DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

AN ANALYSIS OF ATTITUDES, BEHAVIOUR AND PERCEPTIONS OF WATER USE WITHIN URBAN HOUSEHOLDS IN THE CITY OF DURBAN

Submitted in fulfilment of the requirements of the degree of Doctor of Philosophy specialising in Public Management and Economics within the Faculty of Management Sciences at the Durban University of Technology

ISMAIL BANOO

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Supervisor:

Professor N. Dorasamy Date: 24 May 2022

Co-Supervisor:

Professor F. Bux Date: 24 May 2022

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ABSTRACT

South Africa is facing increasing water demands to meet the needs of a rapidly growing and urbanising population, including an urgent need for sustained economic growth. At the same time, climate change is driving the country towards a warmer and drier climatic future, with predicted longer droughts and intense floods. Climate change will result in reduced water availability to meet South Africa's water demands of the future. This study addresses the urban water demand management challenge by focussing on the attitudes, behaviour and perceptions of urban households towards their water consumption, in a search for ways in which domestic demand for water may be substantially reduced. The analysis reflects the attitudes and perceptions of City of Durban urban dwellers in a period when water use restrictions are common across the country. Several national, provincial and local government calls have been made for immediate researched solutions for reducing urban water demand in South Africa (SA). The research study has brought to fore the complexity of competing forces shaping water demand and water use in the context of the socio-demographic composition of households living within different kinds of dwellings, as well as cultural, behavioural and attitudinal aspects of water consumption in City of Durban. In so doing, it aimed to inform public management policy and planning on effective ways to reduce water consumption and identify alternative and complimentary solutions towards effective water demand management. The essential questions the research addressed was to what extent do two key dimensions of urban structure - built form and the socio-behavioural characteristics of household behaviour, influence the pattern of water consumption across the Durban metropolitan area. Additionally, the study also investigated the extent to which people understood water-saving as an environmental concept and the need to conserve the natural resource, including what urban water users believed were the most effective water-saving habits, technology interventions and communication methods with water services authorities.

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DEDICATION

THIS DOCTORATE THESIS IS DEDICATED TO MY LATE MOTHER, MRS HAJRA MOHAMMED BANOO WHO PASSED IN JUNE 2018.

“MAY EVERY TEAR THAT HAS EVER FALLEN FROM YOUR EYES ON MY BEHALF, BECOME AN ETERNAL RIVER FOR YOU IN PARADISE”.

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LIST OF ACRONYMS AND ABBREVIATIONS

DIF – Diffusion of Innovation Theory

DWS – Department of Water and Sanitation

EWS – Ethekwini Water and Sanitation Department

IWRM – Integrated Water Resource Management

KZN – Kwa-Zulu Natal

NEP – New Environmental Paradigm

NGO – Non-governmental organization

NRW – Non-Revenue Water

NWA – National Water Act

SA – South Africa

SADC – Southern African Development Community

SDG – Sustainable Development Goal

SPT – Social Practice Theory

TPB – Theory of Planned Behaviour

TRA – Theory of Reasoned Action

UNWWDR – United Nations World Water Development and Climate Change Report

UW – Umgeni Water

WCWDM – Water conservation and water demand management

WDM – Water Demand Management

CHAPTER 1

ORIENTATION OF THE STUDY

1.1 INTRODUCTION

South Africa (SA) is dealing with a rise in the demand of water in order to meet the needs of economic growth and increasing rural - urban migration. Concurrently, climate change-related effects are resulting in the country becoming warm and dry, whilst also experiencing frequent flooding. Climate change impacts are negatively affecting future water supply in SA, as indicated by the South African Department of Water and Sanitation (DWS). Several authors have suggested that an increase in the overall water demand from urban households, agriculture, industry; rapid urbanisation; climate change; increasing pollution; and changing consumption patterns are serious threats to household water security, nationally and globally. (Sershen *et al*. 2016; Dos Santos *et al*. 2017; Wutich *et al*. 2017; Long and Pijanowski 2017; Fan *et al*. 2017; Mata *et al*. 2018).

A combined policy which includes demand and supply side management approaches is necessary to respond to the growing demand for water resources in South Africa and to support long-term integrated water resource management. The opportunity for supply-side management measures in South Africa is fast dwindling, with traditional alternatives for boosting water supply becoming increasingly costly and unsustainable in light of the country's current political and economic woes. As a result, implementing efficient demand-side management measures is also critical to strategic water resource management in South Africa.

