The water crisis in Durban: An analysis of the role of households in water conservation.

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Abstract

The continued water crisis in South Africa is causing many municipalities to exhibit performance problems in water service delivery. While South Africa is a water-scarce country, factors like population growth, climate change, urbanisation, and economic development contribute to water shortages. This implies that new and innovative ways of managing freshwater resources should be adopted. This study aims to examine the role of households in water conservation in the city of Durban. The study fulfils four main objectives to achieve this aim. The first objective is to establish the daily water consumption behavioural practices of households. Secondly, the study seeks to establish the households' willingness to adopt water-saving technologies. Thirdly, it seeks to identify the factors preventing households from practising water-saving behaviours. Furthermore, the study finally seeks to recommend some possible solutions that the eThekwini Municipality could adopt to promote households' water conservation.

The study uses a mixed methods approach where quantitative and qualitative data are separately collected, analysed, and discussed. Quantitative data is collected through a survey conducted on 300 household heads residing across different spatial residential areas. On the other hand, qualitative data is collected from seven (7) employees in the Water and Sanitation Unit of the eThekwini Metropolitan Municipality. The thematic approach is then used to analyse the qualitative data, while descriptive statistics and probit regression models analyse the quantitative data.

Four key findings are reported in the study. First, the study found that households in the city of Durban generally practice water-efficient behaviours in their daily water consumption activities. Secondly, the type of access to potable water services was the primary determinant for practising water-efficient behaviours. Third, more residents in the suburbs and townships have water-efficient technologies installed, while none of the respondents from the informal settlements has such technologies installed. Lastly, some biographical characteristics emerged as crucial determinants of water consumption behaviour and the adoption of water-efficient technologies. Key recommendations are given based on these findings.

Declaration by student

Following the university's rules, I declare that this dissertation is my work, except where indicated in the text. I further declare that it has never been submitted for assessment of a degree to another University or qualification.

Signature :.....

Dedication

This dissertation is dedicated to everyone who believed in me and my work.

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List of acronyms

BPD	Business Partners for Development
CoGTA	Cooperative Governance and Traditional Affairs
DWS	Department of Water and Sanitation
EDU	Education
GEND	Gender
INC	Income
KZN	KwaZulu Natal
MC	Municipal Council
NDP	National Development Plan
WSAs	Water Services Authorities
WSPs	Water Services Providers

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CHAPTER 1

INTRODUCTION

1.1 Background of the study

The unavailability of sufficient water resources is a serious issue of concern for most countries. Climate change, population growth and economic development are among the widely cited determinants of water shortages across the globe (Mukuhlani and Nyamupingidza 2014; Murwirapachena 2021). As countries continue to use their water resources with growing intensity, poor rainfall increasingly leads to national water crises as water tables fall and reservoirs, wetlands and rivers run dry (Adewumi et al. 2010). Generally, the causes of water shortages vary from place to place and from one region to the other. However, such causes are broadly grouped into natural factors and other human factors. In this context, natural factors include geographical and climatic conditions such as the amount of rainfall received, while human factors include water pollution, poor consumption behaviours, and poor water resources management (Martin-Carrasco et al. 2013; Rahmanpou et al. 2015).

Two-thirds of the population in the world currently live in areas that face a shortage of water for about one month in a year (Mekonnen and Hoekstra 2016). Evidence exists that an estimated 1.8 billion people are expected to be living in countries or regions with absolute water scarcity by 2025, while two-thirds of the world population could be underwater stress (Asthana 2021; Delpasand, Bozorg-Haddad and Goharian 2021; Nishad and Kumar 2021). Generally, arid, semi-arid, and most developing countries face a severe water crisis due to lessening water resources and the accumulative costs of developing new water sources (Huang et al. 2021; Esmaeilion et al. 2021; Misra 2014).

Water resources remain under pressure in water-scarce countries like South Africa, where there is a great challenge to balance supply and demand for freshwater (Mancosu et al. 2015). Like in other semi-arid countries, factors such as population

growth, unpredictable weather patterns, economic development, mismanagement of water resources are causing a strain on water resources in South Africa (Lau et al. 2012; Ringwood 2015). Some parts of the country are even without enough water available to meet the needs of citizens (Luker and Harris 2018). Thus, the future of the water supply in South Africa faces potential challenges. Unless there is a rapid and significant change in rainfall patterns, there is still a long road to recovery.

While the National Development Plan emphasises that all South Africans should have access to clean water in their homes by 2030, progress towards this is very slow. The South African government is criticised for failing to implement feasible policies and set effective structures to ensure water is accessible to all households (Ojo 2018). The current water management in South African cities fails to keep up with the growing demand for freshwater resources. In most cities, various measures continue to be implemented to manage the excessive demand for freshwater resources. Standard measures include the imposition of water-use restrictions, reduction in the pressure of potable water, and water rationing (Leck and Simons 2018; Martel and Sutherland 2019; Roberts 2008; Wilson and Pfaff 2008).

Further, many municipalities in South Africa appreciate the role of household water conservation in reducing water demand, thus reducing pressure on water resources. Demand management policies that promote conservation and efficient water use have been shared across South Africa. Such policies are designed on the background of initiatives that reduce consumption by using water-efficient technologies and practising efficient water consumption behaviours that can yield positive results (Lau et al. 2012). Various technologies that can be fitted in different parts of the house can reduce water demand. Murwirapachena and Dikgang (2021) categorise such technology based on four primary areas in a home: kitchen technology, bathroom technology, toilet technology, and garden and outdoor technology. Regarding kitchen technologies, the study reports that using an efficient tap reduces water consumption by about 60%, while an efficient dishwasher reduces water consumption by about 50% (Murwirapachena and Dikgang 2021). Standard bathroom technologies include efficient showerheads and shower timers, while toilet technologies include dual-flush cisterns, small-sized cisterns, interruptible-flush cisterns, as well as using cisterns displacement technologies.

While such technologies can play a huge role in water demand, they should be combined with households adopting efficient water-use behaviours. Common behaviours cited as efficient include avoiding running a tap when: washing utensils, brushing teeth, washing the hair, taking shorter showers, fixing or reporting water leaks, among others (Babić et al. 2014; Meyer et al. 2018; Murwirapachena 2021; Willis et al. 2011). Efficient water consumption behaviour can be instrumental even when people install water-efficient technologies in their homes. In most cases, some people may practice inefficient behaviour only because they installed efficient technologies. For example, a household taking longer in the shower because they have an efficient shower installed. Such behaviour has a “cancel-off” effect as the benefits of the efficient technology are cancelled off by bad water consumption behaviours. Thus, water authorities have a duty to craft policies that nudge residents to practice efficient water consumption behaviours, whether they have installed efficient technologies or not.

1.2 Problem statement

The continued water crisis in South Africa is causing many municipalities to exhibit performance problems in water service delivery. With 403 mm of rainfall that South African Weather Service recorded in 2015, attributed to South Africa’s average dam levels to drop from 93% in 2014 to a low of 48% in the beginning of 2016 (Wolski 2018). Even though in early 2017 national dam levels recovered Western Cape remained seriously affected. According to Samuels (2020), in July 2017 Cape Town’s dam levels were just over 26% which instigated the City of Cape Town’s water committee to implement stricter water restrictions to reduce consumption. Low dam levels were not only limited to Cape Town though as dam levels were also plummeting in the eThekwini Municipality as well, which was experiencing 53.7% full the same year 2017 (Water and Sanitation 2017).

Further, the shortage of water supply has been also attributed by population growth, climate change, urbanisation, and other factors challenging freshwater resources imply that new and innovative ways of managing water resources should be adopted.

Most studies in the literature view the water crisis in South Africa as a supply-side issue, with most of the criticism piled on water authorities for failing to meet demand (Rockström et al. 2007; Olmstead and Stavins 2009; Arbue et al. 2010; Mhlongo et al. 2012; Viljoen 2018; Habiyaremye 2020). Inadequate of water supply is a huge issue that water management is facing caused by inefficient households' water consumption. Thakur et al. (2019) Murwirapachena (2021) reported that South Africans household water consumption is higher compared to the international average of 173 litres per person per day. It is estimated that the average of suburban family of four households in Durban uses about 300 litres per person per day (Thakur et al. 2019). This highlight that sustainable water consumption is still a key challenge in South Africa.

While authorities play a role in developing and implementing policies that promote sustainable water service delivery, it is essential to appreciate that water consumers, mainly households, can play an essential role in addressing the ongoing water crisis bedevilling South African municipalities. Although various technologies can be installed and efficient behaviour be adopted to reduce water demand, very little is known about the extent to which South African households have installed water efficient technologies and adopted efficient water-use behaviours. Thus, it is essential to investigate the adoption of water-efficient technology and households' behaviours to develop and implement water demand management policies. A study similar to this study was conducted by Murwirapachena (2021) in the city of Johannesburg. Therefore, it is imperative to get insights from other significant cities since water service delivery continues to be a challenge in all South African cities. These cities operate in different operating environments.

1.3 Aim of the study

The study aims to analyse the role that households can play in water conservation in Durban. This aim is achieved by satisfying the following four objectives:

i. To determine the current water consumption behaviours of households in the city of Durban,

ii. To establish the factors preventing households from adopting water-saving behavioural practices,

iii. To establish the households' willingness to adopt water-saving technologies, and

iv. To recommend possible solutions towards water conservation by households in the city of Durban.

1.4 Research questions

i. What are the current water consumption behaviours by households in the city of Durban?

ii. What are the factors impeding households from adopting water-saving behavioural practices?

iii. Are households willing to adopt water-saving technologies?

iv. How can the eThekwini Municipality promote households water conservation?

1.5 Significance of the study

South Africa is naturally a water-scarce country implying that water resource conservation is of great importance. With increasing population growth and the scourge of urbanisation, most urban water authorities struggle to meet increased water demand. In the wake of the scarcity of water resources amid the ever-increase

demand, efforts should be devised to find solutions that promote moving current water needs without compromising the needs of future generations. Water authorities are expected to play a leading role in crafting sustainable water demand management policies. Developing and implementing these policies requires precise information on current water consumption patterns and dynamics among consumers. Such dynamics cannot be generalised as they usually vary across places, social classes, and personal characteristics. While municipalities acknowledge the importance of water-efficient technologies and adopting efficient water consumption behaviours, little is known about how well South African households are practising such behaviours and adopting those technologies. The literature's efforts to bridge this gap is noted in very few emerging South African studies (Booysen et al. 2019; Matikinca et al. 2020; Murwirapachena 2021).

Nevertheless, it is essential to note that except for very few studies like Murwirapachena (2021) conducted in other metropolitan municipalities, most studies on this phenomenon were conducted in Cape Town. This is mainly because the city of Cape Town faced a “Day-Zero” scenario in the recent past, where the whole city was expected to run dry. In these studies, it has surfaced that there is a need for municipalities to create cities that are water-sensitive and resilient, ensure sustainable and equitable water availability through integrated water planning and management and create water-smart cities that are linked to real-time data and information that is publicly disseminated. Therefore, many studies emerged to galvanise knowledge and address water shortages and the possible impacts in the city. However, the issue of water shortages is widely common across most South African municipalities. Such shortages are even worse in urbanised municipalities, especially the metropolitan municipalities that are highly populated due to urbanisation. Currently, this study is one of the few that seek to understand water consumption patterns, the adoption of efficient technologies, and water consumption behaviours in Durban. It is imperative to conduct such a study in the city as it also battles massive population growth and increases water demand which it struggles to satisfy.

In some cases, the city even applies strict water demand management measures like water restrictions and rationing to manage increased demand. Understanding the behaviour of households and the extent of efficient water technologies will assist

municipal authorities in crafting evidence-based water conservation policies. This is important for a city struggling to meet its water demand. Therefore, this study is significant since it seeks to address the role of households in sustaining water shortage in Durban. The findings might aid the eThekwini Municipality in making informed water supply decisions in the future. The research might also serve to add to the body of information already available and advise government policymakers.

1.6 Organisation of the study

The rest of this study is organised into four (4) chapters. Chapter 2 presents a review of the theoretical and empirical literature on household water conservation. Chapter 3 discusses the methodology used in the study. Chapter 4 discusses the data and reports on the findings of the study. Moreover, Chapter 5 concludes the study, providing recommendations and areas for future research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The role of households in water conservation continues to gain attention in the literature. There are discussions in the literature on the reasons behind the involvement of households in water conservation. Some studies suggest that households practise water conservation as a way to cooperate with conservation campaigns. On the other hand, studies argue that some households conserve water to pay less for their consumption or avoid excessive consumption punishment. Various other arguments on water conservation exist. This chapter reviews some of the literature that is linked to water conservation. The chapter also reviews other philosophies and empirical literature on water conservation and the legislations and policies around water conservation in South Africa. More precisely, the chapter is divided into six (6) main sections. After the introduction, section 2 of the chapter provides a discussion of the theoretical literature. Section 3 a discussion of the empirical literature. Section 4 the water-related legislation and policies in South Africa. And section 5 a discussion of the water-related policies in the eThekwini Municipality. Section 6 concluded the chapter.

2.2 Theoretical literature

The literature comprises water conservation theories. A significant number of the available theories converge on the assumption that people's environmental beliefs determine their conservation behaviour. Given this assumption, promoting changes in people's beliefs is central to achieving sustainable water conservation. Theories that explain water conservation behaviour from the point of people's environmental beliefs

include the utilitarian theory, the ecological theory and the egocentric ethics theory. This section briefly discusses these theories.

2.2.1 The utilitarian theory

The utilitarian theory was introduced by Bentham (1789) and related to normative ethics in philosophy. The theory assumes that human happiness is compulsory for people. This theory promotes happiness among people, and the moral is to behave in a way that does not harm others but maximises utility. According to the theory, human beings should practice water conservation only if the whole human society benefits from it. In normal circumstances, water conservation efforts that rely on a utilitarian mindset are assessed based on costs and welfare (Wolff 2008). The theory looks to the significance of simultaneously increasing positive human action and reducing actions that harm water resources.

Utilitarian water beliefs are believed to influence water conservation positively (see Corral-Verdugo et al. 2003). According to Kang et al. (2017), utilitarian beliefs may encourage households to install certain water-saving appliances in their homes. However, some criticism of the utilitarian theory exists in the literature. Gezon (2017) criticises the theory for not considering justice as it emphasises the supreme gain of happiness. Equally, Jones and Felps (2013) argue that utilitarianism justifies using water without considering how individuals are affected. In this sense, utilitarianism does not provide enough support for individuals' rights if it compromises water to many people. Regardless of these notable criticisms, the theory is essential in shaping discussions in this study because it helps explain people’s water consumption behaviour by the reasoning behind people’s water consumption patterns.

2.2.2 The ecological theory

Developed by Haeckel (1870), the theory observes organisms and their environment as essential factors to the ecosystem. The theory emphasises the connection between creatures and the environment they live in. Thus, it suggests that the good of all

species, in general, should be considered, not just the good of a specific member of the species in the environment. The ecological theory identifies nature, including water, as a limited resource to be conserved (Fenderson et al. 2012). The theory encourages households to share scarce resources with other species in the environment. Through ecological ethics, the theory gives proper guidelines for how water conservation can be done without harming the various elements of the environment (for example, animals and plants). The ecological theory suggests that when households conserve water, they must do it from the goodness of their hearts and for a good purpose.

After the original formulation of the theory by Haeckel in 1870, there has been a broad discussion on the theory in the literature. For example, Sessions (1987) mentions that most environmental historians and anthropologists agree that primitive societies worldwide experience ecological ways of life. Everything has to be respected in its own right. Critics of the ecology theory argue that some religions may claim to have a larger share of nature, a problem referred to as 'deep ecology' (see White 1967). During the 1960s, a radical wave of critics of a conservation movement of primary consumption was observed in Western societies.

For water resources managers in other countries, there have been claims that there is an ecological U-turn, whereby drinking water sources are gradually becoming more important to guarantee water security (Sun et al. 2018). For example, in many countries, China, the United States of America, Australia, Germany and New Zealand, ecological compensation is used as an economic incentive to protect water resources and other services provided to the public (see Koh et al. 2017). According to Xu et al. (2015), households' ecological compensation is essential to manage the relationship between local economic development and water security in the arrears where water conservation is crucial.

2.2.3 The egocentric theory

Developed by Piaget in the 1920s, the egocentric theory assumes that variations in views do not exist. According to the theory, people with selfish thinking act greedily to get what they want without considering other people. Such people can justify unethical behaviour with great cleverness. However, they often use ethical terms to justify their behaviour even though they do not consider ethical principles. The logic behind egocentric theory is that what is suitable for an individual is good for society.

Egocentric thinking can put the water supply under tremendous pressure as large quantities of water are lost before even reaching the intended final consumers. In Durban, for example, there are numerous water pipe bursts despite the authorities being in the grips of acute water cuts and drought threats (Mwelase and Dzwairo 2018). Most of these bursts occur during illegal connections, whereby residents connect themselves to the water supply system. Even when these illegal connections are detached from the system, residents repeatedly reconnect themselves. Such illegal activities are unmetered and result in massive losses of water and revenue for the Municipality.

Noga and Wolbrin (2013) criticise the egocentric theory for developing a tendency of determining that human beings have a right to dictate the course of events for other species. It permits human beings to extract and use natural resources to enhance their lives without considering how much damage it may cause in the ecosystem. Furthermore, egocentrism is criticised because it assumes that the human being is the highest in the order of nature. The collective behaviour of human groups should not be questioned as long as it benefits the people at large.

For this study, the utilitarian theory will be adopted because of the philosophy of encouraging morally appropriate behaviour towards water consumption to maximise utility. According to the theory, human beings' practices water conservation so that the whole human society will benefit from it. Utilitarian water beliefs encourage the implication of increasing optimistic human action to practice water conservation, like installing certain water-saving appliances in their homes. In this manner, the theory will guide the study to ensure that it answers the research questions and fulfils the study's objectives.

2.3 Empirical literature

Various studies exist in the literature on water conservation. This section reviews some of the empirical literature on issues around water conservation. More precisely, the section reviews the empirical literature on water conservation, the adoption of water saving technologies and consumption behaviour in South Africa, and water demand management. The section also discusses some of the water management policies in Durban. A review of some of the existent empirical literature on water conservation will provide a greater understanding of issues around the phenomenon.

2.3.1 Water conservation

Water resources are increasingly becoming stressed due to the growing levels of demand, climate change and poor water resource management. In other parts of the world, rapid economic development and urbanisation threaten water resources and reduce water quality due to increasing pollution (Ma et al. 2021). Large proportions of the world's population currently experience water shortages. Approximately 2.4 billion to 4 billion people worldwide live within watersheds exposed to water scarcity (see Kumar et al. 2019). With continued population growth, the intensity of water shortages is likely to increase in the future. Since water is an essential element for existence, its scarcity has far-reaching effects on humans, the environment and production in the economy. Metropolitan water executives must develop strategies to ensure future water sustainability while maintaining the strategic economic, social and environmental targets (Chen and Olden 2017).

To meet the current water demands without compromising future needs, water resource managers need to adapt to water scarcity and adopt approaches that promote sustainability. Over the years, there has been an increase in adopting innovative water management policies across the world. One problem associated with water as a resource is that people generally give it less attention if it is available and of good quality. For water resource policies to achieve the desired outcomes, there is a need for a holistic approach that involves all players in the water value chain. In

pursuit of this, water managers worldwide continue to use innovative approaches that address both the demand and supply sides of water resources.

Households can play a significant role in water conservation. According to Willis et al. (2011), water consumption by households depends on many factors, including household size, age, education levels, size of the property, income levels, the competence of water devices installed, and the attitudes of consumers. These contextual factors influence the effectiveness of water conservation strategies. Commonly, it is not easy to get households involved in water conservation activities. Lau et al. 2012 state that despite efforts from policymakers to get households on board, evidence exists that these efforts are yielding unsatisfactory results. There is a gap in the South African literature on information regarding households' water use behaviour and consumption patterns. Such information is essential in formulating and implementing effective water conservation policies (March et al. 2015).

One of the many approaches that policymakers can use to promote water conservation behaviour among households is education in schools and multimedia awareness campaigns. For example, water managers in Durban have managed to develop students into responsible water consumers (Morote et al. 2020). It is essential to educate people starting from childhood before they develop negative behaviour about saving water. On the other hand, multimedia awareness campaigns can also quickly convey conservation messages, inducing changes in consumer behaviours, thus, promoting water conservation. More precisely, people learn better when actively engaged. Therefore, getting households involved in water conservation campaigns is essential in changing their perceptions and behaviours relating to conserving water (see Koop et al. 2019).

