperature fluctuations than smaller volumes of water retained in small water tanks.

RAINWATER COLLECTION

Rainbow Reservoirs potable water tanks are fitted with Aluzinc steel roofs (included in the price of the tank). When fitted with our optional gutter system, the dome-shaped roof provides a surface area ideal for harvesting rainwater directly into the tank. Unlike Rainbow Reservoir tanks, polyethylene plastic tanks are not suitable as stand-alone, rainwater-harvesting vessels.

AESTHETICS

One professionally built steel water storage tank of elegant design is aesthetically far more appealing than a number of smaller plastic tanks often lumped together in a mismatched clutter of different brands, sizes, colours and shapes.

ADVERTISING

The large, steel-panel wall of our ***Rainbow Reservoirs*** water and liquid storage tanks is able to be utilised as an advertising "billboard", providing an ideal vertical surface for high-impact, visual advertising. Our larger water tanks have a diameter of 19m while others have a height of almost 7m - perfect advertising space should the tank be positioned in a highly visible position i.e., beside a busy motorway!

PLUMBING: INTER-TANK CONNECTIONS

When opting for the installation of number of smaller plastic tanks connected to one another, each tank requires at least two plumbing connections (inlet and outlet) in order to connect the tanks as a combined, large-volume unit. These inter-tank connections are prone to temperature, pressure and movement stresses as the tanks fill or empty. Such stresses may cause the inter-tank connections and connection seals to fail resulting in constant leaking at the connection points.

CLEANING BETWEEN THE TANKS

When an array of plastic tanks is installed directly on the ground without a common concrete base, grasses and weeds will take root between the tanks, most especially when a water source is provided by leaking inter-tank connections. This is not only unsightly, but it also requires time and effort to clean between the tanks and their inter-tank connections.

ECOFRIENDLY – MATERIAL MASS

The volume of materials utilised in the construction of several smaller tanks is far greater by comparison, than the materials required to construct a single tank of the same volume.

RESISTANCE TO FIRE

Steel-panel ***Rainbow Reservoirs*** water storage tanks are infinitely more resistant to damage by bushfires than plastic water tanks.

THEFT DETERRENT

Plastic tanks are often targeted by thieves - it's easy enough for 2 people to load/steal an empty plastic tank of 5000l/10000l using an LDV as transport. Indeed. This has become a major problem in certain areas! However, "You Can't Steel a Rainbow". Although Rainbow tanks are able to be re-located, the time and effort and equipment/tools required to dis-assemble/re-assemble a Rainbow

tank upon a specially prepared sand base, are a daunting proposition, and huge deterrent for would-be thieves.

Rainbow Reservoirs (www.rainbowtanks.co.za) is a manufacturer, supplier and installer throughout Africa of bolted-steel, panel tanks for the bulk storage of potable drinking water. Ranging in size from 9,550 litres to several million litres, the walls and roofs of our water storage tanks are made of anti-corrosive Aluzinc steel. All our water tank liners are certified for human potability. ***Rainbow Reservoirs*** water tanks are completely sealed units - no ingress of light (no algal growth), dust and insects (no mosquitoes i.e., NO MALARIA!)