Water demand-side management requires the application of regulatory, economic and social instruments to ensure more structured and efficient water usage and as

such, lowers water demand. Through adopting more effective demand- side management tools such as increased environmental awareness and the widespread implementation of water saving technologies, water usage per capita can be significantly reduced (Mata *et al*. 2018: 3; Fan *et al*. 2017: 124, Wutich *et al*. 2017: 7).

Several demand management/mitigation policies, plans and strategies have been implemented by national government, water boards and local authorities. In addition, some have come from the private sector and non-governmental organisations (NGOs). However, most of these policies have been limited in their relative successes with reducing urban household water consumption. Mata *et al*. (2018: 2) mention that domestic consumption remains high in SA, despite many strategies and instruments being implemented towards changing water use and water use behaviour at the household level. Such examples include the instituting of mandatory water restrictions across all metropolitan cities in the country during the period of 2017 – 2019 followed by a day 'zero' scenario for the City of Cape Town and further recent water restrictions imposed in the Nelson Mandela Bay metro. Furthermore, most of these strategies and instruments are proving to be ineffective or over-simplified (Mata *et al*. 2018: 5; Wutich *et al*. 2017: 1).

There are several studies which have looked at the causative relationships between water availability and water wastage and such studies also point to a direct link between increased access and increasing water wastage. Increased access to water, according to Strydom (2009: 21), leads to increased water waste. Due to non-maintenance of urban residential infrastructure, up to 50% of treated water is wasted in many locations, particularly within impoverished households in SA (Strydom 2009: 23). As a result, rather than focusing just on increasing freshwater availability, researchers propose that water consumption must also be reduced (Christian-Smith et al. 2011: 40-41). A better understanding of current household water usage and views on how water is used including determinants of household water use behavior will significantly help demand-side policy responses to future freshwater unpredictability (Christian-Smith et al. 2011: 42). The key determinant questions of

this study included investigating an awareness of whether South Africans know that the country is semi-arid, water scarce and that freshwater sources are very limited? Do urban households have any idea about the amount of water they consume in their daily lives? When urged to preserve water, do residents realize which behavioural and technological adjustments are most effective to save water? What are the primary motivators and drivers of such behavioural change?

In a study on the City of Cape Town's perceived urban residential water consumption trends, laundry washing was noted as the highest water use activity in the informal housing category (hand washing) and the moderate category (hand or washing machine), with 55.82 percent and 62.86 percent of respondents reporting laundry washing as the highest water use activity, respectively (Viljoen 2015: 2). Showering was the most commonly reported water use activity in the middle-to-high-income category, with 46.51 percent of respondents citing it as the most common water use activity in their houses (Viljoen 2015: 2). A Green Cape Market Intelligence Report for Water (2017: 15), on the other hand, offered a significantly different viewpoint. Actual water consumption statistics found that flushing toilets was the most common water use activity in low-income households, accompanied by bathing or showering. In households of high-income earnings, water usage for flushing toilets was nearly comparable to water used to shower or bath as the ones with the highest water consumption activities. Given that the Viljoen study examined perceived water usage while the Green Cape data examined actual water consumption, there are significant discrepancies between actual and perceived water use practices in South Africa. This study intended to analyze such disconnects and ambiguities in the urban water demand management research domain, notably within the City of Durban metropolitan area. This study was done with the goal of addressing some of these water demand management challenges by focusing on creating a deeper understanding of urban household water use behaviour in order to find strategies to significantly reduce domestic water demand. Following the recent implementation of water restrictions across the country, several national, provincial and municipal government agencies have called for immediate and scientifically credible researched solutions to reduce urban household water demand. The research study objectives centred on developing an in depth

understanding on the extent of two fundamental features of urban structure, that is, architectural form and socio-behavioural characteristics of households as well as the influences on water consumption patterns across the Durban metropolitan area.