Equally, the inclusion of the views of women is essential in the formulation and implementation of community awareness campaigns. Women are traditionally recognised as prime participants in most water-use activities. According to Meyiwa et al. (2014), the problem commonly observed in the formulation of most water-saving campaigns is that women are not considered equals to men when contributing to water governance. This is due to gender discrimination, tradition, culture, and several other limitations. As a result, the views of women in conservation are consistently ignored in

public policies (Lau et al. 2012). Without recognising the vital role of women, water conservation initiatives and policies will continue to fail to achieve the desired goals.

2.3.2 Water consumption behaviour and the use of water-efficient technology

Like many other cities in South Africa, Durban experiences water shortages. The leading causes of water shortages include drought, climate change, surface runoff, illegal tap connections, urbanisation, pollution and leaking pipes. In 2015 the city had to ration water supply in Durban due to shallow dams' levels. The extreme water rationing, which saw supply being restricted to only six hours a day, resulted from water levels in the main dams dropping to as low as 28% of capacity (see Patterson and de Loe 2017). Water managers in the city have been calling for a collective effort from all its residents to use water sparingly. Although water loss reduction targets are set, there is no clear indication of how much water is lost and split between physical leakage and commercial losses.

The eThekwini Municipality is experiencing a challenge of supplying adequate water to households in the face of increased demand (Muller 2020). Therefore, the municipality will have to take somewhat harsh decisions such as water rationing to maintain water security during times of crisis. Nevertheless, the Municipality may also reduce water demand by promoting the installation of water-efficient technologies. Evidence exists in the literature that implementing new water-saving technology significantly reduces domestic water consumption (see Stavenhagen et al. 2018). Due to persistent water shortages in Durban, water conservation should become a priority for eThekwini Municipality. Therefore, installing water-efficient technologies should be part of the solution (Rasoulkhani et al. 2018).

According to Baki et al. (2018), an awareness of water-saving devices and promoting their installation when people build new properties is ideal for most cities. The installation of water-saving technological devices is beneficial in water conservation and is also helpful in reducing monthly water costs for households. Water-efficient devices that can be installed include water-efficient showerheads, dual flush toilets, efficient taps, and shower timers. Kumarasamy et al. (2017) explain that standard

showerheads typically have a flow rate of 30 litres per minute, whereas water-efficient showerheads usually have about 7.6 litres per minute. About 30% of households' water consumption is associated with the toilet in terms of flush toilets. Thus, installing a dual flush toilet will reduce water use for flushing as different quantities of water are used for solid and non-solid waste (Abansi et al. 2018).

Although a wide range of water-saving technologies can be employed to achieve water savings, offset behaviour may still undo the benefits of installing water-saving technologies (Kumarasamy et al. 2017). According to Abu-Bakar et al. (2021), there is evidence of offsetting behavioural responses to water conservation policies where households use more water after installing water-efficient devices. For example, households tend to extend their time in the shower after installing water-efficient showerheads, thus using the same amount of water as was used before the new installation. Therefore, for the installation of water-efficient devices to yield significant results, it should be accompanied by positive water consumption behaviour.

It follows that awareness should be on installing water-saving devices and adopting efficient water use behaviour. Stavenhagen et al. (2018) state that an investigation and re-analysis of current models of water consumption behaviour can be an excellent investment (Stavenhagen et al. 2018). Although the future need for freshwater sources is expected to increase due to population and industry growth (see Gude 2017), the little that households can conserve is essential for sustainability. According to Wills et al. (2011), there can be a disruption of sufficient water supply and increases in water provision costs if there is no change in water behaviour. Therefore, getting household to comply with practising water conservation now is key to ensuring future water availability.

Adopting good water consumption behaviour does not necessarily require high-cost outlays. Affordable water conservation tools can be used efficiently as an alternative (Abansi et al. 2018). Domestic appliances such as water-saving dishwashers and clothes washers can also be cost-effective. All these products are available in models that reduce water use without sacrificing performance. Furthermore, these watersaving equipment should be treated as a lasting strategy in achieving water efficiency by relying on them and efficiently using them all the time. However, focusing

on household behavioural change can be a quick and more focused inexpensive alternative because water conservation is more understood once all households are sure a water crisis exists. It is within their powers to ease the situation.

Despite the intensity of water conservation campaigns in Durban, water demand is still excessively high. Outdoor water consumption is still high for high-income earners and households that own swimming pools and gardens, for example (Wills et al. 2011). With the rising temperature due to climate change, water demand is further due to irrigation, watering, and other outdoor activities. Therefore, more still needs to be done to reduce household water demand.

2.3.3 Water demand management

Water demand management is the development and implementation of strategies, policies, measures, and initiatives that influence water conservation (Mhlongo et al. 2012). It helps develop households' water consumption benchmarks to support conservation by employing programs for saving water by the municipality. Water demand management enhances an improved clever and efficient daily water use in homes.

Water supply is under pressure due to a continuous rise in water demand due to structural changes in the economy and increasing water requirements. As the population grows and the economy expands, the monetary expenses of developing new water infrastructure would exceed the economic benefits from these new developments. For developing countries, it has been costly to expand water infrastructure to satisfy their population demand. Therefore, models like water-saving campaigns should be considered. Water service providers must ensure that all households cooperate with the authorities in adopting water-saving measures to achieve water conservation.

More work has to be done on demand-side policies (Molinos-Senante et al. 2018). In this sense, there is a need for strategies that encourage behavioural change in water users. Most frequently, policymakers use pricing reforms as an instrument to induce

water conservation. According to Arbue's et al. (2010), the usefulness of water management policies in engaging water consumption depends on the price elasticity of water demand. When policymakers use price to control demand, the element of interest would be the price elasticity of water demand (Olmstead and Stavins 2009; Garrone 2019). If demand is elastic, any increase in the price of water per litre reduces households' water consumption. On the other hand, a decrease in the price of water could promote overuse since additional units eventually become slightly cheaper.

However, literature shows that the water demand is commonly inelastic because water is a necessity. Using water consumption data for low-, middle- and high-income households in Durban, Molinos-Senante et al. (2018) found that the water demand is price inelastic. Nevertheless, the study reports that demand was more inelastic among the middle- and high-income earners than low-income earners. These findings were also reported in Vuuren et al. (2004); Bruno et al. (2019) in a study on water demand in Durban and are consistent with findings in other studies across South Africa (see Dockel 1973; Jansen and Schulz 2006; Veck and Bill 2000; Tortajada et al. 2019). Furthermore, the demand for water is observed to be price inelastic in most developing countries (see Ayadi et al. 2003; Dandy et al. 1997; Espey et al. 1997; Kayaga and Motoma 2009; Nauges and Van den Berg 2009; Dharmaratna and Parasnis 2010; Ponzoni Ghinis et al. 2020).

There are various ways to promote equity, competence, and sustainability in the water segment. Theoretically, water pricing is the simplest method to address these issues. However, water tariffs are mainly below the total supply cost (Rockström et al. 2007; Salgot and Folch 2018). If water tariffs reflected the actual cost of water provision, the revenue collected would help promote water conservation. Therefore, there is a need for water tariffs to be cost-reflective if they are to be used as a measure to promote sustainability in water provision.

Since the water demand is generally inelastic, increases in the prices will not necessarily reduce water consumption but raise revenue. However, access to water is regarded as a fundamental human right in South Africa. Thus, water service providers do not have enough room to excessively increase water tariffs. Approval of water tariffs is a prerogative of the Municipal Council (MC). Adopting high-water tariffs

is likely impossible as council members will regard it as punishing residents who voted them into office. In Durban and other municipalities around the country, tariff increases are mainly for high-income households who pay for water services. Such households can afford to pay for water services and will continue using more water, regardless of the price. As such, water tariffs may not be an appropriate tool to gauge households to conserve.

Since water problems have become more complex both in Durban and across the country, they may not be resolved by the water authorities (see Biswas 2004; Patrick Bond 2019). For effective water demand management, water policies and related issues should be assessed, analysed, reviewed, and resolved within an overall societal and development context (Biswas et al. 2001; Martel and Sutherland 2019). Both the society and private sector should have the opportunity to make positive contributions towards sustainable solutions. Currently, Durban has been part of the worldwide Business Partners for Development (BPD) programme organised by the World Bank (Durham et al. 2003). This project provided a suitable and cost-effective supply of freshwater. Training has also been offered to households, water officials and to local staff to provide maintenance.

2.4 Water management, legislations, and policies in South Africa

In South Africa, the delivery of water services is the responsibility of the municipalities. However, the actual authority to deliver water lies with the 152 Water Services Authorities or WSAs (Ncube and Taigbenu 2019). These are determined by the Minister of Cooperative Governance and Traditional Affairs (CoGTA). WSAs encompass district municipalities that deliver water services within the jurisdiction of their local municipalities and local municipalities that deliver within their jurisdictions (Brettenny and Sharp 2018). In most cases, where a district is authorised to provide water, the local municipalities in the area do not have such authority. In instances where the local municipalities within a district are authorised, the related district municipality is not authorised. This asymmetric delivery of water services across the South African local government is due to the incapacity of many local municipalities to deliver water services.

The right to sufficient water is enshrined in the Constitution of the Republic of South Africa. Section 27(2) of the Constitution requires the State to take reasonable legislative and other measures to achieve the progressive realisation of this right (DWAF 1997). In line with the Constitution, the South African government has implemented various legislations and policy frameworks to address water-related issues. The National Government has the constitutional mandate to monitor the performance of subnational governments, setting policies and standards for water service delivery. The Department of Water and Sanitation (DWS) is the regulator of water delivery. It sets national standards for water services, monitors the performance of water services authorities (WSAs), provides support to WSAs, and intervenes in cases of water service delivery failure. Some of these legislations and policies include the National Water Act (36 of 1998) and the Water Services Act (108 of 1998), the Municipal Systems Act (32 of 2000), and the Municipal Structures Act (117 of 1998). In this section, we briefly discuss these pieces of government legislation.

2.4.1 National Water Act (36 of 1998)

The National Water Act states that all scopes of government must provide water supply services proficient, sustainable, and reasonable. The Act also requires the insurance that water resources are protected and managed to meet current water needs without compromising the needs of future generations. Under the Act, all municipalities given the right to act as Water Services Providers (WSPs) must provide procedures that promote water conservation, demand management, reasonable access to water, social and economic development, and the protection of water resources and associated ecosystems. More precisely, the main thrust of the Act is to promote equal and sufficient access to water while maintaining water security and enabling socioeconomic development.

The Act carries necessary alterations to the South African water segment. As reported by Seago (2016), the act provides the legislative outline for managing water as a national resource and improving ground and surface water quality. The Act's primary purpose is to protect water resources by ensuring they are used and managed efficiently. Furthermore, the Act aims to address the evils of the apartheid era by

eliminating gender and racial discrimination in access to water services. The Act stresses the need for a national water resource strategy that outlines how water will be managed at regional or catchment levels in defined water management areas. It provides some actions to meet predictable future water needs through conservation and set out principles relating to water conservation. In terms of this study, the National Water Act is relevant as it provides some guidelines on the strategies that may be used to promote household water conservation.

2.4.2 Water Services Act (108 of 1998)

The Water Services Act makes provision for an institutional framework for the delivery of water services. The Act's primary purpose is to develop models that can be used as guidelines by WSAs in ensuring the development and implementation of water conservation strategies. Such models include providing framework controls and looking after several water institutions such as water boards and WSPs. As part of the government’s strategy to alleviate poverty, this Act also provides free essential water to the indigent. The rationale for providing free essential water in the Act is to ensure that no one is completely deprived of access to the water supply because of their inability to pay.

As stated by Rogoll (2017), the Act provides guidelines on how water services should be supplied. It also specifies that no person may obtain water from any source other than the distribution system of the WSP jurisdiction to that specific area. Further, the Act states the need to optimise and reduce operating costs such as non-revenue water due to water leaks resulting from ageing infrastructure, illegal connections, and water wastage. The Act focuses more on the supply and distribution of water and suggests how all water stakeholders can avoid non-revenue water.

The main objective of the Act is to support municipalities in undertaking their WSP obligation to fulfil water demand by consumers. It declares the right to a fundamental quantity of drinking water and obliges the WSP to ensure quality drinking water. The Act places every WSP to realise water as a human right and provides clear guidelines on water services provision to communities by promoting the effective management of

water resources and conservation. Section 12 of the Act specifies that all water services establishments must repair any significant, visible or reported leak in their water services system within 48 hours of becoming aware of them. This section demonstrates the importance of endorsement and execution of water conservation and water demand management.

2.4.3 The Municipal Systems Act (32 of 2000)

The Municipal Systems Act provides the fundamental principles, mechanisms and processes necessary for municipalities to progress and uplift the socio-economic statuses of local communities. According to the Act, there is a need to ensure access to essential services that are affordable to all South Africans. The main aim of the Act is to help the local government create structures for municipal planning, performance management and the use of resources. As municipalities put control policies and charge tariffs for services rendered, the Act protects citizens by considering their needs and promoting their participation in local governance.

The Act ensures that municipalities create common approaches, share resources and enhance co-operation amongst themselves to find solutions for local government problems. However, as much as municipalities can have common approaches, each municipality has the privilege to create and implement its legislation (also called bylaws). According to the Act, the Council for each municipality should create a platform for consulting the local community on municipal services. This consultative framework allows the public to contribute to how services are delivered. The Act highlights that municipalities must consider the budget and capacity available when fulfilling these duties and make communities aware of how much is budgeted for a particular financial year.

In this study, the act clarifies the role of municipalities in water conservation. It states the essential role of municipalities in providing raw water to ensure acceptable a reasonable quality of life. As the current water situation in eThekwini Municipality is unsustainable, among other reasons is the lack of clarity on the responsibilities of stakeholders, “specifically” households in water conservation. Therefore, the act gives

proper guidelines on support, organisational capacity on the part of municipalities, and clear common principles on the sustainability of water delivery.

2.5 Water-related policies in the eThekwini Metropolitan Municipality

The eThekwini Metropolitan Municipality is a WSA and WSP, providing water to approximately 3.5 million people in its jurisdiction, consisting of suburbs, townships, informal settlements, and some rural areas. The water services provision mandate of the Municipality is within the competence of its Water and Sanitation Unit, which works closely with other municipal units towards the adequate provision of sufficient, reliable and suitable quality water services. The Municipality aims to provide all households with easy access to potable water to address poverty and minimise health risks to communities. Where possible, the minimum standard of service is a standpipe provided to serve a community where the maximum distance from the furthest dwelling to the standpipe is 200 metres. Currently, critical priorities for the Unit include the eradication of the backlog in water provision, reducing non-revenue water levels, improving asset management systems, and improving customer services. Over the years, the Unit has been at the forefront, spearheading water provision initiatives in South Africa. Various initiatives were first applied in the Municipality before being introduced to South Africa, such as free essential water, flow limiters, plastic bodied water meters, ground tanks, and semi-pressure water service levels.

In line with the dictates of the Constitution and various other water-related laws, the Municipality has formulated and implemented various policy instruments to render adequate water services successfully. The most notable policies include the free basic water policy, the debt relief policy, the municipality rates policy, the leak repair policy, and the credit control and debt collection policy. In addition to assisting the municipality to discharge its water provision duties, these policies also help the municipality raise revenue, recoup costs linked to service delivery, and set guidelines through which the municipality could be efficiently managed.

The free basic water policy (or indigent policy) entails that all domestic residential customers who reside in properties valued at less than R250 000 are provided with

nine kilolitres (9 kl) of free essential water per month. The indigent policy authorises the Head of the Water and Sanitation Unit to make water available to informal communities by using standpipes approximately 200 meters away from an informal dwelling. The water undertaking authority meets the cost of these installations. If members of informal communities served by standpipes wish to receive a higher level of water service, this may be provided on the prescribed tariff charge. The provision of a free standpipe is strictly limited to people living in informal communities. The indigent policy aims to provide portable water to poor households who cannot afford water services privately.

The debt relief policy assists low-income families in arrears for water service charges for ninety (90) days or more. Eligible households reside on properties with a rateable value as determined by the Municipality Council. Regardless of their property value, those who are confirmed to be too poor to afford their current water services debt. To qualify, the poverty of households should be reported either by the Ward Councillor, Municipal Social Worker, Water and Sanitation official. Customers are obliged to sign a contract and have the conditions of the contract explained, where-after the debt is written off over twenty months. If a customer fails to pay their current monthly water account in full by the due date, they may have time added to their write-off period on a month for month basis. When signing the debt relief contract, customers stay on a total or semi pressure water supply. Alternatively, choose to have a flow limiter installed, thus limiting consumption to an amount per day equal to the free basic water allowance as determined in the schedule of tariffs. The effect of a flow limiter is that a customer will receive a zero account at the end of the month for water services and still benefit from the monthly write-off of one-twentieth of the outstanding water services debt.

The eThekwini rates policy aims to regulate the municipal power to impose rates on property in a sustainable, fair, and equitable way. Privileges for the Municipality to determine tariff rates are contained in the Municipal Property Rates Act (Act 6 of 2004) and the Municipal Finance Management Act (56 of 2003), which endorse municipalities to adopt and implement policies on the levying of rates on the rateable property. The eThekwini Municipality’s rates policy document sets out the rates policy of the Municipality and must be read with the Municipal Property Rates Act. Its

institutional requirement is that the Treasury is the responsible municipal cluster that should meet the Municipal Property Rates Act and the Municipal Finance Management Act. These include any regulations made under these two Acts when applying the rates policy. The Municipal Council annually reviews the rates policy, which affects the effective date of the first valuation roll prepared by the Municipality.

The credit control and debt collection policy are compiled under Section 97 of the Municipal Systems Act (32 of 2000). The policy is designed to provide for credit control and debt collection procedures and mechanisms. Its central commission is to ensure that the Municipality's approach to debt recovery is sensitive, transparent, and equitably applied throughout the Municipality's geographic area. The prevalence of high poverty levels within the various areas of the eThekwini Municipality led to this policy aiming to assist customers who are economically unable to meet standard rates and service charges. The policy is usually read in conjunction with the 'payment for services policy'. The latter was developed to provide reasonable water charges and procedures for the Council to limit or discontinue water provision if customers fail to comply with reasonable conditions set for the provision of such services. The two policies ensure that the Municipality raises as much revenue as possible with minimum defaults from its customers while simultaneously providing affordable essential services to its residents.

2.6 Conclusion

This chapter reviewed the literature relevant to water conservation in South Africa. It began by providing theoretical literature whereby theories related to water conservation were reviewed. This was followed by a discussion of some empirical literature on water conservation, water consumption behaviour and water demand management. Legislations governing the South African local government and the water sector were reviewed. The chapter also reviewed some of the water policies in the eThekwini Municipality. It emerged from the review of literature that there are many factors influencing consumer behaviour in water consumption. Key factors that emerged from the literature include the price of water, psychological factors, and sociodemographic factors. The reviewed literature also showed that water

consumption behaviour could be influenced by water consumption awareness and instant practical advice regarding water-saving activities.

CHAPTER 3

METHODOLOGY

3.1 Introduction

A methodology obtains, organises, and analyses data (Polit and Hungler 2004). It details how data is collected, the surveys and instruments used, the kind of data collected, and the data analysis techniques employed. According to Mouton and Marais (1996), a research methodology philosophy of precise technical decisions focuses on the individual steps in the research process and the objective procedures to be followed. This chapter presents a discussion of the methodology used in the study. The chapter is organised into eight main sections. Section 2 discusses the research design used in the study. Section 3 presents the study area, population, the target sample and the sampling technique used to collect survey data. Section 4 gives a discussion of the data collection instruments. Section 5 discusses the data collection procedures. Section 6 presents the data analysis techniques. Section 7 presents a discussion of issues on ethical considerations, anonymity and confidentiality. Section 8 concludes the chapter.

3.2 Research Philosophy

Pragmatism paradigm was deemed appropriate to this study as it is adopting both quantitative and qualitative methods. Pragmatism recognises that the reality is constructed by the individual but at the same time this is a reconstruction of something relatively stable exist (Creswell 2009). Basically, values both the assumption of interpretivist views and positivist views, moreover, pragmatism emphasize the importance of the empirical observation but at the same time it stresses that these observations rely on the researcher's interpretation of these observations. Therefore, the researcher explored the organisation from the perspective of different groups of

people. This allowed for an understanding of the social world which was derived from the participants' perceptions.