1.2 PUBLIC MANAGEMENT AND INTEGRATED WATER MANAGEMENT POLICY

It is assumed that the general publics' knowledge of freshwater resources is limited to a simplistic definition that water is a 'limited' natural resource in South Africa. South African public policy dictates that every citizen has the right to safe and clean water for drinking and hygiene purposes. In water resource allocation, safe drinking water and water for hygiene is one of the highest priorities of the state. Allocation of water for industrial, agricultural and other economic needs are generally based on prioritization and often such allocations are constrained by making adequate supply of water available for maintaining the environmental health of ecological systems. Development of reliable sources of freshwater, e.g. storage reservoirs, dams and irrigation schemes can be regarded as an essential task of government. Therefore, the role of public policy is crucial in any research relating to national water security. There is an urgent need for more effective linkages between government departments operating at various levels who are mandated as custodians of South Africa's water resources. A review of the current institutional arrangements indicated that there are primarily three different kinds of typical functions of public management of water resources in SA. These included administrative, managerial and regulatory or adjudicatory. Water regulatory authorities are not fully autonomous, professional, inter-disciplinary bodies but are seen to be more managerial and adjudicatory in their policy approach and capabilities. There is a general lack of consultative and participatory approaches from water authorities functioning in SA with the general public. Therefore, this research study has been contextualised as a focal point to suggest that public policy on water use has to start including inputs from representatives of civil society. Currently water regulatory authorities are mainly concerned with regulating water-use in the interest of equity,

social justice, ecological sustainability, and for avoidance or resolution of disputes. It is therefore important that policy decisions about water consumption attitudes, behaviour or perceptions are co-developed between the authorities and informed by citizen science inputs. A hands-on approach towards capacitating ward councillors and community based committees who are actively involved in day to day localised water management has to be urgently established in order to address key issues relating to non-revenue water losses, aging infrastructure and deteriorating water quality.

The study was premised with an understanding that the SA citizens have the right to expect his or her elected representatives at the local government level to be directly responsible for their water supply. Recently there have been increasing political calls for more privatization of water supply in metros, however this cannot absolve the state of its constitutional responsibilities and therefore this research project has aimed to propose an argument for more citizen science-based inputs into future public management policy as they relate to water conservation and demand management in the city of Durban and South Africa.

1.3 PROBLEM STATEMENT

Despite the severe droughts in South Africa, which has resulted in national water restrictions being implemented in most metropolitan areas, many South African urban families continue to consume more water than the global norms and averages prescribe. The National Water Services Act of 1997 and the National Water Act of 1998 (NWA) describe the objective and mandate of water supply and demand as, ensuring the "rights of access to a basic water supply." The "basic" supply is 25 litres which a person can utilise per day and is easily found within a distance of 200 meters from their home. Getting basic water for free, became national policy in July 2001, derived from a revamped tariff/pricing system that provided at a minimum 6 kilolitres (cubic meters) of free water every month (40 litres per capita per day for a household of five, or 25 litres per capita per day for a family of eight). In reality, South Africans

consume substantially more water on a daily basis. South Africans consume over 237 litres of domestic water per capita per day, which is 64 litres more than the global average of 173 litres per capita per day (South Africa, Department of Water and Sanitation 2018: 10). As a result, the average urban water use in South Africa exceeds both South African legislation and international norms and standards.

1.4 AIM AND OBJECTIVES

The aim of the research was to undertake an analysis of urban water use behaviour in the Durban metropolitan area with the goal of improving our knowledge of household water consumptive practices and current water-wise behaviour in the city. The study analysed a variety of indoor and outdoor activities in various dwelling types (e.g., homes, apartments, units, formal and semi-formal). Perceptions of the most effective water-saving activity by individuals, as well as the primary perceptions and forces affecting behavioural change in support of more efficient water demand management planning, were also examined in the study. Finally, the research revealed a number of important water-saving/public awareness/demand management strategies and actions. Chapter 7 incorporates some of these tools as key recommendations. The findings support their mandates to influence water use behaviour and practice in the metro, thereby reducing water demand. The objectives of the study were:

- To examine public levels of knowledge, awareness and perceptions of water wise behaviour in urban households;
- To investigate the impact of socioeconomic, behavioural, and technical factors on water demand management policies and strategies;
- To identify the key drivers, barriers and perceptions of responsible urban household water use behaviour;
- To identify and evaluate the effectiveness of water demand management policy, awareness, instruments and interventions targeted at changing water use behaviour; and

- To inform public management policy and decision-making on future water conservation and demand management planning.

1.5 LITERATURE REVIEW

The next section will review literature relevant to this research work.