3.3 Research approach

Depending on the type and aim of the study, a mixed method design may be used. Such a design combines both quantitative and qualitative approaches to address the research objectives (Hesse-Biber 2010). The literature identifies various advantages of mixed-method designs. First, since a mixed method combines both quantitative and qualitative approaches, it provides different perspectives that improve the study's robustness (see Leech et al. 2009; Torres et al. 2010). Second, Bergman (2008) suggests that a mixed methodology improves focus on the research objectives and links to the survey data, data collection, analysis, and interpretation of findings. Third, a mixed-method design reduces restrictions of both qualitative and quantitative approaches, offering a comprehensive understanding of the research objectives.

Due to these and many other advantages of the mixed-method design, this study adopts a mixed-method approach to examine the role of households in water conservation in Durban. By adopting a mixed-method design, the study provides richer data essential in addressing water shortages that currently and constantly affect social and economic activities across South Africa. A comprehensive dataset contains the views of both policymakers and recipients of water services. As such, quantitative data was collected from households who are the recipients and consumers of water services, while qualitative data was collected from municipal officials involved in the provision of water services. The qualitative approach provided the opinions of water services practitioners from the eThekwini Metropolitan Municipality. In contrast, the quantitative part quantifies the overall behaviours and role of households towards water conservation.

3.4 Research design

A research design refers to the process of research that includes conceptualising a problem, writing research questions, data collection, analysis, interpretation, and report writing (see Creswell 2007; Mitchel and Jolly 2012). Research designs are mainly categorised into quantitative and qualitative designs. A quantitative design mainly entails the systematic process of quantifying, describing, and testing relationships (Nardi 2018). This type of design allows for an examination of the causes and effects of the interaction between variables. On the other hand, a qualitative design focuses on obtaining data through public and conversational communication to apprehend individuals or groups' social authenticity by allowing survey participants to supply answers in their own words (Holliday 2007).

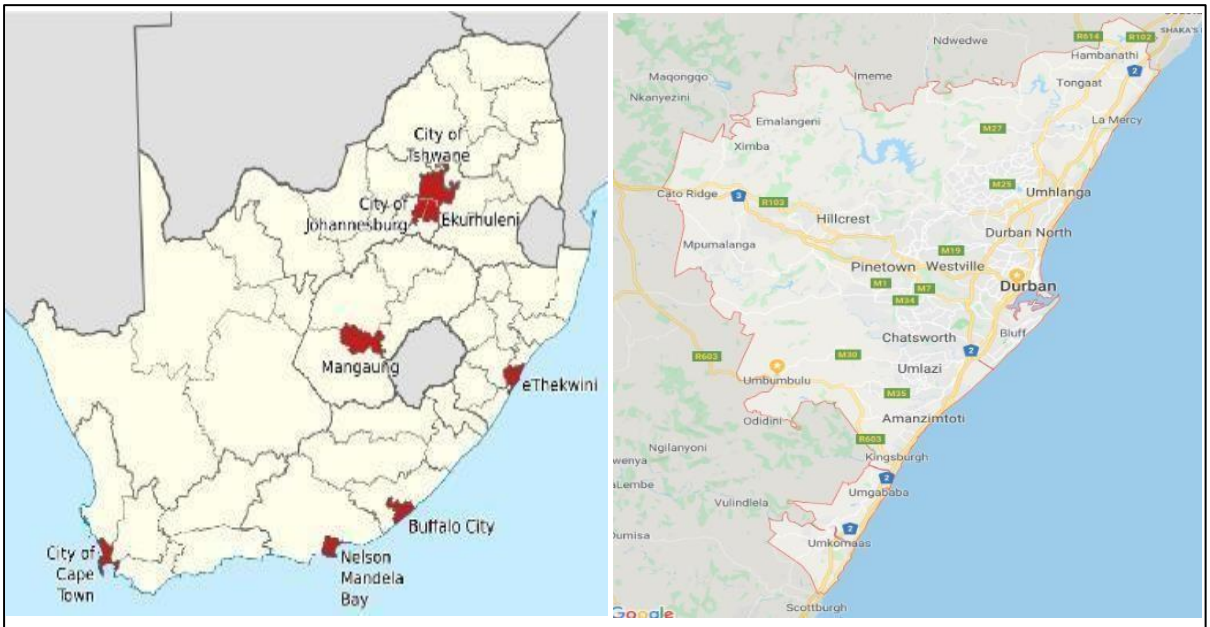
3.4.3 Data triangulation

Data triangulation entails gathering accounts from a variety of respondents in a predetermined setting, at various phases in the setting's activities, and, if necessary, from several locations within the setting (Banister et al. 1994). Data triangulation also comprises using numerous ways at different times to cross-check the consistency of specific and factual data items from diverse sources (Guba and Lincoln 1989; Patton 1990). Data triangulation was used in this study to compare qualitative data from semi-structured interviews with water practitioners and with quantitative data from questionnaires on Durban residents. Using this dual method does not produce a single, clear-cut, consistent picture, but it does create a challenge in terms of improving comprehension various reasons for the existence of inconsistencies between the two sets of data (Patton 1990).

3.3 The study site and population

This study was conducted in the city of Durban. The city is located in the eThekwini Metropolitan Municipality, in KwaZulu-Natal (KZN), in eastern South Africa. While Durban has slightly over 595 000 people, the eThekwini Metropolitan Municipality has

approximately 3.8 million people (Muttoo et al. 2018). In terms of racial dynamics, according to the 2011 National Census statistics, about 74% of the population is Black, while Indians constitute 17% of the population, whites constitute 7%, and Coloured constitute about 3% of the population. The most spoken language in the Municipality is isiZulu. In terms of access to safe drinking water, more than 91% of households in the Municipality has access to safe drinking water. However, due to the segregation laws of the past, the Municipality is spatially divided into suburbs, townships, informal settlements, and rural areas. While the affluent residents in the suburbs, most poor residents live in townships and informal settlements. Figure 3.1 consists of two panels. Panel A shows the position of the eThekwini Metropolitan Municipality on the South African map, while Panel B shows a detailed map of the eThekwini Metropolitan Municipality.



Panel A: Position of the eThekwini Municipality on the South African map

Panel B: Map of the eThekwini Municipality

Figure 3.1: South African Map

Source: Author's diagram

Figure 3.1 exhibits panel A and panel B. In Figure 3.1, Panel A shows the South African map, indicating the special distributions of the country's metropolitan municipalities. There are primarily populated urbanised regions that encompass the country's largest cities. In the context of this study, the panel shows the position of the eThekwini

Municipality on the South African map. On the other hand, Panel B shows some selected areas in the eThekwini Metropolitan Municipality. The areas shown in Panel B include rural areas (for example, Umbumbulu), townships where a large number of lower to middle-income people reside (for example, Chatsworth and Umlazi), and suburbs where the affluent reside (for example, Umhlanga and La Mercy).

The city of Durban was chosen as an ideal site to investigate households' role in water conservation for many reasons. First, Durban constantly experiences water shortages due to irregular rainfalls, which cause dam levels to drop drastically (Martel and Sutherland 2019). Over the years, the eThekwini Municipality, the water services provider (WSP), has been imposing water restrictions as a water management exercise. Second, Durban is a fast-growing city facing socio-economic challenges such as high population growth and urbanisation. The problem of urbanisation often leads to increased water demand, resulting in severe pressure on the water infrastructure and water resources. Finally, the suburbs, townships, informal settlements, and some rural areas make the eThekwini Municipality a typical representation of South African spatial distribution, hence an ideal site to explore the role of households in water conservation.

3.4 Target sample

A target sample is the subset of the entire population selected for analysis (Creswell 2009). The selected sample must have a sufficient size and represent the total population to warrant robust statistical analysis. Literature suggests that when determining a target sample, the researcher must compromise between supposedly perfect and practically viable (Burns and Bush 2014). However, using a correct sample size is not always an assurance that the verdicts of the study will precisely replicate the target population (Clow and James 2014). Therefore, the target sample needs to be large enough to disclose patterns in the data. In this study, the sample population were grouped into two main categories namely probability sampling and non-probability sampling.

Firstly, the study surveys 300 household heads from suburbs, townships and informal settlements in Durban. In calculating sample size, the Raosoft sample size calculator

was used. With a total population of 3.8 million people, a confident of 90%, and a 50% response distribution, the Raosoft sample size calculator recommended a minimum of 271 respondents. While the minimum number was recommended, 300 responses were collected. More precisely, 100 responses were collected from suburban areas, namely, Morningside, Musgrave and La Lucia. One hundred responses were collected from three townships, namely, Umlazi, Ntuzuma and Chatsworth. The final 100 responses were collected from three informal settlements, namely, Bhambayi, Mayville and Chesterville. This sample is a fair representation of the spatial distribution of the population of Durban. These areas were chosen because surveying households in these areas gave the study a balance of demographic dynamics. In the suburbs, residents are usually middle- to high-income earners, while those residing in townships and informal settlements are usually low-income. Understanding the roles of each of these groups towards water conservation is essential in terms of sustainable water consumption.

Secondly, we conduct semi-structured interviews with water practitioners from the eThekwini Metropolitan Municipality, the authority responsible for water services provision in Durban. Water services practitioners are interviewed to understand the municipality's efforts towards water conservation, its policies, challenges and successes in promoting household water conservation. In the Municipality, the Water and Sanitation Unit is responsible for water services issues. However, other units in the municipality work to complement the efforts of the Water and Sanitation Unit, for example, the Engineering Unit, Human Settlements Unit, Sizakala Customer Service Unit, amongst others. However, only practitioners from the Water and Sanitation Unit are interviewed because of budget and time constraints.

The eThekwini Water and Sanitation Unit have a staff complement of 3670 workers. These workers range from senior management, including the Unit Head and Deputy's heads, Supervisors, and various Junior employees. For this study, semi-structured interviews were used to collect information from 10 practitioners in the Unit. More precisely, the study elicits the professional opinions of three (3) managers, three (3) supervisors, and four (4) junior practitioners that deal directly with household water services. Interviewing ten respondents from the Unit will provide significant insights into water provision and conservation issues in the Municipality. The selected sample

size is justified in the literature, suggesting that 10 to 15 participants work very well in qualitative research when participants are homogeneous to reach saturation (Ling-Pan 2016). According to Ling-Pan (2016), less than 20 participants in a qualitative survey allow the researcher to sustain a closer relationship, thereby improving the exchange of information between the researcher and the participant. Equally, a sample size below 20 helps mitigate the typical biases and validity threats prevalent in qualitative research.

3.5 Sampling techniques

Sampling is the science of choosing a percentage of the population that is representative of the entire population. According to Bryman and Bell (2011), sampling techniques are methods used to reduce the amount of data collected by considering only data from a subgroup rather than all possible elements in a given population. Two main sampling categories are identified in the literature, namely, probability sampling and non-probability sampling.

Probability sampling utilises some form of random selection from a larger population whereby every member of a population has an equal chance of being selected (DuFrene 2018). Employing probability sampling allows researchers to develop a precisely descriptive sample of the real-life population of interest. Wolf et al. (2016) state that when using probability sampling, the researcher must choose the type that best suit the study out of five types, namely, stratified random sampling; simple random sampling; systematic sampling; cluster random sampling; and multi-stage random sampling. Additionally, statistical techniques like confidence intervals and margins of error are primarily used in probability sampling to find sample sizes and validate study results.

Non-probability sampling does not give all the individuals in the population equal chances of being selected (Greenfield and Greener 2016). In this sampling technique, the researcher chooses the samples based on their judgement. Non-probability sampling is most appropriate for exploratory studies. These are studies where the survey is organised into smaller samples, and it becomes improbable to use random

probability sampling due to time or cost constraints. The literature identifies five main types of non-probability sampling: convenience sampling, consecutive sampling; quota sampling; snowball sampling; and judgmental sampling (Wolf et al. 2016).

To select household respondents, this study uses the stratified random probability sampling technique. In this sampling technique, the entire population is divided into different subgroups or strata then participants are randomly selected, proportionally from each stratum (Maree 2007). Using the stratified random probability sampling technique gives an extremely descriptive population sample, making the statistical conclusions from the data collected robust (Rensburg et al. 2007). In this study, the population into equal groups based on the residential area they reside in. More precisely, the target population will be divided into suburban, township and informal settlement dwellers. Subsequently, participants are randomly selected from each stratum. Categorising respondents based on their residential area is a proxy to categorising them based on their income levels. This is essential because income levels correlate with the ability to buy water-saving appliances and other technologies.

In terms of the 15 participants surveyed from the eThekwini Water and Sanitation Unit, the purposive (or judgemental) sampling technique is adopted. This sampling technique considers only respondents with certain characters (Etikan et al. 2016). When the purposive sampling technique is employed, researchers guarantee that the selected participants can articulate the subject under investigation to address the research objectives. In this study, managers and supervisors involved in water provision in the municipality will be interviewed because they are key personnel in formulating and implementing water management policies and strategies. Equally, junior water practitioners are interviewed because of their direct involvement with household water services provision. Thus, junior practitioners are the structure that carries through water conservation policies from management to households. Hence, they are an integral part of the water management process.

3.6 Survey instruments

Survey instruments are devices such as questionnaires, tests, structured interview schedules, and checklists to collect data (Babbie 2014). Since this study adopts a mixed-method approach, two instruments are used to collect survey data. First, the study uses a self-administered questionnaire to collect quantitative data on water consumption dynamics from the heads of households. Second, a semi-structured interview schedule is used to collect qualitative data from practitioners in the Water Services Unit of the eThekwini Metropolitan Municipality. The construction and structure of each of these two instruments are discussed in this subsection.

3.6.1 Questionnaire construction and structure

Kumur (2011) defines a questionnaire as a research instrument that consists of questions written to collect quantitative data from a respondent. Questionnaires are mainly used to collect data from many respondents, where it is impractical to conduct in-depth interviews (Wisker 2008). Practically, questionnaires are employed for research motives that are primarily quantitative. Generally, questionnaires may have close-ended and open-ended questions. The former are questions that require respondents to pick from a different set of defined answers, such as “yes/no” or numerous options (in the case of Likert-scale options).

On the other hand, open-ended questions allow respondents to answer in an open text format. Hence respondents are not limited to a set of options (Adams and Lawrence 2015). Since open-ended questions have no limits in terms of the answers given by respondents, they provide answers in complicated situations and give researchers a chance to learn from respondents, hence understanding the phenomenon better.

In order to maximise the information elicited from households, the questionnaire developed in this study consists of both closed and open-ended questions. Structuring the questionnaire in this way allows for a relatively good exploration of patterns and trends that help to describe the status quo in Durban in terms of water demand, supply, and consumption dynamics. Equally, this allows for the provision of more appropriate remedies towards promoting household water conservation in Durban. In addition to

the open-ended questions, the questionnaire developed in this study contains dichotomous (yes/no) and Likert scale closed questions. The open-ended questions allow respondents to share their opinions and experiences on the phenomenon. The questionnaire used to collect data in the study is given in Appendix 1.

3.6.2 Interview schedule

To gain insight into water services, programmes and challenges experienced by the water services provider, semi-structured interviews are used to collect information from water practitioners. An interview is a qualitative data collection method that elicits respondents' opinions, perceptions, knowledge, and experience on a specific program or condition (see Evans and Lewis 2018). Interviews are usually conducted in a more comfortable environment. Hence respondents feel more relaxed, thus providing detailed information. In this study, an interview schedule is developed to guide conversations. However, respondents will be allowed to express their reasonable opinions and knowledge even beyond the asked questions using a semi-structured approach. The purpose of using a semi-structured approach is to yield as much information about the research topic as possible and not to abandon the research purpose. The interview guide involved five questions that dealt with the participants' background, water conservation policies, and challenges with water conservation. The questions consist of three to five probes. The study's semi-structured interview guide used to collect qualitative data from water practitioners is given in Appendix 2.

3.6.3 Pretesting survey instruments for reliability and validity

Before conducting any survey using self-designed instruments, it is essential to determine whether the questions are clear to respondents and relevant to the study (Graziano and Raulin 2013). Therefore, the preliminary testing of the survey instrument is essential before data collection. The preliminary testing of survey instruments is referred to as pretesting and involves the trial administration of the instruments to identify possible flaws. Pretesting is an essential procedure for

improving the robustness of data collected (Bowden et al. 2002; Hurst et al. 2015). Essentially, pretesting survey instruments aims to address two main aspects, namely, instrument reliability and validity. These two are further discussed in this subsection.

3.6.3.1 Testing for instrument reliability

Reliability entails the consistency with which the instrument measures the target attribute and implies the extent to which an instrument produces the same results on repeated trials (Maree 2007; Graziano and Raulin 2013). The reliability of an instrument suggests its adequacy and accuracy as a tool of measurement. If reliable, various researchers' administration of the same instrument under the same conditions should give the same results. Three main types of reliability are identified in the literature, namely, over time (or test-retest reliability), across items (or internal consistency), and across different researchers (or inter-rater reliability). In this study, the test-retest approach is used to test the reliability of the survey instruments used.

The test-retest reliability indicates the instrument's ability to measure consistency in the results produced and those to be produced if the same test is done multiple times under comparable conditions over time (Graziano and Raulin 2013). To test whether the study will produce the same results, the survey instrument should be administered to the same respondents twice, at different times, and examine whether results will be the same. This is more common in quantitative analyses where a questionnaire is pretested, and its validity tested using tools such as the Pearson's coefficient and the Cronbach alpha.

In the context of this study, the questionnaire developed to elicit quantitative data from households is piloted on 15 respondents from the target sample. The same group is also surveyed later, and a test-retest correlation is performed between the two datasets. The test-retest is done by graphing the data in a scatter diagram and then compute the Pearson's coefficient (or *Pearson's r*). A higher *Pearson's r* (+0.85 and above) indicates that the questionnaire is reliable. Regarding the interview schedule developed to collect qualitative data from water practitioners, reliability is tested on three respondents. Triangulation will be used to test the reliability of the interview

questions. Golafshani (2003) explains triangulation as a tactic for improving the reliability of research and evaluation of findings. In order to control bias and establish reliability, triangulation raises methodological issues that traditional scientific techniques are incompatible with. In this study, triangulation will also be used to interpret data at different times and locations. This will be done using multiple methods and data sources such as observations, interviews and recordings to improve analysis (Heale and Twycross 2015).

3.6.3.2 Testing for instrument validity

Validity refers to how the survey instrument accurately answers the questions it was intended to answer. Four types of validity are identified in the literature: face validity, content validity, criterion validity, and concurrent validity (see Maree 2007). Face validity requires the questionnaire to be relevant to participants in the study. In contrast, content validity entails that the researcher should seek the opinion of experts in the field on the adequacy of the questionnaire. On the other hand, criterion validity implies the capacity of the respondents' responses to predict the behaviour of the respondents.

In contrast, concurrent validity indicates whether responses to items on the questionnaire is parallel to other facets of the respondents' overall behaviour. In this study, survey instruments are designed using key concepts from existing water conservation literature. As such, valid research instruments are used. The literature proposes certain principles to be considered if validity is to be achieved. These principles are authority, purpose, scope, audience, and format. All these principles are considered and adequately addressed in this study.

When designing questionnaires and interview guides, the main aim is to correctly ask the right questions to the right people (Bertram and Christiansen 2014). In developing the research instrument used in this study, we review surveys conducted by other researchers on water conservation. The extensive literature review is essential in understanding the various components and questions in the survey instruments.

Equally, formats that enable survey instruments to flow smoothly and systems are used to achieve validity. Most importantly, questions are kept short and easy to be understood by the respondents. To achieve validity, the study applies the principle of content validity. Content validity measures the appropriateness of the subject researched, ensuring that it includes everything necessary and does not include unnecessary subjects. In this study, validity is determined by asking a sequence of questions and a review of the existing literature.

3.7 Data collection

Data collection is the process of gathering information on the variables of interest to address the research objectives (Creswell and Clark 2011). To produce a more robust dataset and reliable research, precision in data collection is essential—literature groups data into two main categories, namely, primary data and secondary data. The former entails data collected from first-hand sources through surveys, whereas the latter refers to information already published in sources of information like books, newspapers, magazines, journals, and online portals (Sapsford and Jupp 1996; Creswell and Clark 2011). The data used in this study is collected in two main phases.

In the first phase, quantitative data on water consumption dynamics is collected from the heads of households in Durban. This phase collects data from the three strata identified earlier, namely, townships, informal settlements, and suburbs. These areas are distinct and cover the demographic dynamics of the population of Durban. The researcher self-administers the survey, and questionnaires are completed in the presence of the researcher. Self-administering the survey allows the researcher to clarify questions that may be ambiguous to respondents. The questionnaire is designed in English. However, the researcher, who will also be the principal enumerator, is conversant in both English and isiZulu. Therefore, questions are translated and interpreted in isiZulu when it becomes necessary. Since the researcher will be personally involved in the data collection, the true meaning of the questions will not be lost in translation. Before data is collected from the household heads, a letter detailing what the research is about is provided to each respondent. In the letter of information, respondents are informed that they can opt not to continue with the survey

at any time, should they feel so. The letter of information presented to the respondents is given in Appendix 3. After the letter of information, each respondent is presented with a consent letter. Respondents will be informed of what the consent letter entails before they can sign it. The consent letter used in the study is provided in Appendix 4.

In the second phase of data collection, semi-structured and in-depth face-to-face interviews are carried out to elicit the opinions and views of practitioners from the Water and Sanitation Unit of the eThekwini Municipality. Water practitioners will be surveyed on the role households can play in water conservation, the policies and programmes of the municipality, as well as successes and challenges in water conservation. In the household survey, respondents are presented with both the letter of information and consent before conducting the interviews. Subsequently, respondents are provided with a list of questions, and an interview appointment is set. Each interview takes approximately 45 minutes, and an audio recorder captures the respondents' views. The permission to record the interview will be acquired before each interview session. Respondents will be informed before the interview commences that the session will be recorded. Probing questions will also be asked for further clarity.

3.8 Data analysis

Data analysis is a practice in which raw data is ordered and organised so that valuable information can be extracted from it (Silverman 2013). According to Creswell (2013), data analysis is a method of processing a phenomenon into its essential measures to understand it better. It is a powerful and creative process that gives a deeper understanding of the studied (Tailor and Bogdan 1998; Thomas 2003). When a mixed method is used, the primary purpose is to collect and analyse data concurrently using a triangulation process (Bergman 2008). Such data can also be analysed sequentially if the purpose is for development. The study is designed in phases. Data from the first phase is collected, analysed, and developed in a second phase (Creswell 2013). In this study, data analysis is performed in two main stages. The first stage analyses the quantitative survey data collected from households, while the second stage presents a qualitative analysis of the data collected from interviewing water practitioners.

3.8.1 Analysis of quantitative data

Firstly, quantitative data collected from the household survey is analysed through descriptive statistics and frequency distributions. Welman et al. (2005) explain that descriptive statistics assist the researcher to organise the data into a reasonable and readable manner, making it easy to identify patterns in the data. Descriptive statistics are used in this study to summarise critical variables, and these will be presented using tables and graphs. Among other statistics, this study will present measures of central tendency, dispersion qualities, and t-statistics.

Secondly, a probit regression model is used to ascertain the determinants of household water consumption behaviour. A probit regression model gives a binary dependent variable (for example, a yes or no outcome) and assumes that a positive outcome's probability is determined by the standard normal cumulative distribution function (Aldrich and Nelson 1984; Hosmer and Lemeshow 2000). It fits maximum likelihood models with dichotomous dependent variables coded as 0 or 1. The word probit is invented from a combination of the probability and unit of the word. It aims at transforming data to a representable manner that can be viewed as a linear function. The basic mathematical formulation of a probit model, as suggested in (Aldrich and Nelson 1984), is:

$$Pr(yi \neq 0|xj| = \phi(xj\beta) \quad (1)$$

where $\Pr$ is the probability of the dependent variable; y_i s the dependent variable, which in the context of this study is the dummy for the dichotomous water conservation variable; x_j Are the explanatory variables in the context of this study entail the selected determinants of water conservation behaviour; Φ is the standard cumulative normal, and β is the coefficient of each selected determinant. Using this model, variables that are statistically significant in determining household water conservation will be ascertained. More precisely, the empirical probit model to be estimated in this assumes the following function:

$$CONSERVE = \beta_0 + \beta_1 EDU + B_2 INC + \beta_3 GEND + \beta_4 AREA + \beta_5 OWN + \beta_6 SIZE + \beta_7 AGE + \beta_8 RACE + \beta_9 SUPPLY + \varepsilon \quad (2)$$

where EDU is the level of education of the respondent w (between never attend school, primary school, high school certificate, diploma/degree and postgraduate); INC is the average income for each household (<R3000, R3001-6000, 6001-9000, 9001-2000 and >20000); GEND is the respondent's gender (male and female); AREA is the type of area the respondent resides in (i.e. suburb, township or informal settlement); OWN is whether the respondent owns the property they reside in, or they are tenants; SIZE is the average household size for each respondent (average of 4 residents); AGE is the age of the respondent (average of 39 years old); RACE is the racial group of the respondent (Black, White, Coloured and Indians); SUPPLY is how each respondent receive water (i.e. in the house, in the yard, or from a community tap); β_0 is the constant; β_1 to β_9 are coefficients of the selected determinants of water conservation, and ε is the standard error. We hypothesize that these variables are vital in determining household water conservation in the context of South Africa. According to Aldrich and Nelson (1984), it can be concluded that Probit model provides a flexible and useful research technique that can be used to provide a rich and detailed outcome that can help researchers when analysing complex data.

3.8.2 Analysis of qualitative data

The literature identifies various methods through which non-numeric information collected through interviews can be analysed. The most common methods of analysing such data include content analysis, narrative analysis, discourse analysis, framework analysis, and grounded theory (Coyle and Lyons 2007). Content analysis is employed to create replicable and valid implications by interpreting and coding textual material, including verbal and graphic communications (Duriau et al. 2007). In contrast, narrative analysis exists when speakers share and recount an experience or event (Chase 2005). According to Charmaz (2006), grounded analysis is an inductive method of an emerging theory that entails generating a theory through the collection and analysis of data by the elucidation of how a social occurrence works. The method examines ongoing spoken communication with all other text types (Chase 2005). On

the other hand, framework analysis brings together and manages data using the method of summarization (Duriau et al. 2007).

To analyse the qualitative data collected from water practitioners, this study uses the framework analysis method. In addition to providing clear steps to follow and producing a highly structured output of summarised data, framework analysis is credited for many other advantages (see Bryman and Burgess 2002). Among them is the ability to provide more detailed data and accurate information about the population because the method is primarily based on the observation and accounts of the participants. Additionally, framework analysis is credited for its flexibility, allowing researchers to make changes, additions, and amendments throughout data collection. Further, the method is comprehensive, entailing a clear audit trail from original raw data to the final theme (Duriau et al. 2007).

In framework analysis, qualitative data in this study will be analysed by following through five main steps: familiarisation, thematic framework, indexing, charting, and mapping and interpretation. The implementation of these steps in this study is discussed briefly in Table 3.1.

Table 3.1: Steps taken in qualitative data analysis

Step	Explanation
1. Familiarisation	This is an essential step in qualitative data analysis because it allows the researcher to understand key ideas. The researcher will listen to audio recordings, study the field, and read transcripts to familiarise with the recorded data.
2. Identifying the thematic framework	After familiarisation, the researcher identifies the themes emerging from the collected data. In this step, the researcher uses proceedings taken during the familiarisation stage to filter and categorise the data into specific themes.
3. Indexing	Indexing is an act of recognising some sections of the data that resemble a particular theme researched in the study. This involves statistically interpreting transcripts to detect consistencies through coding.
4. Charting	Charting involves reorganising the data to create order. This is done by lifting the data from its original textual setting and placing it in charts. Although the researcher will lift the data from their context, all cases are kept in the same order in each chart when developing a final coding.
5. Mapping and interpretation	This is the pictorial and graphical representation of themes, illustrating how the themes relate to each other. It involves an analysis of the key characteristics as set out in the charts.

3.9 Ethical considerations, anonymity, and confidentiality

Ethical considerations are customs and morals of conduct that differentiate right and wrong (Bryman and Bell 2007). These customs and morals help to regulate the modification of accepted and unaccepted behaviour. In this study, the ethical principle of self-determination, where respondents are treated as autonomous agents, is maintained. This is communicated to the respondents before conducting the survey. Furthermore, respondents are informed about the study and that their participation is voluntary. Hence, they can choose to participate or discontinue the survey at any time should they feel so. Respondents are also provided with information about the researcher and the institution (Durban University of Technology) in the event of further questions or complaints[1].

Equally, respondents' anonymity is maintained throughout the study. Anonymity is a state in which the distinctiveness of respondents is only known by the researcher and not revealed in the study. In this study, anonymity is ensured by non-disclosure of the participants' names on the questionnaires and research reports. Written consent given by respondents is detached from the questionnaires. Additionally, respondents' confidentiality is maintained in the study. Confidentiality in this context refers to a condition where the researcher knows the identity of the respondents but shields it from being exposed to others (see Maxwell 1996). In this study, confidentiality is maintained by keeping the collected data strictly confidential and not revealing the respondent's identities when reporting or publishing the study.

3.10 Conclusion

This chapter discussed the methodology used in the study. The study adopts a mixed methodology where both quantitative and qualitative data is collected and analysed. Quantitative data will be collected from households, while qualitative data will be collected from water practitioners from the Water and Sanitation Unit of the eThekwini

[1] This study is guided by the guidelines on the ethical standards of the Durban University of Technology. Consent and information letters are respectively attached in Appendices 3 and 4.

Metropolitan Municipality. Two research instruments, a questionnaire for the households and an interview schedule for the water practitioners, are developed. The researcher will self-administer the surveys using data collection procedures outlined in this chapter. Further, the chapter gives details on the analysis of both quantitative and qualitative datasets. Finally, the chapter presented how ethical issues and anonymity and confidentiality will be maintained throughout the study. In the next chapter, the empirical results of the study are presented and subsequently discussed.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This study was set to achieve four main objectives. The first objective was to determine households' current water consumption behaviour. The second objective was to establish the households' willingness to adopt water-saving technologies, while the third objective was to identify factors preventing households from practising water saving behaviour. Finally, the study will recommend possible approaches that the eThekwini Metropolitan Municipality could utilise to promote households' willingness to save water. To achieve these objectives, a mixed-method approach was used. Qualitative data were collected from municipal employees through interviews, while a survey was conducted to collect quantitative data from households. This chapter presents the results of the study and is divided into two main sections. The first section presents results from quantitative data analysis, while the second section presents results from qualitative data analysis.

4.2 Analysis of quantitative data

A survey was conducted on 300 household heads in the city of Durban during the period February 2020 to April 2021. One hundred responses were collected from suburban areas, namely, Morningside, Musgrave, and La Lucia. One hundred more responses were collected from three township areas, namely, Umlazi, Ntuzuma, and Chatsworth. The final 100 responses were collected from three informal settlements, namely, Bhambayi, Mayville, and Chesterville. Therefore, the sample covered the various spatial areas within the city. Participants were randomly selected, and the researcher administered the survey.

The survey was conducted when South Africa was battling the COVID-19 pandemic, and various health and safety protocols were in place. To avoid physical contact and minimise the risk of transmission, mitigating protocols were observed by the researcher during data collection. More precisely, the researcher had two copies of the questionnaire for every respondent. The first copy was handed to the respondent to read, while the second copy remained with the researcher to capture responses. The social distancing of at least 2 meters apart was maintained between the researcher and each participant, and both the researcher and respondent correctly wore face masks throughout the survey. Furthermore, the researcher carried a sanitiser bottle and both the researcher and each participant sanitised hands before and after the survey. The descriptive statistics of the data collected are presented in Table 4.1.

Table 4.1: Descriptive statistics of the quantitative data (N=300)

		Mean/Frequency
Household size		4
Age		39
Gender (%)	*Male*	47
	Female	53
Race (%)	*Black*	59
	White	27
	Indian/Asian	13
	Coloured	1
Education level (%)	*Never attended school*	3
	Primary school	9
	High school	23
	Certificate	24
	Diploma/Degree	20
	Postgraduate	21
Area type (%)	*Suburban*	33
	Township	33
	Informal settlement	33
Property ownership (%)	*Owner*	74
	Tenant	19
	Other	8
Access to water (%)	*Inside dwelling*	67
	In the yard	11
	Community tap	22
	Other	-
Monthly income (%)	*< R3 000*	7
	R3 001 – R6 000	16
	R6 001 – R9 000	15
	R9 001 – R20 000	20
	>R20 000	41
Appliance ownership (%)	*Yes*	53
	No	47
Installation of water-saving equipment (%)	*Yes*	59
	No	41

The average household size was four members, while the average age was 39. More females participated in the survey (57%), while most of the participants were Black (59%), followed by Whites (27%), then Indians (13%) and Coloured (1%). These statistics are consistent with the population statistics of the city, where Blacks and Whites have the most numbers, respectively. Further, most participants (i.e., 88%) possessed a high school education, with only 12% having either primary school or not attended formal schooling. Each of the three primary spatial distributions of the city (i.e., suburbs, townships, and informal settlements) were equally represented in the sample. It is also important to note that most participants owned the property they dwell in (i.e., 74%) and accessed potable water inside the house. About 47% of the participants did not have water-saving appliances installed in their homes. One of the major reasons for not owning water-saving appliances was that many participants did not have the infrastructure to connect these appliances. These descriptive statistics are essential in shedding light on the data and giving intuitions on the behaviour of the sampled participants.

4.2.1 Opinions on water-saving appliances and water scarcity

Participants were asked to express their opinions on water-saving appliances and water scarcity in South Africa. Various questions around these two phenomena were asked. Five (5) questions were asked using a Likert scale with four options (strongly agree, agree, disagree, and strongly disagree) for water-saving appliances. Participants were supposed to choose one option in each question. These questions explored the opinions and perceptions of households on the use of water-saving appliances and ascertained their willingness to adopt these technologies. This was in line with the study's third objective, which sought to establish the extent to which households are willing to adopt water-saving technologies. Frequency distribution results on the opinions of participants regarding water-saving appliances are given in Table 4.2.

Table 4.2: Responses on opinions about water-saving appliances (N=300)

		Frequency	Modal response
Appliances such as washing machines can help save water	Strongly agree	53%	Strongly Agree
	Agree	37%	
	Disagree	9%	
	Strongly disagree	1%	
Appliances such as washing machines reduce the water bill	Strongly agree	46%	Strongly Agree
	Agree	38%	
	Disagree	14%	
	Strongly disagree	2%	
Using technology in doing household chores saves more water than doing it manually	Strongly agree	35%	Agree
	Agree	48%	
	Disagree	13%	
	Strongly disagree	4%	
Campaigns by the municipality on water-saving appliances make people buy them	Strongly agree	10%	Disagree
	Agree	37%	
	Disagree	43%	
	Strongly disagree	10%	
Most people in my community are aware of the benefits of using water-saving appliances	Strongly agree	22%	Disagree
	Agree	32%	
	Disagree	35%	
	Strongly disagree	10%	

Table 4.2 shows that most respondents (i.e., 90%) agreed or strongly agreed that appliances such as washing machines can help save water. Further, most respondents (i.e., 84%) affirmed that efficient washing machines could reduce the water bill. Many respondents (i.e., 83%) also agreed that using technology for household chores saves more water than manually. However, 53% of the respondents did not agree that campaigns by the municipality to promote the acquisition of water saving appliances yield positive outcomes. Lastly, a slightly larger number of respondents (54%) affirmed that people in their communities are aware of the benefits of water-saving appliances. These results show that the sampled households possess the correct opinions and perceptions regarding water-saving appliances. However, the municipality should develop more and better initiatives to encourage households to buy and install these appliances.

In terms of opinions and perceptions on water scarcity in South Africa and the role of the eThekwini Municipality, participants were asked seven (7) dichotomous questions where they could give a “yes” or “no” response. These questions shed light on the households’ knowledge and appreciation that South Africa is generally a water-scarce country with annual rainfalls below the world average. Such knowledge is likely to significantly correlate with household behaviour regarding water consumption which will lean more towards conservation. Results on the participants’ opinions regarding water scarcity in South Africa are shown in Figure 4.1.

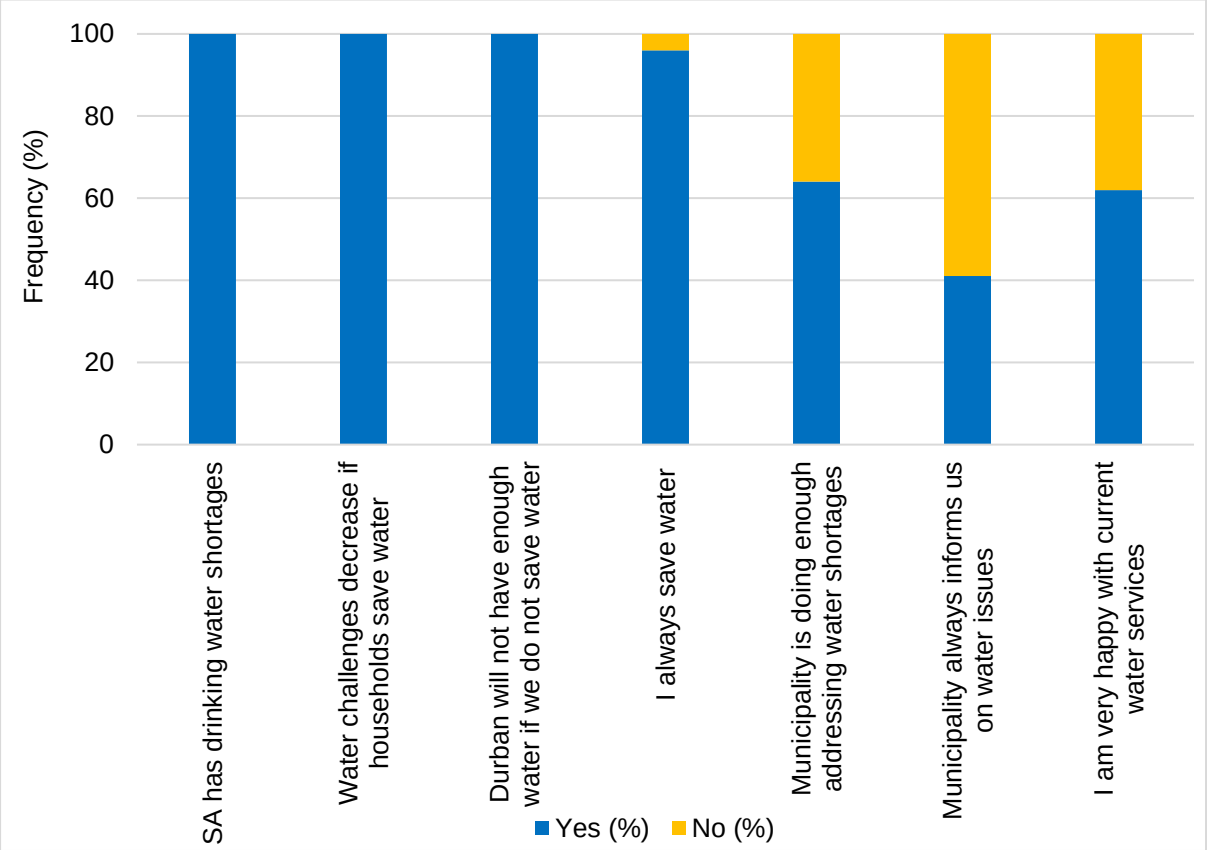


Figure 4.1: Responses on opinions about water scarcity (N=300)

Figure 4.1 shows that all respondents agreed that South Africa has a shortage of water to drink. Water challenges in the city will decrease if households save water and that the city of Durban will not have enough water in the future if households do not save water. These responses show that households understand the water crisis the country is currently facing, with most of them (96%) indicating that they save water every time they use water. Regarding their views about the municipality, 36% of the respondents think that the municipality is not doing enough to address water shortages. Further,

59% of the respondents indicated that the municipality does not always inform them about water issues. This is concerning considering the level of water scarcity in the city where water restrictions are sometimes implemented. Thus, the municipality needs to consider new and effective ways to reach out to the people, engaging them more on water issues. Also, to note that 38% of the respondents indicated that they were not happy with the water services that they receive from the municipality, implying that the municipality should also improve its water service delivery mandate.

Further, participants were also asked to describe the potable water they currently receive. About 36% of the participants indicated that the water they received was excellent, while 26% said it was good, with 24% saying it was poor, and 14% indicating bad. These statistics suggest that 38% of the respondents were not satisfied with the potable water they currently receive from the municipality. Participants who indicated dissatisfaction with the current potable water service delivered were further asked to use words and describe the water services that they received from the municipality. Most of them complained about the time taken by the municipality to fix water leaks. Participants from informal settlements complained about community taps which they said were fewer, causing people to wait longer in queues to get water. They further complained that some people walk long distances to access these community taps far from their homes.

4.2.2 Household water consumption behaviours

The first objective of this study was to understand the daily water consumption behavioural practices of households. To achieve this objective, participants were asked ten (10) behavioural questions using a Likert scale with four options (i.e., never, occasionally, always, and not applicable). Selecting the option “never” implies that participants are highly water-conserving in their behaviour while selecting “always” suggests that they waste water. The frequency distributions of participants’ responses are given in Figure 4.2.