1.5.1 Background

SA is already a water-scarce country, faced with a myriad of water availability and security related challenges, whilst water demand is continuously increasing. This increasing water demand is situated within a context of a predicted decrease in the availability of freshwater resources in the medium to long-term (South Africa, Department of Water and Sanitation 2018: 1). Bates *et al*. (2008: 56) assert that global water supply will also become more variable due to the rapid salinization of ground and surface water resources and increased variability in precipitation, primarily caused by climate change-induced impacts. Recent data from the 2020 United Nations World Water Development Report and Climate Change (UNWWDR) suggests a worsening condition, as illustrated in Figures 1.1 and 1.2 below, which depict the current global drought severity and climate change as well as scenario trends for water availability across the world.

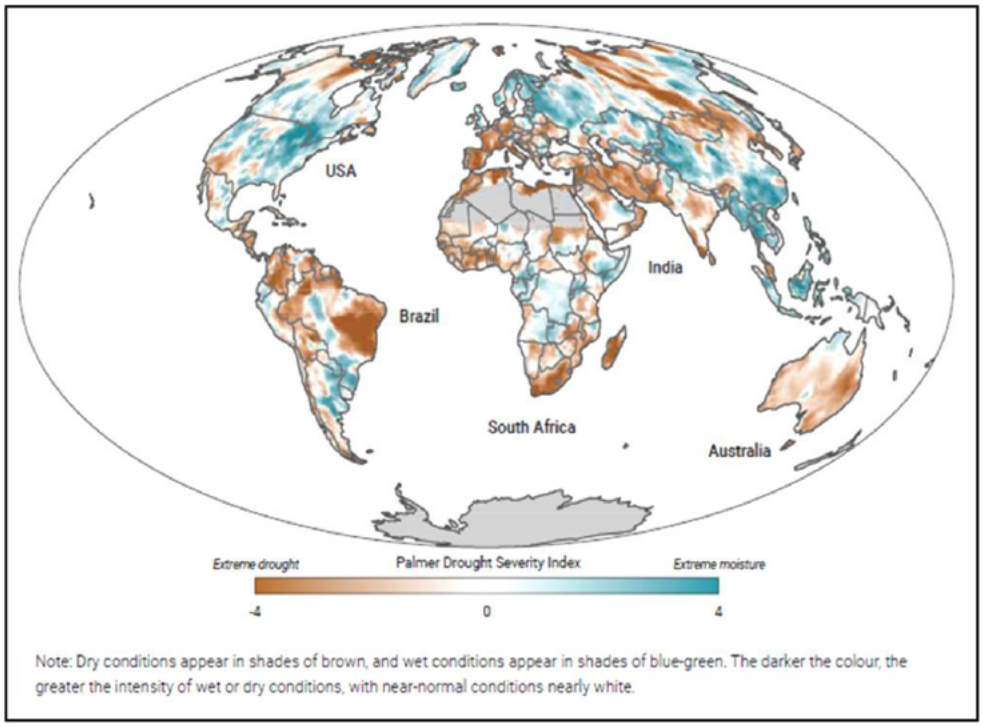

Figure 1.1: Global Drought Severity Index (2020)

Source: Adapted from UNWWDR (2020)