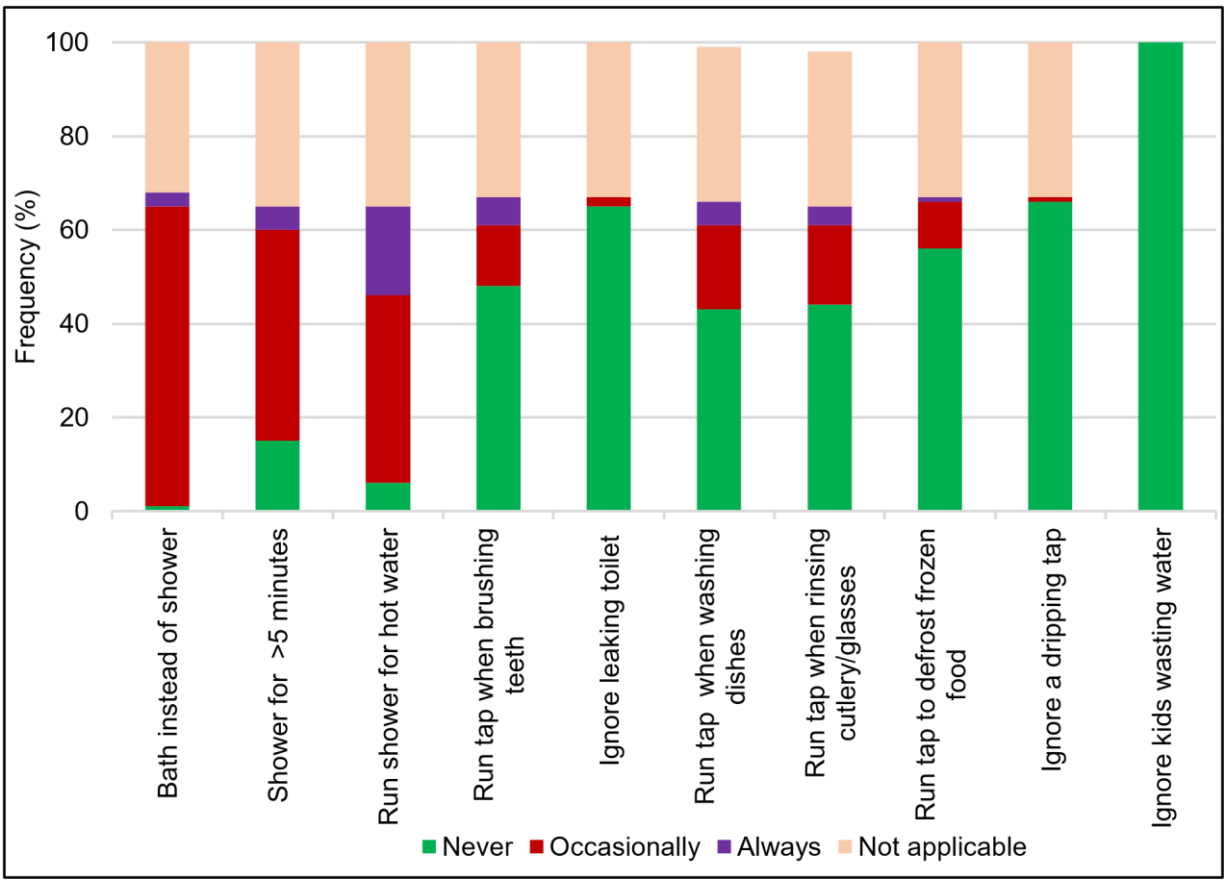


Figure 4.2: Responses on respondents' daily water behaviour

Except for the first three questions where the modal response was “occasionally”, Figure 4.2 shows that the sampled participants “never” practised wasteful behaviours in their daily water consumption habits. Most respondents (65%) never ignore leaking toilets and a dripping tap. Further 58% respondents never run tap when brushing teeth as well as 100% never ignore kids wasting water. These results suggest that participants are conscious of water-conserving behavioural practices, which are applauded in the literature (Bernedo et al. 2014; Borisova et al. 2013; Hasan et al. 2021). Water conserving behaviour is essential, especially in Durban and South Africa at large, where rising population growth, climate change and economic development are pressuring the limited water resources. Such behaviour is commendable and should be promoted.

4.2.3 Water consumption behaviour and biographical characteristics

There is growth in the number of studies examining biographical characteristics' impact on water consumption behaviour (Dean et al. 2021; Martinez and Maia 2021; Russell and Knoeri 2020). Common biographical characteristics examined include gender, age, education level, household size, and income levels (Araya et al. 2020; Cauberghe et al. 2021; Lameck et al. 2021). This study also examines the relationship between water consumption behaviour and the biographic characteristics of respondents. The impact of biographic variables on water consumption behaviour is examined in line with the study's second objective, which sought to identify factors preventing households from practising water-saving behaviour. To do this, probit regression modelling is used as an estimation tool. Inconsistent with other studies in the literature, the biographies examined in this study are gender, age, education level, homeownership, household size, and income levels (Araya et al. 2020; Cauberghe et al. 2021; Martinez and Maia 2021; Russell and Knoeri 2020).

Understanding the individual relationships between these biographical variables is essential before being used as explanatory variables in the probit regression modelling. Therefore, correlation tests are run to examine whether the problem of multicollinearity exists among the explanatory variables. The existence of multicollinearity among the explanatory variables will affect fitting the probit models, thus producing unreliable results. Therefore, a simple Pearson correlation test measures the strength and direction of association among the explanatory variables. The Pearson correlation test was preferred because some of the biographic variables are continuous. Correlation values range from 0 to 1, where a correlation value of 0 implies no association between the variables, while a correlation value of 1 implies an influential association (Gujarati 2012). Thus, the strength of association of variables increases as the correlation value approaches 1. Results from the correlation test are presented in Table 4.3.

Table 4.3: Correlation matrices for the possible explanatory variables

	Gender	Age	Edu	Ownership	Hh size	Income	Area type	Access type
Gender	1.000							
Age	0.009	1.000						
Edu	0.132	-0.044	1.000					
Ownership	0.057	-0.307	-0.127	1.000				
Hh size	0.105	0.153	0.112	-0.128	1.000			
Income	0.083	0.150	0.607	-0.271	0.248	1.000		
Area type	-0.106	-0.100	-0.657	0.252	-0.184	-0.861	1.000	
Access type	-0.067	-0.178	-0.558	0.271	-0.258	-0.827	0.817	1.000

Apart from the six biographical variables mentioned earlier, two other variables were included in the correlation test as possible determinants of water consumption behaviours (i.e., area type and access type). Table 4.3 shows correlation coefficients that are generally very small, except for the relationship between “area type and income”, “access type and income”, as well as “access type and area type”, which all have absolute statistics greater than 0.8. Thus, closer relationships exist between these variables, implying that including them together as explanatory variables in the probit regression modelling will produce spurious relationships that can impact the robustness of the models. Therefore, the variable “income” will be used as a proxy for “area type” and “access-type”. This is consistent with reality, where people commonly reside in different areas depending on their income levels. Thus, a probit regression model with six biographical variables is estimated, as illustrated earlier in Equation 3.2.

Probit regression modelling requires a binary dependent variable (Aldrich and Nelson 1984; Hosmer and Lemeshow 2000). However, participants were asked ten (10) water consumption behavioural questions using a 4-point Likert scale with “never, occasionally, always, and not applicable” options in this study. Participants who chose “never” were considered to be performing water consumption behaviours. Therefore, we follow Murwirapachena (2021) and deduce a dummy binary variable from the Likert scale responses, where all “never” responses were coded 1 and 0 otherwise. This was done for all ten behavioural questions. However, out of the ten behavioural questions,

only questions where “never” was the modal response were selected for further analysis. There was a behavioural question where all respondents indicated “never”.

This question was excluded from further analysis because it had no variability in responses, and regression analysis would have been pointless. Thus, only 6 of the ten behavioural questions were analysed further. Using the generated dummy variable as the dependent variable, probit regression models were estimated for each of the six behavioural questions. In this context, the regression models examined the probability of selecting “never” given the biographical variables of each respondent. Results for each model are presented in Table 4.4.

Table 4.4: The relationship between water consumption behaviour and biographic characteristics

	Run tap to brush teeth	Ignore water leaks	Run tap to wash dishes	Run tap to rinse the cutlery	Run tap to defrost	Ignore drip tap
Gender	-0.261	0.226	-0.210	-0.295*	-0.050	0.090
	[0.172]	[0.271]	[0.170]	[0.172]	[0.182]	[0.327]
Age	0.027***	0.038**	0.005	0.005	0.010	0.011
	[0.010]	[0.020]	[0.010]	[0.010]	[0.011]	[0.022]
Education	0.116	0.325***	-0.055	-0.061	0.093	0.313**
	[0.078]	[0.126]	[0.079]	[0.079]	[0.082]	[0.148]
Home ownership	-0.152	-0.064	-0.022	-0.021	-0.001	-0.152
	[0.153]	(0.231)	[0.153]	[0.154]	[0.167]	[0.261]
Household size	0.094**	-0.036	0.127***	0.142***	0.071	0.087
	[0.050]	[0.078]	[0.050]	[0.050]	[0.053]	[0.092]
Income	0.528***	1.363***	0.675***	0.695***	0.805***	1.841***
	[0.093]	[0.178]	[0.101]	[0.102]	[0.105]	[0.277]
_cons	-3.446***	-7.194***	-2.990***	-2.951***	-3.913***	-7.715***
	[0.666]	[1.278]	[0.676]	[0.681]	[0.742]	[1.501]
LL	**-151.1**	**-54.5**	**-152.7**	**-150.5**	**-121.9**	**-38.5**
Chi^2	**113.2**	**280.8**	**105.0**	**110.0**	**167.7**	**307.6**
Prob> Chi^2	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Pseudo R^2	**0.272**	**0.721**	**0.256**	**0.267**	**0.407**	**0.800**
Observations	**300**	**300**	**300**	**300**	**300**	**300**

*Note: ***, ** and * = statistical significance at 1%, 5%, 10% level, respectively. Standard errors in parenthesis.*

Results in Table 4.4 are read based on the statistical significance and the sign of the coefficient of each biographical variable in each model. Statistically significant relationships exist when the p-value is less than 0.001 (i.e., significance at 1%), or pvalue is more significant than 0.001, but less than 0.005 (i.e., significance at 5%) or pvalue is more significant than 0.005 but less than 0.010 (i.e., significance at 10%). On the other hand, a negative coefficient implies a negative relationship between given biographical characteristics and the given water consumption behavioural practice. Thus, a positive coefficient implies otherwise.

Estimation results in Table 4.4 show income as the most consistent variable, statistically significant at a 1% significance level across all water consumption behavioural models. The coefficient is consistently positive across all models. Results on the relationship between income and water consumption behavioural practices imply that households with higher income levels were likely to practice water-efficient behaviours in their daily water consumption activities. This revelation is consistent with findings from other studies in the literature, which report similar results (Addo et al. 2018; Barnett et al. 2020; Moglia et al. 2018).

Further, household size has the second greatest number of significant coefficients. The variable has positive coefficients, which are statistically significant in three models. It is statistically significant at 5% in the first model and 1% in the other two models. This result implies that bigger households with more members are more likely to practice efficient water consumption behaviour in their daily consumption activities. Households with many members can reduce water consumption by sharing other activities like washing laundry and dishes. Furthermore, in larger households, members share resources such as the bathroom, so people take short showers to allow others to quickly get their turns using the bathroom (Alarcón et al. 2019; Araya et al. 2019; Barnett et al. 2020).

Age and the level of education are statistically significant in two models, both with positive coefficients. This implies that out of the six models, age and education were only crucial in the two models. The results separately suggest that relatively educated people were likely not to ignore water leaks and dripping taps. In contrast, relatively older people were likely not to run the tap when brushing teeth and ignore water leaks. These results are consistent with findings from other studies in the literature that also reportage and education to positively impact water consumption behavioural practice (Willis et al. 2011; Ehret et al. 2021; Onyenankeya et al. 2021).

Further, gender has a positive coefficient that is statistically significant at 10% in one model. The negative coefficient in this context means that males were more likely not to run a tap when rinsing cutlery. This is concerning given that females generally spend more time doing house chores than males. However, results indicate that males are more conscious of water-efficient behaviour when rinsing dishes and cutlery.

Differently, homeownership is revealed to be an unimportant determinant of water consumption behaviour. However, the consistently negative and statistically significant intercepts across all models suggest that other factors that cause inefficient water consumption behaviours exist apart from the biographical variables. While estimates presented in Table 4.4 show the relationship between water consumption behavioural practices and biographic characteristics, it is vital to understand the exact impact of each biographic variable on the given behavioural practice. Such information is obtained from the estimation of average marginal effects. Williams (2012) explains that a margin is a statistic based on a fitted model that fixed some or all covariates. In most cases, marginal effects are changes in response to a change in a covariate, which is reported as a derivative. For example, a marginal effect of 0.4 means that the dependent variable increases with the independent variable at a rate. If the rate were constant, the dependent variable would increase by 0.4 if the independent variable increased by 1. This study estimates the average marginal effects of all covariates for efficient water consumption behaviours, and the results are presented in Table 4.5.

Table 4.5: Marginal effects of biographic characteristics on water efficient behaviour

	Run tap to brush teeth	Ignore water leaks	Run tap to wash dishes	Run tap to rinse cutlery	Run tap to defrost	Ignore drip tap
Gender	-0.074	0.023	-0.060	-0.083*	-0.011	0.007
	[0.048]	[0.028]	[0.048]	[0.048]	[0.042]	[0.024]
Age	0.008***	0.004**	0.002	0.001	0.002	0.001
	[0.003]	[0.002]	[0.003]	[0.003]	[0.003]	[0.002]
Education	0.033	0.033***	-0.015	-0.017	0.021	0.023**
	[0.022]	[0.012]	[0.022]	[0.022]	[0.019]	[0.010]
Home ownership	-0.043	-0.007	-0.006	-0.006	-0.000	-0.011
	[0.043]	[0.024]	[0.044]	[0.043]	[0.038]	[0.019]
Household size	0.027**	-0.004	0.036***	0.040***	0.016	0.006
	[0.014]	[0.008]	[0.014]	[0.014]	[0.012]	[0.007]
Income	0.149***	0.140***	0.193***	0.196***	0.183***	0.134***
	[0.022]	[0.012]	[0.022]	[0.021]	[0.017]	[0.011]
Observations	**300**	**300**	**300**	**300**	**300**	**300**

*Note: ***, ** and * = statistical significance at 1%, 5%, 10% level, respectively. Standard errors in parenthesis.*

The statistical significance of the margins is consistent with those reported earlier in Table 4.4. Thus, income has the most statistically significant margins, followed by household size, age and education, and gender in that order. Equally, the signs of the statistically significant margins are like those reported earlier in Table 4.4. The most minor absolute significant marginal effect is 0.004 reported for “age” in Model 2 (i.e., ignore leaks). At the same time, the largest is 0.196 reported for “income” in Model 4 (i.e., run tap to rinse cutlery). In terms of the most minor absolute significant marginal effect, this result means that the probability of not ignoring water leaks increases with age at a rate such that, if the rate were constant, the probability of not ignoring water leaks would increase by 0.004 if age increased by 1. For the most considerable absolute significant marginal effect of 0.196 reported, it means that the probability of not running the tap while rinsing cutlery increases with income levels at a rate such that, if the rate were constant, the probability of not running the tap while rinsing cutlery would increase by 0.196 if income levels increased by 1. Generally, it is observed from

the results that the level of income has the most considerable marginal effects on behavioural practices. This is observed across all models.

4.2.4 Ownership of water-saving appliances and biographical variables

Consistent with the study's second objective, whose thrust is on adopting water-saving appliances by households, the study examines the nexus between biographical variables and ownership and installation of water-saving appliances. Respondents were asked two dichotomous (yes or no) questions on the ownership of water-saving appliances and the installation of such appliances. About 53% of the respondents indicated that they owned water-saving appliances such as efficient washing machines and dishwashers, while 59% had water-efficient equipment installed in their homes. A binary variable was captured for each of these two questions where a “yes” response was coded 1 and 0 otherwise. Probit regression models were then estimated to examine the relationship between the biographic characteristics of respondents with ownership and installation of water-efficient technologies, respectively. Results are presented in Table 4.6.

Table 4.6: The relationship between using efficient appliances and biographical characteristics

	Ownership of efficient appliances	Installation of efficient technologies
Gender	0.196	0.059
	[0.225]	[0.244]
Age	0.001	0.005
	[0.013]	[0.015]
Education	0.429***	0.303***
	[0.103]	[0.106]
Home ownership	-0.078	0.056
	[0.220]	[0.228]
Household size	0.074	0.151**
	[0.067]	[0.074]
Income	1.106***	1.240***
	[0.146]	[0.155]
_cons	-6.605***	-6.654***
	[1.060]	[1.097]
LL	**-80.4**	**-67.7**
Chi^2	**253.9**	**270.7**
Prob> Chi^2	**0.000**	**0.000**
Pseudo R^2	**0.612**	**0.667**
Observations	**300**	**300**

*Note: ***, ** and * = statistical significance at 1%, 5%, 10% level, respectively. Standard errors in parenthesis.*

Table 4.6 shows education and income as consistent determinants of ownership and installation of water-saving appliances and technologies. These two variables are statistically significant at 1% in both models. In addition, household size is also an essential determinant of installing water-efficient technologies. A positive coefficient implies that larger-sized households are more likely to install water-efficient technologies. Generally, the results are consistent with other studies in the literature, which also report the same biographical characteristics as essential determinants of

water consumption behaviours (Millock and Nauges 2010; Murwirapachena 2021; Quesnel et al. 2020; Russell and Knoeri 2020; Sparkman and Walton 2017).

Further, the actual impact of biographical variables on the ownership and installation of water-saving appliances is examined. This is done using the marginal effects approach explained earlier in section 4.2.3. Results are presented in Table 4.7.

Table 4.7: Marginal effects of biographic variables on the use of efficient appliances

	Ownership of efficient appliances	Installation of efficient technologies
Gender	0.029	0.008
	[0.033]	[0.031]
Age	0.000	0.001
	[0.002]	[0.002]
Education	0.063***	0.039***
	[0.014]	[0.013]
Home ownership	-0.011	0.007
	[0.032]	[0.029]
Household size	0.011	0.019**
	[0.032]	[0.009]
Income	0.163***	0.158***
	[0.014]	[0.013]
Observations	**300**	**300**

*Note: ***, ** and * = statistical significance at 1%, 5%, 10% level, respectively. Standard errors in parenthesis.*

The statistical significance of the margins is consistent with those reported earlier in Table 4.6. Thus, education and income have consistently significant margins across the two models, while household size has a significant margin only in the second model. Equally, the signs of the statistically significant margins are like those reported earlier in Table 4.6. Further, the size of the statistically significant margins is vastly closer to each other for each variable across the models. The results are interpreted to mean that the probability of owning water-efficient appliances increases with

education at a rate. If the rate were constant, the probability would increase by 0.063 if the level of education increased by 1.

Further, the probability of owning water-efficient appliances increases with the level of income at a rate. If the rate were constant, the probability would increase by 0.163 if the level of education increased by 1. Almost the exact impact is reported for Model 2, which additionally shows that the probability of installing efficient appliances increases with the household size at a rate. If the rate were constant, the probability would increase by 0.019 if the household size increased by 1. The impact of biographical characteristics reported in this study is in line with those reported in similar studies (Aslam et al. 2021; Murwirapachena 2021; Shahangian et al. 2021).

4.3 Analysis of qualitative data from municipal employees

This section presents the qualitative data collected from employees in the Water and Sanitation Unit at the eThekwini Metropolitan Municipality. The data was collected during the period May to June 2021. Employees in the Water and Sanitation Unit were selected because they were better positioned to provide professional opinions on water service issues in the municipality since they directly deal with such issues daily. Due to the prevalence of the COVID-19 pandemic and the need to adhere to health and safety protocols at the time of data collection, it was not possible to physically meet with the employees as planned earlier. Therefore, open-ended questions were prepared, coded in Google documents, and a link containing the questions was sent to the employees. The study targeted to receive ten (10) responses. However, only seven (7) responses were collected, giving a response rate of 70%. This was a reasonable response rate that is expected to yield valuable information that can improve the discussions and recommendations of this study. Details on how the respondents were to answer the questions and all ethical issues were emailed together with the link. Informed consent was obtained from all participants prior to the interviews.