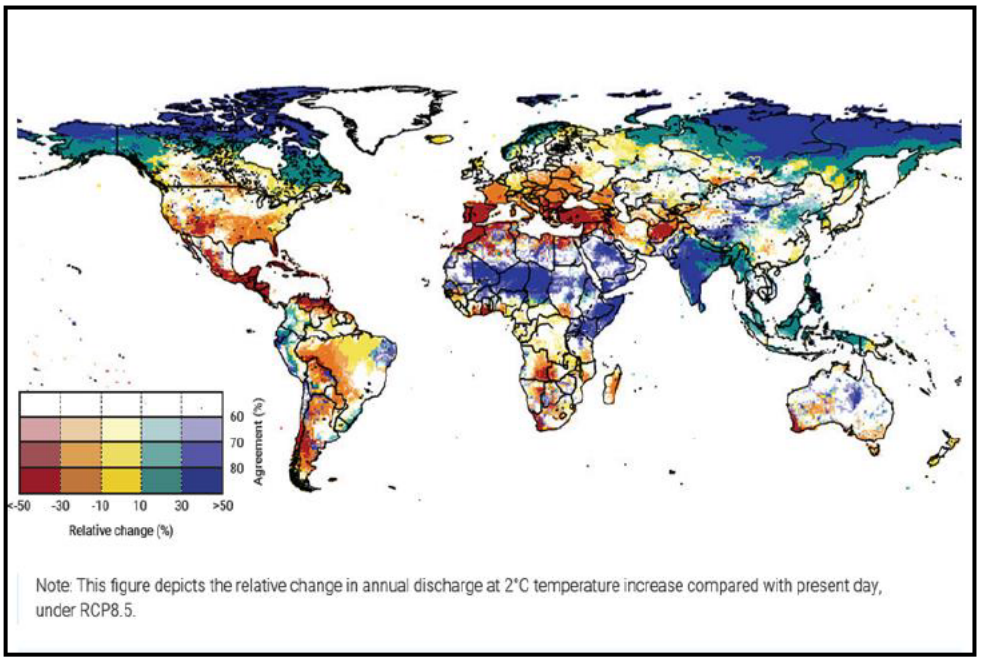

Figure 1.2: Climate change scenario trends in water availability

Source: Adapted from UNWWDR (2020)

According to the UNWWDR (2020), SA is already recognised as a country where climate change induced impacts will directly affect its water resources and availability within the next ten years. As an example, Figure 1.3 depicts the major crops that will face permanently drier conditions due to climate change induced greenhouse gas emissions. The data reveals that in South Africa between 2030 and 2070, 99% of arable land that is currently utilised to growing of wheat will receive significantly less precipitation.

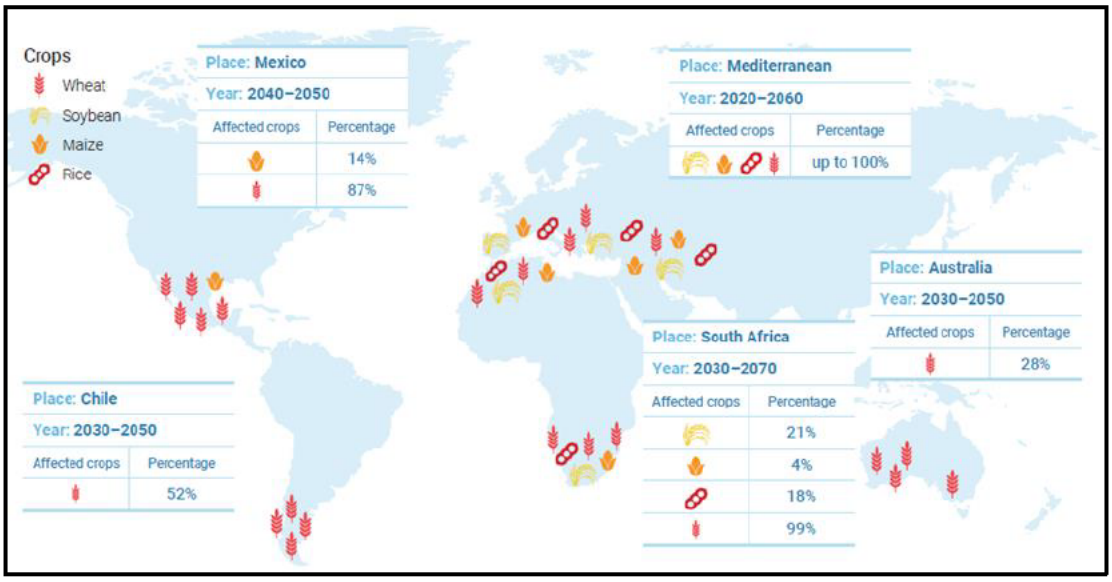

Figure 1.3: Major crops facing drier precipitation conditions

Source: Adapted from UNWWDR (2020)

In the Kwa-Zulu Natal (KZN) province, water demand contestation has already been identified as a key risk for the provinces water security and sustainability. Therefore, immediate actions and solutions are required. An increase in urban household water demand will in turn increase the competition for water supply in the KZN province for agricultural, industrial, energy, mining, commercial and domestic water use needs (Kwa-Zulu Natal Provincial Planning Commission 2017).

Therefore, in order to mitigate our burgeoning water scarcity challenges and to meet the growing water demands, all water user groups, including domestic water consumers, need to enhance their efficiency of water usage. In addition to increasing levels of water demand, all municipalities in SA face current challenges of system water losses and high volumes of non-revenue water (NRW) loss, which directly affect water supply and demand planning. In the Gauteng province, Rand Water reported that NRW worsened from 22% in 2005 to over 31% in 2015, in its original area of supply. The extent of NRW in Rand Water's extended area of operations is of even greater concern, with levels of NRW generally fluctuating between 40% and 77% (Rand Water 2016: 2). According to recent data, municipalities lose roughly 1660 million m3 each year due to NRW loss, with a unit cost of R6/m3. This amounts to approximately R10 billion in revenue lost nationally each year (South Africa, Department of Water and Sanitation 2018: 10).