4.3.1 Demographic profiles of the participants

Demographic data give a better understanding of the characteristics of participants. Such data include race, age, employment status, gender, level of education and marital status (Connelly 2013). In this study, the real names of participants were replaced by numbers to protect their identity. Concealing the identities of participants and maintaining confidentiality protect them against exploitation and harm (Surmiak 2018). Thus, numbers (1 – 7) were used to identify participants in this study. Table 4.8 presents the demographic profiles of the employees who participated.

Table 4.8: Demographic profiles of participants

Participant	Position	Education	Age	Years in Unit	Years in municipality
1	Community liaison officer	Degree	28	5	5
2	Administrator	Degree	34	8	11
3	Education officer	Degree	33	2	2
4	Community liaison officer	Matric	42	14	14
5	Education Officer	Masters	48	21	22
6	Project executive	Masters	53	15	17
7	Engineer	Degree	35	7	7

Table 4.8 shows that all the participants except for one possessed at least a degree in academic qualifications. Overall, the participants have been working in the municipality for a very long time. The combined experience of all participants in the municipality is 78 years, with an average experience of 11 years. The least serving participant was in the municipality for two years, while the longest-serving participant was 22 years. However, the average years that participants have been employed in the Water and Sanitation Unit is slightly lower than the average years they have been employed in the municipality (i.e., average experience in the unit is ten years). This indicates that some participants served in other municipality departments before joining the Water and Sanitation Unit. The rich experiences of the participants imply that they have more profound insights regarding issues related to water service provision. The average age was 39 years, with the youngest participant being 28 years old, while the eldest was 53 years old. Participants occupied various portfolios in the Water and Sanitation Unit,

which improved the quality of the data collected. Responses were received from community liaison officers, education officers, project executives, engineers, and administrators. The diversity in positions, age, education, and experience means that data containing different views on water service provision may be obtained.

4.3.2 Findings from the employees

Findings from employees are presented according to the objectives of the study. As highlighted in the previous chapter, the thematic approach is used to analyse qualitative data collected from employees. In this regard, each objective is used to represent a different theme of the study. Subthemes (i.e., core ideas under each theme) are then used to explain each theme further. A summary of the qualitative results is in Table 4.9, and the discussion is presented after that.

Table 4.9: Summary of qualitative results.

Theme	Subtheme	Frequency
1. Households' current water consumption behaviour.	a. The demand for water is very high.	3
	b. Households do not save water.	2
	c. Damage to infrastructure.	5
2. Households' willingness to adopt water efficient technologies.	a. Influence of area type.	5
	b. Water saving technologies are expensive.	4
3. Factors preventing households from adopting water saving behaviour.	a. Lack of understanding the value of water.	3
	b. Households do not pay for water services.	3
	c. Water efficient technology is expensive.	1
	d. Low water tariffs.	5
4. Recommendations to the Municipality to promote household water conservation	a. Imposing sanctions.	2
	b. Education and awareness.	4
	c. Tariff reduction.	2

4.3.2.1 Theme 1: Households' current water consumption behaviour

This theme is linked to the first objective of the study, which sought to establish households' current water consumption behaviour. Participants were asked to express their thoughts on whether households are doing enough to save water. Three subthemes emerged under this theme. Namely, the water demand is very high, and some households are not saving water and damaging water infrastructure.

a) High demand for water

High water demand came to the spotlight as a major constrain. Participants stated that households are not responsible for water consumption, leading to increased water demand. One participant stated, *"Water demand is still high, and the municipality has high non-revenue water due to illegal connection and vandalism"*. If households do not take precautionary measures and conserve water, shortages will worsen due to water demand exceeding supply. Water supply in Durban has come under great stress due to the high demand caused by urbanisation, population growth, economic development and changing consumption patterns.

b) Households do not save water

Household water conservation is essential for sustainable water supply in Durban. Every household should practice water conservation behavioural practices. Respondents expressed deep concerns about households' water conservation in Durban. They pointed out that "*Some households do not save water. As a result, the city is currently sitting at 35% water loss, and non-revenue water has increased drastically over the years. Pressure on water services is also increased by urbanisation as people migrate from rural areas to the city for better job opportunities. In most cases, the migrants are not knowledgeable about the water crisis in the municipality, let alone the need for water conservation"*.

c) Damage to infrastructure

Adequate water infrastructure is critical in ensuring a reliable water supply. Good governance of water infrastructure ensures a sustainable balance between water

demand and water supply. However, factors like poor maintenance, ageing pipes, vandalism, and illegal connections contribute to the poor conditions of water infrastructure. This affects water service delivery, cost the municipality money, and leads to significant water losses. Respondents showed great concern about the vandalism of infrastructure and illegal water connections across Durban. Participant cited that, "o*ne major problem with illegal water connections is that those who illegally connect into the main pipes do not do so correctly, damaging pipes in the process and causing water leaks which are usually not reported. Further, underground water leakage due to illegal connections and damaged pipes is another major challenge. There is damage when such leaks are reported very late to the municipality."*

4.3.2.2 Theme 2: Households' willingness to adopt water-efficient technologies.

Managing water demand is crucial in addressing water scarcity. The fundamental philosophy in managing water demand is to ensure that measures to reduce households' water usage are executed (Magnus et al. 2018). Millock and Nauges (2010) argue that it is preferable to manage water consumption by promoting the installation of water-efficient devices at residential homes than imposing water restrictions. The installation of improved water technologies by households directly impacts water pricing and rebate programs (Dolmicar and Shafer 2006). Even though households can easily install water-efficient technologies, there are still barriers impeding the adoption of these technologies. Participants in this study identified the cost of water-efficient technologies and the type of area that households reside in as crucial determinants of the households' willingness and ability to adopt water-efficient technologies. These two determinants are identified as subthemes for this theme and are discussed in detail in this subsection.

a) The influence of area type

Participants argued that water access differs from one area type to the other in Durban. Therefore, the households' willingness to adopt water-saving technologies depends on how they access water services. Households who reside in the informal settlements mostly access water from public taps, whereas those in townships and suburbs have

the privilege of accessing water inside their homes. This implies that residents in the informal settlement commonly have no facilities to install water technologies. However, there is no guarantee that households that have taps inside their homes will install water-efficient devices. Participant cited that *"In communities where there are no toilets, the municipality offers flushable toilets and showers in the form of containers which are installed with water-saving technologies".* This is a critical intervention that promotes household access to water and sanitation facilities that also save water.

b) Water-efficient technologies are expensive

The diversity of living standards and socioeconomic classes has been an essential variable in using water-efficient technologies. Participants argued that while some households may have the facilities to install water-efficient technologies, they may not afford them because these technologies are mostly expensive. One participant mentioned that "*Cost, accessibility and not knowing that these technologies exist, especially when it comes to water-efficient toilets, are key determinants".* Even though reducing domestic water consumption from water-saving technologies is perhaps the easiest method to conserve water, the cost of acquiring such technologies is high for most households.

4.3.2.3 Theme 3: Factors preventing households from practising water-saving behaviour.

Theme 3 is linked to the second objective of the study. This objective sought to establish the key factors preventing households from practising efficient water consumption behaviour. Thus, participants were asked for their opinions on what they think are the critical determinants of inefficient water-consumption behaviour among households. The question on the determinants of households' water consumption behaviour was asked as a probe to whether participants thought households were sufficiently saving water in consumption. Four main subthemes emerged from the participants' responses. These four subthemes were: not understanding the value of water, not paying water bills, the cost of water-saving technology, and low water tariffs.

A detailed discussion of these findings is presented in this subsection.

a) Households do not understand the value of water

Participants indicated that inefficient water-consumption behaviour is also because some households do not understand the value of water and appreciate the reality that the country has a shortage of water resources. It emerged from the interviews that the way households access water services affect the value they give to water. Another participant cited that "*households that access water services from public taps and illegal connections tend to value water less than those with taps inside their homes."*

b) Some households do not pay for water services

Participants also argued that some households do not save water because they do not pay for water services. Not paying for water services sometimes makes households disregard its value and practice inefficient water-consumption behaviours.

Participants stated that *"Those who pay for water services know the implications and do save water, while those who live in informal settlements and do not pay for water services tend to use water anyhow because they do not know the implication of it".* Informal settlement dwellers mainly access their water through public taps, and they are more likely not to conserve water because they do not pay for it.

c) The cost of water-efficient technologies

The cost of water-efficient technologies was also cited as a determinant of households' inability to practice water-efficient consumption behaviours. Participants argued that households could not afford water-saving technologies, thus preventing them from practising water-efficient behaviours. Literature provides that steady progress in water saving technologies exists worldwide, which enables households to use water sparingly (Perez-Urdiales and Garcia-Valinas 2016). However, in Durban, the income levels are generally low, especially in townships and informal settlements. Thus, the adoption of water-efficient technologies is minimal. One participant emphasised that "*Most residents in the municipality are poverty-stricken. Consequently, they do not have access or cannot afford these technologies. Worse, some households do not even have the facilities to install water-saving technologies".*

d) Low water service tariffs

Low water service tariffs were also identified among the reasons for households not to save water. Participants argued that the price of water services impacts how households perceive water as a good and their willingness to save it. Water tariffs in the municipality are very low, such that some households may see no significant reason to use water sparingly. It emerged from the participants that, *"households tend to undervalue water if it is still running from their taps. Water service tariffs are low because the municipality wants to make water affordable to all residents, as enshrined in the country's constitution. However, higher water service tariffs may push many households to save water and reduce consumption levels to lower the water services bill."*

4.3.2.4 Theme 4: Participants' recommendations to the municipality

Participants also provided recommendations that the municipality may consider promoting household water conservation. This is linked to the study's fourth objective, which sought to recommend approaches that the municipality may adopt to promote household water conservation. Three subthemes emerged from the information collected from participants. The suggested solutions were imposing water sanctions, improving education and awareness, and targeted tariff reduction. Details on these emerging subthemes are discussed below.

a) Imposing water sanctions

Sanctions are mostly considered a drastic but significant element of successful water demand management. Participants suggested the imposition of water-related sanctions as an effective tool for enforcing water conservation. One participant said, *"The municipality has initiated most programmes. The responsibility is up to the community to change their mindset. The only thing that the municipality needs to do is impose sanctions on those who do not adhere to the rules."* Imposing water-use related sanctions becomes a vital component to govern water consumption. The main

objective of imposing such sanctions is to change the behaviour of water users and promote sustainable water consumption.

b) Education and awareness

Conservation programs that focus on educating households to reduce water consumption and improve water-conservation awareness are essential. Participants suggested that these campaigns can be essential tools to influence households to change behaviour and attitudes. One participant said, "*Over the years, the municipality has tried to empower the residents with the requisite information on how to conserve water. Through the various media platforms, water users are informed about the various steps to take to conserve their water. This has helped them in avoiding various water-related problems".* Education and awareness campaigns created an understanding of water issues and shared water-conservation values, which can nudge households towards efficient water-use behavioural practices (see Murwirapachena 2021).

c) Targeted tariff reduction

Participants further recommended the reduction of water service tariffs as an incentive to those who take initiatives and save water. One participant suggested that *"Households should be given subsidies and tariff reductions for using water-efficient technologies. The municipality should provide incentives to households who can show consistent water use reduction by a certain percentage over some time".* Participants argued that if the municipality can create an economic incentive as a reward for using water sparingly, more people can be encouraged to adopt water-saving behavioural practices.

4.4 Summary

This chapter presented the empirical results of the study. Results were presented in two parts. First, quantitative results based on a survey conducted on households were presented. Second, qualitative results based on interviews conducted with municipal employees were presented. Key results emerged from the study. Among these results was the revelation that households are aware of the need to save water and try to practice water-efficient consumption behaviours. However, their living conditions and the cost of water-efficient appliances impediment their desire to save water.

Further, income emerged as one of the most consistent determinants of water consumption behaviours and the adoption of efficient technologies. It also emerged from the results that the municipality is battling high water demand levels that are worsened by households' consumption behaviour and attitude towards the water as a social good. The next chapter concludes the study and suggests possible recommendations towards improved household water conservation in Durban.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter is represented in four sections. The first section contributes to the overall summary of the study. Furthermore, the findings are discussed in summary, including their conclusions. Secondly, recommendations of the whole study are then discussed. This chapter then discusses the areas of future research, followed by the conclusion. Generally, this chapter aims to cover the result of the study.

5.2 Summary

The previous chapter presented and discussed the results of the study. This chapter concludes the study, giving recommendations and identifying areas of future work. It is essential to recall that the study aimed to examine the role of households in water conservation using a case of households in the city of Durban. To achieve this aim, the study was set to fulfil four main objectives. The first objective was set to establish daily water consumption behavioural practices of households in Durban. Secondly, the study sought to establish the households' willingness to adopt water-saving technologies in the city. Thirdly, it sought to identify the factors preventing households from adopting water-saving behaviours in their daily water consumption practices. Finally, the study sought to recommend some possible solutions that the eThekwini Metropolitan Municipality could adopt to promote households' willingness to save water.

To achieve the aim and outlined objectives, the study adopted a mixed methods approach where quantitative and qualitative data were separately collected, analysed, and discussed. The quantitative data was collected through a survey conducted on 300 household heads residing across different spatial residential areas of Durban. The

300 households surveyed were distributed evenly across three strata, namely, suburbs (100 responses), townships (100 responses), and informal settlements (100 responses). A questionnaire was used to collect quantitative data from randomly selected households. On the other hand, qualitative data was collected from employees in the Water and Sanitation Unit of the eThekwini Metropolitan Municipality. A total of 7 employees with diverse designations, qualifications, ages, and experience levels participated in the study. The thematic approach was then used to analyse the qualitative data manually, while descriptive statistics and probit regression models were used to analyse the quantitative data. Several key findings were reported, and these are categorised according to the objectives of the study.

In terms of the first objective, which sought to establish households' daily water consumption behavioural practices, the study found that households in Durban generally practice water-efficient behaviours in their daily water consumption activities.

This is despite evidence of increased pressure on water resources. Efficient water use behaviour was more prevalent in the suburbs and townships than in informal settlements where residents generally do not have the enabling water infrastructure. This is a crucial concern since the households in the informal settlements are the recipients of non-revenue water. Conservation in these areas would play a significant role in minimising pressure on water resources and water services in the city (Jessoe et al. 2021). Equally, the municipality would save money through household water conservation since it sustains operational costs for the wasted water in these areas.

Further, the study found some biographic attributes of residents as essential determinants of water consumption behaviours in the city. Household income emerged as the most important determinant of water consumption behaviour, followed by household size, age and education, and gender, in that order. Higher-income households, bigger-sized households, educated respondents, older respondents, and male respondents emerged more likely to practice water-efficient behaviours.

In terms of the objective that sought to establish the factors preventing households from practising water-saving behavioural practices, the study found the type of access to potable water services as the primary determinant. It emerged that households who access potable water services from public standpipes tend to value water less than

those that have taps inside their homes. This could be because these households do not pay for water services. Generally, getting water for free makes the water look like it is an infinite product. The value attached to water by households getting water for free is very low, as long as the water is available and of good quality. The implication is that most people who do not pay for water services will end up not using water sparingly. This is worsened by the revelation that the eThekwini Municipality is not sufficiently educating residents about water conservation.

Regarding the objective that sought to establish the willingness of households to adopt water-efficient technologies, most households in the suburbs and townships were found to appreciate the role of water-efficient technologies in saving water and reducing the bill. However, many respondents from the informal settlements did not share the same sentiment. The study found that most people in the suburbs and townships already had water-efficient technologies installed, while none of the respondents from the informal settlements had such technologies installed. The main reason for the latter not installing such technologies were that they found the technologies too expensive. Most of the respondents had no infrastructure to connect such technologies.

Further, it was revealed that the level of education and income determines the adoption of water-efficient technologies. At the same time, biographic factors like gender, age, and homeownership did not have any impact. More precisely, it was observed that improvements in education and income increased the probability of adopting water efficient technologies. Further, it also emerged that as the household size increased, the probability of installing water-efficient technologies also increased.

5.3 Recommendations

Based on the findings reported in the study, four key recommendations can be made. The first recommendation is that the municipality must clearly understand water consumption behaviours and patterns within the city to design effective household water conservation strategies. This study reported that water consumption patterns vary among the three spatial areas studied. Hence strategies that specifically relate to

each spatial area should be carefully developed. Households from all three spatial areas can be nudged to save water. More attention should be given to informal settlements since these were found not to be at the same level of practising efficient consumption behaviours and using efficient water infrastructure compared to households from the suburbs and townships.

Secondly, several social and biographical characteristics were reported to influence water consumption. Thus, when developing strategies that seek to promote household water conservation, policymakers in the municipality should target low-income households, smaller-sized households, relatively younger residents, relatively less educated residents, and female residents. These residents were reported to be more likely to practice inefficient water consumption behaviours in their daily consumption activities. This recommendation is also consistent with recommendations in similar studies conducted in other South African metropolitan municipalities (see Murwirapachena 2021; Murwirapachena and Dikgang 2021). Strategies that should be adopted by the municipality when targeting these groups should effectively control outdoor water consumption through nudging residents to practice efficient consumption behaviours or even imposing restrictions to moderate water demand. These water restrictions should focus on reducing water consumption for nonessential activities.

On the other hand, nudging efficient behaviour may include rewarding residents who take initiatives to save water through various incentives. The municipality can use rebate and discount programs, technical assistance, and audit programs as incentive programmes (Diringer and Morgan 2021). This will help to improve household water consumption behaviour to save water and money.

Thirdly, the revelation that most residents in the informal settlements use shared water infrastructure, which makes it impossible for individuals to install water-saving technologies, also requires attention. Even though there are interventions by the municipality to respond to related water issues by installing flushable toilets and showers in the form of containers that are installed with water-saving technologies, such interventions are not enough to ultimately improve water conservation. The municipality needs to improve the current standpipes to ensure the best control of

pressure and rapid filling of the containers. Further, all standpipes can have an isolating valve at each standpipe to control water flow coming out. Alternatively, standpipe taps should preferably be a “pushbutton” type or a “self-closing” type to address the continuous water flow immediately after individuals have finished collecting water this assists in reducing water spillages. Further, regularly servicing the standpipes and replacing damaged and worn-out components can significantly reduce the amount of water lost in the informal settlements.

Finally, in terms of the relationship between biographic characteristics and the adoption of water-efficient technologies, the revelations on the impact of education, income and households’ size are also noteworthy. While other barriers such as water access type should be considered, this study recommends that policymakers make an effort to promote the adoption of efficient technologies among less-educated residents, low-income residents, and smaller-sized households. In this regard, the municipality should create policy interventions that prioritise possible financial support to assist low-income households to acquire and installing water-efficient technologies. Further, there is a need to invest in promoting greywater and water reuse in the municipality. This will help households to achieve their daily water needs using fewer water resources. A rebate allocation program for those households who installed water saving technologies and showed consistent water-use reduction will be an effective tool to nudge households to invest in saving water.

5.4 Areas of future research

The findings of this study will help the eThekwini Metropolitan Municipality craft and implement evidence-based policies that can promote water conservation in the city of Durban. Very few similar studies exist on this topic, and it would be helpful to explore this phenomenon in other South African metropolitan municipalities. This is important because these municipalities differ in operating environments and water consumption patterns in these municipalities. Further, a larger sample size would be desirable to expand the results reported in this study. Due to financial constraints, only 300 household heads were sampled. Also, this study only collected data from the household heads, and future studies should consider collecting data on residents

regardless of whether they are household heads or not. This can provide more holistic results, which are essential for effective water policymaking.

5.5 Conclusion

This study on household water conservation in Durban found that the issue of water access makes it difficult for informal settlements households to practice efficient behaviour. This is because these households do not value water as it is free for them. The municipality needs to offer support by educating these households on how much they can contribute when saving water. Further, even those households who access the water inside their houses do not save water. Demographic characteristics and cost of efficient technology were among other determinants reported in this study.

Hopefully, this study contributed to an understanding of households' current water behaviours, and its findings and recommendations can serve as a future solution to convince households to save water.

References

Abansi C.L., Hall R.A. and Siason I.M.L. 2018 Water demand management and improving access to water. Water Policy in the Philippines. Global Issues in Water Policy, Vol. 8.

Abu-Bakar, H., Williams, L. and Hallett, S. H. 2021. A review of household water demand management and consumption measurement. Journal of Cleaner Production, Vol. 125872.

Adams, K. A. and Lawrence E.K. 2015. Research methods, statistics and applications. California: SAGE Publication Inc.