To respond to the increasing demand for water resources in SA and KZN, an integrated combination of supply and demand-side policy management methods and strategies are required. This is consistent with the widely accepted integrated water resource management approach (IWRM). Rahaman and Varis (2005: 17) define IWRM as an approach that promotes coordination in the use and management of water resources in order to maximize economic and social welfare while protecting vital natural ecosystems. Social justice, economic success, and environmental sustainability are the three pillars of IWRM. From a water consumption and management perspective, the following questions arise when examining these pillars:

i. How will my decisions/actions effect other people's access to water or the benefits that come from using it?

ii. Will my choices/actions result in the most efficient use of water resources?

iii. What impact will my decisions/actions have on natural water systems?

IWRM methodologies have been operationalized in accordance with the internationally accepted concept of sustainable development. The 2030 Agenda for Sustainable Development offers a path for global development in which the acceptance of the whole set of sustainable development goals (SDGs) serves as a roadmap for 'transforming our planet' in order to achieve the desired future while leaving no one behind (UNWWDR 2020: 39). Globally, the SDGs have been applied to address rising disparities, depletion of natural resources, degradation of the environment, and change in climate, which are the most pressing issues in our present days. The SDGs (particularly SDG 6 on Water and Sanitation) state that the sustainable management of global freshwater resources and ecosystems is essential for social development and economic prosperity (UNWWDR 2020: 40).

To create and implement effective, equitable, and long-term solutions to water and water demand management challenges, IWRM can be used to combine knowledge from a range of disciplines with inputs from a variety of research methodologies. As a result, IWRM application demands extensive civil society participatory planning for managing and developing water resources in a way that balances social and economic goals while also ensuring long-term ecological protection. Figure 1.4 below presents a graphical representation of how this research study has been conceptualised in terms of fitting within the framework of the global SDGs (i.e. SDG 6) and the linkages and synergies with the key pillars of IWRM (management interventions) in relation to supporting water demand management policies, strategies and plans at a local government level.

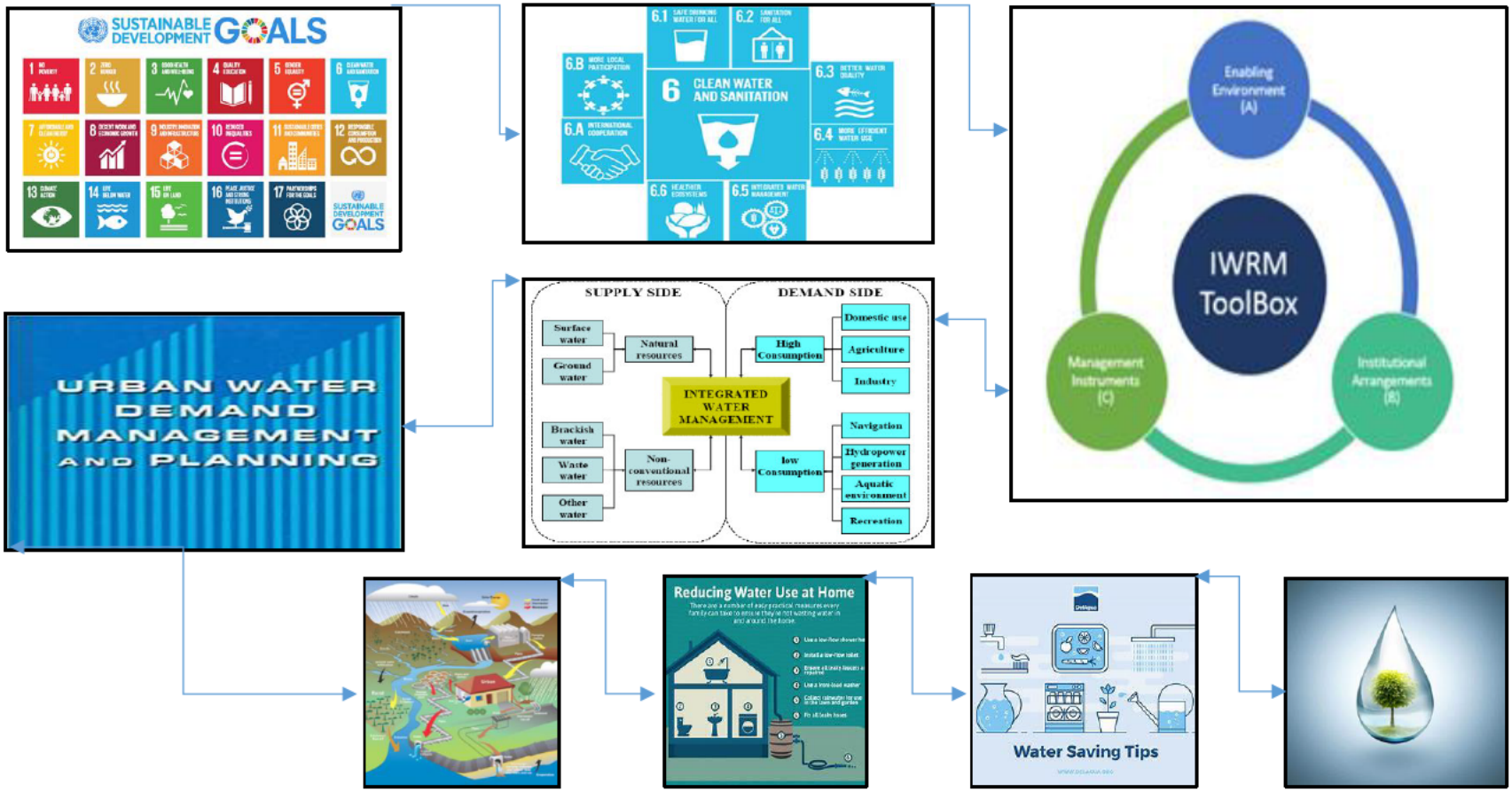

Figure 1.4: Conceptual framework of study showing linkages between SDGs, IWRM, WDM and household water use

Source: Self-generated by the author (2022)

Noteworthy from the conceptual framework above is that water saving practices and behaviour change instruments are integral components of water demand management planning, as well as being core elements of the IWRM framework for sustainable water resources management. Therefore, exploring effective demand-side management measures, such as this research study on water consumption behaviours in urban households, is critical to achieving strategic and integrated water resource management in South Africa.

1.5.2 Theoretical framework: Water conservation behaviour and water demand management

According to Spinks *et al*. (2011: 4), there is a need to understand the drivers of human behaviour that determine the use of water by people, as well as how long-term sustainable water usage can be accomplished and maintained. In this regard, the application of a number of behavioural theories can prove useful. These are briefly discussed below.

The first theory is the Theory of Reasoned Action (TRA), which argues that people's attitudes and beliefs influence their intention to act. This theory maintains that human behaviour is influenced by people's perceptions of social norms (what should be done) and their inclination to comply (Azjen 1991: 181). The Theory of Reasoned Action can be of relevance to understanding drivers of water conservation behaviour in that it suggests that people want to be seen to be doing the right thing, i.e. conserving rather than wasting water.

Secondly, the Theory of Planned Behaviour (TPB) argues that human behaviour is centred on an individual's attitude, beliefs as well as perceived behavioural control (Morris *et al*. 2012: 5). Regarding the performance of a behaviour, the theory argues that the easier it is to perform a behaviour, the more inclined an individual will be to do so (Morris *et al*. 2012: 5). TPB, according to Morris *et al.* (2012: 5), can be used

to understand specific effects on behaviour that can be targeted for modification rather than how to change the behaviour. When linked to water conservation and water demand management (WCWDM), this theory suggests that if it is made easier for people to preserve water, there is a higher chance that they will do so. An example of making it easier for the general public to conserve water could be the installation of pre-paid smart water meters to enable households to track exactly how much water they are consuming per month (instead of the local municipality estimating usage based on their existing outdated conventional household water meters). This will result in them amending their water use behaviour patterns by being able to track water usage more reliably (reduced bills/tariffs could act as an incentive to promote smart meter adoption and improved water conservation behaviour and practice).