Adewumi, J.R., Ilemobade, A.A. and Van Zyl, J.E. 2010. Treated wastewater reuse in South Africa: Overview, potential and challenges. Resources, Conservation and Recycling, Vol. 55(2): 221-231.

Addo, I. B., Martin, C. T. and Parsons, M. 2018. Barriers and Drivers of household water conservation behaviour: A profiling approach. Water, Vol. 10(12): 1-15.

Alarcón, R.A., Rodríguez, J.P. Kua, H.W. 2019. Voluntary management of residential water demand in low and middle low-income homes: A pilot study of Soacha (Colombia). Water. Vol. 11(2): 1-16.

Aldrich, J.H. and Nelson, F.D. 1984. Linear Probability, Logit, and Probit Models. Newbury Park, CA: SageArbue´s, F., Villanu´a, I and Barbera´n, R. 2010. Household size and residential water demand: An empirical approach. Journal of Agricultural and Resource Economics, Vol. 54: 61-80.

Araya, F., Osman, K., Spearing, L. and Faust, K. 2019. Water conservation in the household: The implications of metrics and the association between characteristics and conservation presence. Growing With Youth, Available: https://www.researchgate.net/publication/333825652.

Araya, F., Osman, K. and Faust, K.M. 2020. Perceptions versus reality: Assessing residential water conservation efforts in the household. Resources, Conservation and Recycling, Vol.162: 1-10.

Aslam, S.; Aftab, H.; Martins, J.M.; Mata, M.N.; Qureshi, H.A.; Adriano, A.M. and Mata, P.N. 2021. Sustainable model: Recommendations for water conservation strategies in a developing country through a psychosocial wellness program. Water, Vol. 13(1984): 1-20.

Asthana, V., 2021. Linking water resources and conflict. Routledge Handbook of Environmental Security. Doi:10.4324/9781315107592-7.

Baki, S., Rozos, E., and Makropoulos, C. 2018. Designing water demand management schemes using a socio-technical modelling approach. Science of the Total Environment, Vol. 622: 1590-1602.

Babić, B., Đukić, A. and Stanić, M. 2014. Managing water pressure for water savings in developing countries. WaterSA, Vol. 40 No: 221-232.

Babbie, E. 2014. The practise of social research: Questionnaire construction.14th ed. Boston. Cengage learning.

Barnett, M.J., Smith, D.J., Wada, J.E. and Haeffner, M. 2020. A multilevel analysis of the drivers of household water consumption in a semi-arid region. Science of the Total Environment, Vol. 712: 1-14.

Bergman, M.M. 2008. Advances in mixed methods research: Theories and publications. London: Sage Publication Inc.

Betram, C. and Christiansen, I. 2014. Understanding research: An introduction into reading research. Pretoria: Van Schaik Publishers. Bernedo, M., Ferraro, P. J. and Price, M. 2014. The persistent impacts of norm-based messaging and their implications for water conservation. Journal of Consumer Policy, Vol. 37: 437–452.

Booysen, M. J., Visser, M. and Burger, R. 2019. Temporal case study of household behavioural response to Cape Town's 'Day Zero' using smart meter data. Water Research, Vol. 149: 414-420.

Borisova, T. and Useche, P. 2013. Exploring the effects of extension workshops on household water-use behaviour. Extension Education Methods, Vol. 23(5): 668–676.

Bowden, A., Fox-Rushby, J. A., Nyandieka, L. and Wanjau, J. 2002. Methods for pretesting and piloting survey questions: Illustrations from the KENAOL survey of health-related quality of life. Health Policy and Planning, Vol. 17(3): 322-330

Biswas, A.K. 2004. Integrated water resources management: A reassessment. Water International, Vol. 29(2): 248-256.

Bryman, A. and Bell, E. 2011. Research Methodology: Business and Management Contexts. Oxford University Press, Cape Town, Southern Africa.

Bryman, A. and Burgess B. 2002. Analysing qualitative data. 1st ed. London: Routledge.

Brettenny, W. and Sharp, G. 2018. Evaluation of the effectiveness of the National Benchmarking Initiative (NBI) in improving the productivity of water services authorities in South Africa. Water SA, 44(1): 37-44.

Bruno, E.M. and Jessoe, K. 2021. Using price elasticities of water demand to inform policy. Annual Review of Resource Economics, Vol. 13: 427-441.

Burns, A.C. and Bush, R.F. 2014. Marketing research. 7th ed. Boston: Pearson.

Chase, S.E. 2005. Narrative Inquiry: Multiple lenses, approaches and voices. 3rd ed. Thousand Oaks, CA: Sage Publications.

Charmaz. K. 2006 Constructing grounded theory: A practical guide through qualitative analysis. London: SAGE

Chen, W. and Olden, J.D. 2017. Designing flows to resolve human and environmental water needs in a dam-regulated river. Nature Communications, Vol. 8: 2158.

Clow, K.E. and James, K.E. 2014. Essentials of marketing research: Putting research into practice. Thousand Oaks, CA: Sage.

Connelly, L. M. 2013. Demographic data in research studies. Academy of Medical Surgical Nurses, Vol. 22(4): 269–270.

Corral-Verdugo, V., Bechtel, R. B. and Fraijo-Sing, B. 2002. Environmental beliefs and water conservation: An empirical study. Journal of Environmental Psychology, Vol. 23: 247-257.

Coyle, A. and Lyons, E. 2007. Analysing qualitative data in psychology. London: Sage Publication Ltd.

Cauberghe, V., Vazquez-Casaubon, E. and Van de Sompel, D. 2021. Perceptions of water as commodity or uniqueness? The role of water value, scarcity concern and moral obligation on conservation behaviour. Journal of Environmental Management, Vol. 292: 1-9.

Cockerill, K., Groothuis, P.A., Mohr, T.M. and Cooper, C. 2015. Individualized water source as an indicator of attitudes about water management and conservation in humid regions. Journal of Environmental Planning and Management, Vol. 59(8) 13411359.

Creswell, J.W. 2007. Qualitative inquiry and research design: Choosing among five approaches. 2nd ed, Sage Publications

Creswell, J.W. 2009. Research design: A qualitative, quantitative and mixed-method approach. 3rd ed. Los Angeles: SAGE.

Creswell, J. W. and Clark V.L.P. 2011. Mixed methods research: Designing and conducting. 2nd ed. California: Sage Publications, Inc.

Dean, A.J., Kneebone, S., Lauren, F. T. N. and Smith, L. D. G. 2021. The stickiness of water-saving behaviours: What factors influence whether behaviours are maintained or given up? Resources, Conservation and Recycling, Vol. 169: 1-9.

Dharmaratna, D. and Parasnis, J. 2010. Price responsiveness of residential, industrial and commercial water demand in Sri Lanka No 44-10, Monash Economics Working Papers, Monash University: Department of Economics.

Delpasand, M., Bozorg-Haddad, O. and Goharian, E., 2021. Virtual water. Water resources: Future perspectives, challenges, concepts and necessities: 131. https://doi.org/10.2166/9781789062144.

Döckel, J. A. 1973. The influence of the price of water on certain water demand categories. Agrekon, Vol. 12(3): 17-22.

Dolnicar, S. and Shafer, A. 2006. Public perception of desalinated versus recycled water in Australia. Wastewater Recycling, Vol. 1(11): 1-11.

Diringer, S. and Morgan, S. 2021. Stacked Incentives: *Co-Funding Water Customer Incentive Programs*. Oakland, California: Pacific Institute.

Duriau, V.J. Rhonda, R.K. and Pfarre, M.D. 2007. A content analysis of the content analysis literature in organization studies: Research themes, data sources, and methodological refinements. Organizational Research Methods. Vol. 10 (5): 4-34.

Durham, B., Rinck-Pfeiffer, S. and Guendert, D. 2003. Integrated water resource management through reuse and aquifer recharge. Desalination, Vol. 152(1-3): 333338.

DuFrene, D.D. 2018. Business research report. New York: business Express Press.

Ehret, P. J., Hodges, H. E., Kuehl, C., Brick, C., Mueller, S., and Anderson, S. E. 2021. A systematic review of household water conservation interventions using the information motivation behavioural skills model. Environment and behaviour, Available: https://doi.org/10.1177/0013916519896868.

Etikan, I., Abubakar, S. M. and Alkassimr. S. 2016. Comparison of convenience sampling and purposive sampling. American Journal of Theoretical and Applied Statistics, Vol. 5(1): 1-4.

Esmaeilion, F., Ahmadi, A., Hoseinzadeh, S., Aliehyaei, M., Makkeh, S.A. and Garcia, A.D. 2021. Renewable energy desalination; a sustainable approach for water scarcity in arid lands. International Journal of Sustainable Engineering:1-27. https://doi.org/10.1080/19397038.2021.1948143.

Espey, M., Espey, J. and Shaw, W.D. 1997. Price elasticity of residential demand for water: A meta-analysis. Water resources research, 33(6): 1369-1374.

Fenderson, L.E., Kovach, A.I. and Llamas, B. 2019. Spatiotemporal landscape genetics: Investigating ecology and evolution through space and time. Molecular Ecology, Vol. 29(2): 218-246.

Garrone, P., Grilli, L. and Marzano, R. 2019. Price elasticity of water demand considering scarcity and attitudes. Utilities Policy, Vol. 59: 100927.

Gezon, L.L. 2017. Beyond (anti)utilitarianism: khat and alternatives to growth in northern Madagascar. Journal of Political Ecology. Vol. 24(1).

Ghinis, C.P., Fochezatto, A. and Kuhn, C. V. 2020. Price elasticity of the demand for water in the Brazilian states: a panel data analysis, 2011–2017. Sustainable Water Resources Management, Vol. 6(72).

Golafshani, N. 2003. Understanding reliability and validity in qualitative research. The Qualitative Report, Vol. 8: 597-606.

Graziano, A. M. and Raulin, M. L. 2013. Research methods, a process of inquiry. 8th ed. New York: Pearson

Greenfield, T. and Greener, S. 2016. Research Methods for Postgraduates. New York: John Wiley and Sons, Incorporated.

Gude, V.G. 2017. Desalination and water reuse to address global water scarcity. Reviews in Environmental Science and Bio/Technology, Vol. 16: 591-609.

Gujarati, D.N. 2012. Basic econometrics, 4th ed. McGraw-Hill.

Habiyaremye, A. 2020. Water innovation in South Africa: Mapping innovation successes and diffusion constraints. Environmental Science & Policy, Vol. 114: 217-229.

Hasan, H.H.; Razali, S.F.M. and Razali, N.H.M. 2021. Does the household save water? Evidence from behavioural analysis. Sustainability, Vol. 13(641): 1-20.

Heale, R. and Twycross, A. 2015. Validity and reliability in quantitative studies. Evidence-Based Nursing, Vol. 18(3): 66-67

Hesse-Biber, S. (2010). Qualitative approaches to mixed methods practice. Qualitative inquiry, Vol. 16(6): 455-468.

Holliday, A. 2007. Doing and writing qualitative research. 2nd ed. London; Sage Publications Inc.

Hosmer, D. and Lemeshow, S. 2000. Applied Logistic Regression 2nd ed. New York: John Wiley & Sons, Inc.

Huang, Z., Liu, X., Sun, S., Tang, Y., Yuan, X. and Tang, Q. 2021. Global assessment of future sectoral water scarcity under adaptive inner-basin water allocation measures. Science of The Total Environment, Vol. 783: 146973.

Hurst, S., Arulogun, O.S., Owolabi, A.O., Akinyemi, R., Uvere, E., Warth, S. and Ovbiagele, B. 2015. Pretesting qualitative data collection procedures to facilitate methodological adherence and team building in Nigeria. HHS Public Access, Vol. 14: 53-64.

Jansen, A. and Schulz, C. E. 2006. Water demand and the urban poor: a study of the factors influencing water consumption among households in Cape Town, South Africa. South African Journal of Economics, 74(3): 593-609.

Jessoe, K., Lade, G. E., Loge, F. and Spang, E. 2021. Residential water conservation during drought: Experimental evidence from three behavioural interventions. Journal of Environmental Economics and Management, Vol. 110: 102519.

Jones, T.M. and Felps, W. 2013. Stakeholder happiness enhancement: A neo utilitarian objective for the modern corporation. Business Ethics Quarterly, 23 (3): 349379.

Kang, B., Moudon, A.N., Hurvitz, P.M. and Saelens, B.E. 2017. Differences in behaviour, time, location, and built environment between objectively measured utilitarian and recreational walking. Transportation Research Part D: Transport and Environment, Vol. 57: 185-194.

Kayaga, S. and Motoma, R., 2009. Using tariff structures as a demand management instrument: The case of Kampala. https://wedcknowledge.lboro.ac.uk/resources/conference/34/Kayaga_S_-_329.pdf.

Koh, N., Hahn, T. and Ituarte-Lima, C. 2017. Safeguards for enhancing ecological compensation in Sweden. Land Use Policy, Vol. 64: 186-199.

Koop, S.H.A., Van Dorssen, A.J. and Brouwer, S. 2019. Enhancing domestic water conservation behaviour: A review of empirical studies on influencing tactics. Journal of Environmental Management, Vol. 247: 867-876.

Kumar, P., Avtar, R., Dasgupta, R., Johnson, B.A., Mukherjee, M.D., Ahsan, H., Nguyen, D.C.H., Nguyen, H.Q., Shaw, R, and Mishra, B.K. 2020. Socio-hydrology: A key approach for adaptation to water scarcity and achieving human well-being in large riverine islands. Progress in Disaster Science, Vol. 8: 100134.

Kumarasamy, V., M., Naicker, S., Adu, J. T. and Ocholla, P. O. 2017. An analysis on optimization of domestic water conservation practices. International Journal of Applied Engineering Research, Vol. 12(24): 14958-14963.

Kumur, R. 2011. Research methodology: A step-by-step guide for beginners. Los Angeles: SAGE.

Lameck, E., Sesabo, J. and Mkuna, E. 2021. Household behaviour towards water conservation activities in Mvomero District in Tanzania: a convergent parallel mixed approach. Sustain. Water Resource. Managemen. Available: https://doi.org/10.1007/s40899-021-00514-y.

Lau, S. Y., Yang, F. and MA, Y. W. 2012. Potable water saving in high-density housing. Journal of Facilities Management, Vol. 10(3): 226-240.

Leech, N.L., Dellinger, A. B., Brannagan, K.B. and Tanaka, H. 2009. Evaluating Mixed Research Studies: A Mixed Methods Approach. Journal of mixed methods research, Vol. 4(1): 17-31

Leck, H. and Simon, D. 2018. Local authority responses to climate change in South Africa: The challenges of trans boundary governance. Sustainability, Vol. 10(7): 2542.

Ling Pan, M. (2016). Preparing literature reviews: qualitative and quantitative approaches. 5th ed. New York: Routledge.

Luker, M. and Harris, M. L. 2018. Developing new urban water supplies: investigating motivations and barriers to groundwater use in Cape Town. International Journal of Water Resources Development, Vol. 35(6): 917-937.

Ma, X., Li, N., Yang, H. and Li, Y. 2021. Exploring the relationship between urbanization and water environment based on coupling analysis in Nanjing, East China. Environmental Science and Pollution Research. https://doi.org/10.1007/s11356-021-15161-1.

Magnus, M., Cook, S. and Tapsuwan, S. 2018. Promoting water conservation: Where to from here? Water, Vol. 10(11): 1-17

Mancosu, N., Snyder, R.L., Kyriakakis, G. and Spano, D. 2015. Water scarcity and future challenges for food production. Water 2015, Vol. 7: 975-992.

Maree, K. 2007. The first step in research: Reliability. 1st ed. Van Schaik Publishers.

March, H., Hernandez, M. and Sauri, D. 2015. Assessing domestic water use habits for more effective water awareness campaigns during drought periods: a case study in Alicante, eastern Spain. Natural Hazards and Earth System Sciences, Vol. 15(5): 963-972.

Martel, P. and Sutherland, C. 2019. Governing river rehabilitation for climate adaptation and water security in Durban, South Africa. The geography of climate change adaptation in urban Africa. Palgrave Macmillan, Cham.

Martin-Carrasco, F., Garrote, L., Iglesias, A. and Mediero, L. 2013. Diagnosing causes of water scarcity in complex water resources systems and identifying risk management actions. Water Resources Management, Vol. 27: 1693-1705.

Martinez, M.D. and Maia, A.G. 2021. The effect of social behaviour on residential water consumption. Water, Vol. 13(9): 1-18

Matikinca, P., Ziervogel, G. and Enqvist, J. P. 2020. Drought response impacts on household water use practices in Cape Town, South Africa. Water Policy, Vol. 22(3): 483–500.

Maxwell, J. 1996. Qualitative research design: An interpretative approach. Thousand Oaks: Sage Publications Inc.

Meyer, N., Jacobs, H. E., Westman, T. and McKenzie, R. 2008. The effect of controlled pressure adjustment in an urban water distribution system on household demand. Journal of Water Supply: Research and Technology-Aqua, Vol. 67(3): 218-226.

Meyiwa, T., Maseti, T., Ngubane, S., Letsekha, T. and Rozani, C. 2014 Women in selected rural municipalities: Resilience and agency against vulnerabilities to climate change. Gender and climate change, Vol, 28(3): 102-114.

Mhlongo, N. T., Otieno, F.A.O. and Ochieng, G.M. 2012. Water demand management and losses in Garankuwa and Mabopane, Odi areas in South Africa. http://hdl.handle.net/10321/779.

Molinos-Senante, M., Donoso, G., Sala-Garrido, R. and Villegas, A. 2018. Benchmarking the efficiency of the Chilean water and sewerage companies: a double bootstrap approach. Environmental Science and Pollution Research, Vol. 25: 84328440.

Moglia, M., Cook, S. and Tapsuwan, S. 2018. Promoting water conservation: Where to from here? Water, Vol. 10(11).

Millock, K. Nauges, C. 2010. Household adoption of water-efficient equipment: the role of socio-economic factors, environmental attitudes and policy. Environmental and Resource Economics, Vol. 46(4): 539-565.

Mitchell, M.L. and Jolley, J.M. 2012. Research design explained, 8th ed. United Stare: Wadsworth Publishers.

Misra, A. K. 2014. Climate change and challenges of water and food security. International Journal of Sustainable Built Environment. Vol. 3: 153–165.

Mekonnen, M.M. and Hoekstra, A.Y., 2016. Four billion people were facing severe water scarcity—science advances, 2(2): 1500323.

Morote, A., Hernández, M., Olcina, J. and Rico. A. 2020. Water consumption and management in schools in the city of Alicante (Southern Spain) (2000–2017): Free water helps promote saving water? Water, Vol. 12: 1052.

Mouton, J. and Marais, H.C. 1996. Basic concepts in the methodology of the sciences. 5th edition. Pretoria: Human Sciences Research Council.

Mukuhlani, T. and Nyamupingidza, M. 2014. Water scarcity in communities, coping strategies and mitigation measures: The case of Bulawayo. Journal of Sustainable Development, Vol. 7(1).

Muller, M. 2020. Some systems perspectives on-demand management during Cape Town's 2015–2018 water crisis. International Journal of Water Resources Development, Vol. 36(6): 1054-1072.

Murwirapachena, G. 2021. Understanding household water-use behaviour in the city of Johannesburg, South Africa. Water Policy, 23 (5): 1266-1283.

Murwirapachena G and Dikgang J. 2021. The effects of presentation formats in choice experiments. Environmental Economics and Policy Studies, https://doi.org/10.1007/s10018-021-00328-4.

Muttoo, S., Ramsay, L., Brunekreef, B., Beleen, R., Meliefste, K. and Naidoo. R.N. 2018. Land use regression modelling estimating nitrogen oxides exposure in industrial south Durban, South Africa. Science of the Total Environment. Vol. 610(611): 14391447.

Mwelase, L.T. and Dzwairo, R.B. 2021. Water supply interruptions in Umzinto water system: Ugu district, South Africa. International Journal of Water Resources and Environmental Engineering, Vol.13(2): 135-153.

Nauges, C. and Van den Berg, C. 2009. Demand for piped and non-piped water supply services: Evidence from Southwest Sri Lanka. Environmental & Resource Economics, Vol. 42(4): 535-549.

Nardi, P.M. 2018. Doing survey research: A guide to quantitative methods. Routledge.

Ncube, M. and Taigbenu, A. 2019. Assessment of apparent losses due to meter inaccuracy a comparative approach. Water SA, Vol. 45(2): 174-182.

Nishad, S.N. and Kumar, N., 2021. Virtual water trade and its implications on water sustainability. Water Supply. https://doi.org/10.2166/ws.2021.322.

Ojo, T. A. (2018). Water access challenges and coping strategies in informal settlements: the case of Iscor settlement in Pretoria West, University of South Africa, Pretoria. Unisa.

Olmstead, S. M. and Stavins, R. N. 2009. Comparing the price and nonprice approaches to urban water conservation. Water Resources Research, Vol. 45(4).

Onyenankeya, K., Onyenankeya, O.M. and Osunkunle, O. 2021. Barriers to water use efficiency in rural and peri-urban areas of South Africa. Water and Environment Journal, Available: https://doi.org/10.1111/wej.12707.

Patterson, J.J. and de Loe, R.C. 2017. Rethinking water governance: Moving beyond water-centric perspectives in a connected and changing world. Natural Resources Journal, Vol. 57(1): 75-100.

Pérez-Urdiales, M. and García-valiñas, M.A. 2016. Efficient water-using technologies and habits: A disaggregated analysis in the water sector. Ecological Economics, Vol. 128: 117-129.

Polit, D.F. and Hungler B.P. 2004. Nursing research: Principles and methods. 7th ed. Philadelphia: Lippincott.

Quesnel, K. J., Agrawal, S., and Ajami, N. K. (2020). Diverse paradigms of residential development inform water use and drought-related conservation behaviour. Environmental Research Letters, Vol. 15(12), 124009.

Rahmanpour, H., Ebrahimi, H. and Akrami, F. 2015. Effects of climatic factors on the geography of agricultural production: Wheat Case Study. Journal of Agricultural Science and Soil Sciences, Vol. 3(4): 50-61.

Rasoulkhani, K., Logasa, B., Reyes, P.M. and Mostafavi, A. 2018. Understanding fundamental phenomena affecting the water conservation technology adoption of residential consumers using agent-based modelling. Water, Vol. 10(8): 993.

Rensburg, V., Henning, E. W. and Smit, B. 2007. Finding your way in qualitative research. Pretoria: Van Schaik Publishers.

Ringwood, F. 2015. Smart water saving. Water and Sanitation Africa, Vol. 10(6).

Roberts, D. 2008. Thinking globally, acting locally institutionalising climate change at the local government level in Durban, South Africa. Sage Publications. Vol. 20(2): 521537.

Rockström, J., Lannerstad, M. and Falkenmark, M. 2007. Assessing the water challenge of a new green revolution in developing countries. Proceedings of the National Academy of Sciences, Vol. 104(15): 6253-6260.

Rogoll, J. L. 2017. Shaping hydropolitics in Durban: community activist strategies in Chatsworth. PhD thesis, University of KwaZulu-Natal.

Russell, S. V. and Knoeri, C. 2020. Exploring the psychosocial and behavioural determinants of household water conservation and intention. International Journal of Water Resources Development, Vol. 36(6): 940-955.

Salgot, M. and Folch, M. 2018. Wastewater treatment and water reuse. Current Opinion in Environmental Science & Health, Vol. 2: 64-74.

Sapsford, R. and Jupp, V. 1996. Data collection and data analysis. London: Sage publication Inc.

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. Available: http://www.wrc.org.za/wp-content/uploads/mdocs/KV%20341-15.pdf.

Sessions, G. 1987. The deep ecology movement: A review. Environmental Review, Vol. 11(2): 105-125.

Shahangian, S.A., Tabesh, M. and Yazdanpanah, M. 2021. Psychosocial determinants of household adoption of water-efficiency behaviours in Tehran capital, Iran: Application of the social cognitive theory. Urban Climate, Vol. 39: 1-14.

Silverman, D. 2013. Doing qualitative research: A practical handbook. 4th ed. United Kingdom: Sage Publications.

Sparkman, G. and Walton, G.M. 2017. Dynamic norms promote sustainable behaviour, even if It Is counter normative. Psychological Science. Vol. 28(11): 16631674.

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, Vol. 79: 187-195.

Sun, X., Gao, L., Ren, H., Ye, Y., Li, A., Stafford-Smith, M., Connor, J.D., Wu, J. and Bryan, B.A. 2018. China's progress towards sustainable land development and ecological civilization. Landscape Ecology, Vol. 33: 1647-1653.

Surmiak, A. 2018. Confidentiality in qualitative research Involving vulnerable participants: Researchers' perspectives. Forum Qualitative Social Research, Vol. 19(3): 1-26.

Tailor, S.J. and Bogdab, R. 1998. Introduction to qualitative research methods. 3rd ed. United States of America: John Wiley & Sons, Inc.

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 Environment, Vol. 239: 1-10.

Thomas, R. M. 2003. Blending qualitative and quantitative research methods in theses and dissertations. Thousand Oaks, CA: Corwin Press.

Torres, L., Driscoll, M.W. and Burrow, A.L. 2010. Racial microaggressions and psychological functioning among highly achieving African Americans: A MixedMethods Approach. Journal of Social and Clinical Psychology, Vol. 29(10): 1074-1099.

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, Vol. 45: 649-656.

Ungar, M. 2018. Systemic resilience: principles and processes for a science of change in contexts of adversity. Ecology and Society. Vol. 23(4): 34.

Veck, G. A. and Bill, M. R. 2000. Estimation of residential price elasticity of demand for water by means of contingent valuation. WRC Report No 790/100. Pretoria. Water Research Commission.

Viljoen, G. and van der Walt, K. 2018. South Africa's water crisis - an interdisciplinary approach. Tydskrif vir Geesteswetenskappe, 58(3), 483-500.

Vuuren, D. S., Zyl, H. J. D., Veck, G. A. and Bill, M. R. 2004. Payment strategies and the price elasticity of demand for water for different income groups in three selected urban areas: A study undertaken in the Tshwane, Cape Town and eThekwini metropoles. Gezina: Water Research Commission.

Welman, J.C., Kruger, S.J. and Mitchell, B. 2005. Research methodology. 3rd ed. Cape Town: Oxford University Press.

White, L. 1967. The historical roots of our ecologic crisis. Science, Vol. 155(3767): 1203-1207.

Williams, R. 2012. Using the margins command to estimate and interpret adjusted predictions and marginal effects. Stata Journal, Vol.12: 308-331.

Wilson, Z. and Pfaff, B. 2008. Religious, philosophical and environmentalist perspectives on potable wastewater reuse in Durban, South Africa. Science Direct.

Desalination, Vol. 228: 1-9.

Willis, R. M., Stewart, R. A., Panuwatwanich, P., Williams, P. R. and Hollingsworth, A. L. 2011. Quantifying the influence of environmental and water conservation attitudes on household end-use water consumption. Journal of Environmental Management, Vol. 92: 1996-2009.

Wisker, G. 2008. The postgraduate research handbook: Methods in brief. 2nd ed. Palgrave Macmillan publishers.

Wolff, B.G. 2008. Environmental studies and utilitarian ethics. Journal of College Biology Teaching, Vol. 34(2): 6-11.

Wolf, C., Joye, D., Smith, T. W., and Fu, Y. 2016. The SAGE handbook of survey methodology. London: SAGE Publications Ltd.

Wolski, P. 2018. How severe is Cape Town's "Day Zero" drought? Significance, 15(2): 24-27

List of appendices

Appendix 1: Letter of information for households

LETTER OF INFORMATION

Title of the Research Study: Water crisis in Durban: An analysis of the role of households in water conservation.

Principal researcher: Mbuso Ngcobo (20822469) Masters in Public Management.

Supervisor and Co-supervisor: Genius Murwirapachena, PhD; Maliga Reddy, PhD.

Brief Introduction and Purpose of the Study: The study aims to examine the role of Durban households in water conservation.

Outline of the Procedures: Participants will answer the questionnaires in their homes, where the researcher will visit them door to door. This will only take about 15 minutes of the respondent time, and the sampling will be done randomly.

Risks or Discomforts to the Participant: No risks expected to the respondents

Benefits: Publication of the findings:

Reason/s why the participant may be withdrawn from the study: There will be no adverse consequences if they choose to withdraw.

Remuneration: No remuneration will be offered.

Costs of the Study: This will come at no cost to the participants.

Confidentiality: In this study, anonymity will be ensured by not disclosing the participants' names on the questionnaires and research reports. Written consent given by respondents will be detached from the questionnaire. Confidentiality will be maintained by keeping the collected data strictly confidential and not revealing the respondent's identities when reporting or publishing the study.

Research-related Injury: There will be no injuries expected from the respondents.

Persons to Contact in the Event of Any Problems or Queries:

(Email: geniusm@dut.ac.za) Please contact the researcher: Cell no.: 062 183 9001 Email: mbusong@gmail.com), or the Institutional Research Ethics administrator on Tel. no.: 031 373 2900. Complaints can be reported to the DVC: TIP, Prof F. Otieno on Tel. no.: 031 373 2382 or Email: dvctip@dut.ac.za.

Appendix 2: Letter of information for eThekwini Municipality employees

LETTER OF INFORMATION

Title of the Research Study: Water crisis in Durban: An analysis of the role of households in water conservation.

Principal researcher: Mbuso Ngcobo (20822469) Masters in Public Management.

Supervisor and Co-supervisor: Genius Murwirapachena, PhD; Maliga Reddy, PhD.

Brief Introduction and Purpose of the Study: The aim of the study is to examine the role of Durban households in water conservation.

Outline of the Procedures: Participants will be interviewed in their place of work, whereby the researcher will be visiting them. This will only take about 30-45 minutes of the respondent time.

Risks or Discomforts to the Participant: No risks expected to the respondents

Benefits: Publication of the findings.

Reason/s why the participant may be withdrawn from the study: There will be no adverse consequences if they choose to withdraw.

Remuneration: No remuneration will be offered.
Costs of the Study: This will come at no cost to the participants.

Confidentiality: In this study, anonymity will be ensured by not disclosing the participants' names on the questionnaires and research reports. Written consent given by respondents will be detached from the questionnaire. Confidentiality will be maintained by keeping the collected data strictly confidential and not revealing the respondent's identities when reporting or publishing the study.

Research-related Injury: There will be no injuries expected.

Persons to Contact in the Event of Any Problems or Queries:
(Email: geniusm@dut.ac.za) Please contact the researcher: Cell no.: 062 183 9001 Email: mbusong@gmail.com), or the Institutional Research Ethics administrator on Tel. no.: 031 373 2900. Complaints can be reported to the DVC: TIP, Prof F. Otieno on Tel. no.: 031 373 2382 or Email: dvctip@dut.ac.za.

Appendix 3: Consent letter for households

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Mbuso Ngcobo, about this study's nature, conduct, benefits, and risks - Research Ethics Clearance Number: 111/17 FREC.
- I have also read and understood the above-written information (Participant Letter of Information) regarding the study.
- I am aware that the study results will be anonymously processed into a study report, including personal details regarding my sex, age, date of birth, initials and diagnosis.
- Given the research requirements, 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 this research that may relate to my participation will be made available.

_____ _____ _____ _____ **Full Name of Participant**

Date Time Signature / Right

Thumb print

I, Mbuso Ngcobo, 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 4: Consent letter for eThekwini Municipality employees

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Mbuso Ngcobo, about this study's nature, conduct, benefits, and risks - Research Ethics Clearance Number: 111/17 FREC.
- I have also read and understood the above-written information (Participant Letter of Information) regarding the study.
- I am aware that the study results will be anonymously processed into a study report, including personal details regarding my sex, age, date of birth, initials and diagnosis.
- Given the research requirements, 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 this research that may relate to my participation will be made available.

_____ _____ _____ _____ **Full Name of Participant**

Date Time Signature / Right

Thumb print

I, Mbuso Ngcobo, 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 5: Ethics clearance letter

MANAGEMENT SCIENCES: FACULTY RESEARCH ETHICS COMMITTEE (FREC)

31 May 2019

Student No: 20822469

FREC No: 111/17 FREC

Dear Mr M Ngcobo

MASTER OF MANAGEMENT SCIENCES: PUBLIC ADMINISTRATION

TITLE: Water Crisis and Conservation in Durban: An Analysis of the Role of Households.

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: 17 October 2017

Approval has been granted for 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 three months before the ethics approval for the study expires.

Any adverse events [serious or minor] that occur in connection with this study and 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.

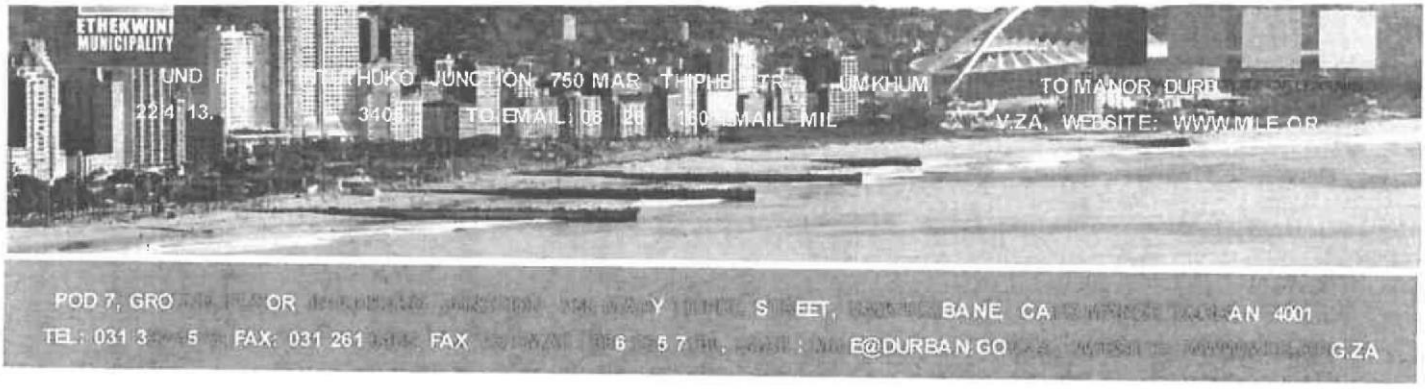
Yours sincerely

_____

Prof JP Govender

Chairperson: Faculty Research Ethics Committee

Appendix 6: Gatekeeper's letter



For attention:
Chair of Research Ethics Review Committee
Faculty of Management Sciences
Durban University of Technology
Durban
4001

27 November 2020

RE: LETTER OF SUPPORT TO M.NGCOBO, STUDENT NO. 20822469 - GRANTING PERMISSION TO USE ETHEKWINI MUNICIPALITY AS A STUDY SITE FOR COURSEWORK RESEARCH

The Water and Sanitation (EWS) Unit and Municipal Institute of Learning (MILE) in eThekwini Municipality, have considered a request from Mbuso Ngcobo to use eThekwini Municipality as a research study site in fulfilment of a Masters in Management Sciences, entitled **"Water Crisis in Durban: An Analysis of the Role of Households in water conservation."**

We wish to inform you of the acceptance of this request and hereby assure the student of our utmost cooperation towards achieving his research goals; the outcome which we believe will help this municipality improve on its services using the research outputs. The student was briefed on the risks in undertaking this study, the ethical considerations involved as well as the current COVID-19 related regulations as per the Disaster Management Act (2020) when conducting the research. **In return, it is stipulate as conditional that the student liaises with the MILE Office to present the results and recommendations of this study to the related unit/s on completion.**

Wishing the student all the best.

.....
Mr Teddy Gounden
Project Executive: EWS
eThekwini Municipality

.....
Dr. Collin Pillay
Program Manager: MILE
eThekwini Municipality

I ..... hereby accept as conditional that I will comply fully as per the conditions stipulated above.

Signed: ..... Date: .....

Appendix 7: Questionnaire

WATER CRISIS AND CONSERVATION IN DURBAN: AN ANALYSIS OF THE ROLE OF HOUSEHOLDS

South Africa is a country with limited water resources. Household's water conservation is vital in addressing water shortages in the country. This survey aims to examine the role that households from Durban can play in saving water. The survey is divided into two sections. Section A collects the personal information of the respondents.

Furthermore, Section B focuses on general questions regarding households' water consumption and conservation.

SECTION A: PERSONAL INFORMATION

1. What is your gender?

Male	
Female	

2. What is your year of birth?

3. Which racial group do you belong to?

African	
White	
Indian/Asian	
Coloured	

4. What is your highest education level?

Never attended school	
Primary school	
High school	
Certificate	
Diploma/ Degree	
Postgraduate	

5. What type of area do you live in?

Suburb	
Township	
Informal settlement	
Rural area	

6. What is the type of housing ownership you have?

I own the property	
I am a tenant	
Other *(Please specify):*	

7. How does your household receive water supply?

We have a tap inside the house	
Our tap is in the yard	
We use a community tap	
Other *(Please specify):*	

8. How many people are in your household?

9. What is your household's average monthly income?

Less than R3000	
Greater than R3000 but less than R6000	
Greater than R6000 but less than R9000	
Greater than R9000 but less than R20000	
Greater than R20000	

SECTION B: GENERAL QUESTIONS

10. Do you use appliances such as washing machines and dishwashers?

Yes	
No	

11. Is your house fixed with water-saving equipment such as efficient showerheads, efficient taps, and an efficient flush toilet?

Yes	
No	

11.1. If your answer above is YES, which of the following water-efficient devices you have installed in your house?

Efficient showerhead	
Efficient taps	
Efficient toilet	
Efficient tub	
Other *(Please specify)*:	

11.2. If your answer to QUESTION was NO, what could be the main reasons you did not have water-efficient devices?

They are a waste of money	
Most people from my community do not use them	
I prefer doing things the way I am used to.	
I cannot afford them	
I did not know about them	
I have no infrastructure to connect them	
Other *(Please specify):*	

12. What do you think about the following statements?

	Strongly agree	Agree	Disagree	Strongly disagree
12.1 Appliances such as washing machines can help save water				
12.2 Appliances such as washing machines reduce the water bill				
12.3 Using technology in doing household chores saves more water than doing it manually				
12.4 Campaigns by the Municipality on water-saving appliances are making people buy appliances				
12.5 Most people in my community are aware of the benefits of using water saving appliances				

13. What would be your response to the following issues?

	Yes	No
13.1South Africa has a shortage of water to drink		
13.2 Water challenges will be reduced if households save water		
13.3 Durban will not have enough water in the future if we do not save water		
13.4 I always try to save water every time I use water		
13.5 The Municipality is doing enough to address water shortages in Durban		
13.6 The Municipality always informs us of water issues		
13.7 I am pleased with the water services I receive		

14. How would you describe the current water supply services you receive?

Excellent	
Good	
Poor	
Bad	

15. In a few words, describe the water services you receive.

16. How often do you do the following in your daily life?

	Never	Occasionally	Always	Not applicable
16.1 Take a bath instead of a shower				
16.2 Shower for more than 5 minutes				
16.3 Run shower for some time, waiting for hot water				
16.4 Keep the tap running when brushing teeth				
16.5 Ignore water leaks from the toilet tank				
16.6 Keep the tap running when washing dishes				
16.7 Rinse cutlery and glasses under running water				
16.8 Use running water to defrost frozen food				
16.9 Ignore a dripping tap				
16.10 Ignore kids wasting water				

Thank you for taking the time to answer this questionnaire.

Appendix 8: Interview schedule

WATER CRISIS AND CONSERVATION IN DURBAN: AN ANALYSIS OF THE ROLE OF HOUSEHOLDS

Sustainable water consumption by households is vital in addressing water shortages in the country. Therefore, municipalities need to implement water policies that promote efficient water use. This survey aims to gain insight into household water conservation in Durban. Kindly answer the questions below to the best of your knowledge.

1. **Can you please tell me more about yourself? Probes:**

    a) Your age;
    b) Your education level;
    c) The position you currently hold;
    d) Years of experience in the Water and Sanitation Unit;
    e) Years of experience in the Municipality.

2. **Please tell me more about your role in the Water and Sanitation Unit. Probes:**

    a) What are your daily activities in the Unit?
    b) Whom do you report to, and how many people report to you?
    c) What are the primary duties of those who report to you?

3. **What is the Municipality's position on household water conservation? Probes:**

    a) What is the Municipality's policy on household water conservation, if any?
    b) What avenues are used to promote this policy?
    c) Is the Municipality achieving its water conservation goals?
    d) Any challenges experienced?

4. **Please take me through the use of water-saving technologies by households in the Municipality. Probes:**

    a) In your professional opinion, do you think households use water-efficient technologies such as efficient taps, efficient showerheads, efficient flush toilets, etc.?
    b) What could be the challenges for households to use these technologies?
    c) What is the Municipality doing to promote water-efficient technologies – any awareness campaigns, subsidies, etc.?

5. **From your experiences, do you think households are doing enough to save water?**

    Probes:

    a) Are households saving water?
    b) What could be the main drivers of their actions?

    c) What should the Municipality do to promote water conservation by households?

Thank you for your time.