The third group of behavioural theories widely used to understand human behaviour is Social Practice Theory (SPT), which is an umbrella term that encompasses various aspects of Social Behaviour Theory (Morris *et al*. 2012: 11). SPT acknowledges the role of human and non-human factors in influencing behaviour. It incorporates three key elements, which also influence behaviour, i.e. materials, meanings and procedures (Morris *et al*. 2012: 11):

- **Materials** refer to the physical objects, such as water conservation technologies/gadgets that can be used to execute certain household activities.
- **Meanings** determine how and when activities might be accomplished and include images, interpretations or concepts associated with that activity, such as awareness raising campaigns around water conservation and reduced water use.
- **Procedures** include the ability, skills or know-how applied to complete certain activities, such as retro-fitting the household with water-saving devices, or the outcomes of environmental water saving education campaigns.

Fourthly, the theoretical framework of the new environmental paradigm (NEP) is also of relevance to understanding environmental and water use behaviour, in particular general citizens environmental awareness. The NEP has become a widely accepted theoretical approach to determine general beliefs about the relationship of human beings to the natural environment and resources and is an extensively used applied theory as a measure of an individuals' environmental awareness (Anderson 2012: 260).

It is important to note that it was quite difficult to discuss these theories within the context of being either core drivers or barriers to WDM, as a positive driver of water conservation behaviour can quite easily become a barrier, when implemented ineffectively. It is also important to indicate that the different research studies reviewed from available literature yielded different and sometimes contradictory findings relating to water conservation behaviour theory. This suggests that theories on human/social behaviour and water conservation and WDM, are quite complex. The next chapter (Chapter 2) expands on these theories and further explains their application and relevance to this study.

1.6 WATER DEMAND MANAGEMENT

Water Demand Management (WDM) needs to address both structural and human behavioural mechanisms to regulate water consumption in order to be effective (Kayaga and Smout 2008: 16). Structural mechanisms are mechanisms employed by governments, water utilities and other organisational entities to manage demand (Russell and Fielding 2010: 6). They are essentially the various structures provided to regulate water consumption. These include WDM policy, strategy, regulation, localised legal instruments such as by-laws, metering, water restrictions and water services development plans; financial incentives or disincentives, pricing or penalties and rebates, and availability of water saving efficient technologies (Russell and Fielding 2010: 7). Technological changes enhance the efficiency of water use by installing fixtures and appliances such as tap aerators or visual display water use

technologies. Behavioural change on the other hand consists of the practices and actions that reduce individual water use, such as a reduced frequency (e.g. number of showers or toilet flushes) and adherence to water restrictions (Kayaga and Smout 2008: 1-5). Behavioural change is a key element of WDM strategies, which are likely to be more effective if they are able to influence community or household behaviours (Corral-Verdugo *et al*. 2003: 250; Turner *et al*. 2008: 4).

It can be argued that it is not effective to develop a single 'one size fits all' WDM policy or strategy for all water consumers in a particular municipality or city due to the variability of the households in terms of income level, type of dwellings, level of education and even the variability in behaviour of household members themselves. Different members in a household will have different attitudes, beliefs, habits and capacity to implement water conservation behaviour, and it is these nuances that the policy developers and implementers of WDM strategies need to take into consideration (Russell and Fielding 2010: 7). One way of diversifying these strategies is through educational information and awareness-raising by ensuring that urban water users are sensitised to a wide variety of information on responsible water conservation behaviour (Trumbo and O'Keefe 2005: 581).

Specifically with regard to the role that policy-makers have in developing effective WDM strategies, the following core questions need to be addressed as comprehensively as possible: what are the environmental and/or socio-cultural aspects of water consumption? What are the drivers of water saving behaviour? What institutional framework is needed to support effective WDM? and lastly, what water conservation and WDM policy measures and designs should influence water consumption patterns at the urban household water use level? This research study on household water use presents a case in point analysis towards providing some answers to these questions. Chapters 3 and 4 present further information on WDM as a key concept to this study, with a literature review focus placed on international, national and city of Durban WDM policies and strategies. The two chapters provide a clearer understanding of water conservation and WDM policy, strategies, plans and then analyses the key drivers that support effective WDM.

1.7 RESEARCH METHOD

The methodology of the study is presented in Chapter five. According to Leedy and Ormrod (2005: 12), research methodology is the researcher's overall plan for carrying out the research project, and it specifies the study's tools. A research method is the process of obtaining data and information. This study's research aims were addressed using an interpretive approach, namely the constructive-interpretative paradigm. This research used a mixed methods approach, combining quantitative and qualitative methodologies. Quantitative data is objective, accurate, and statistically based, whereas qualitative methods are more subjectively interpreted and text or image-based (Bryman and Bell 2011: 312). The advantages of a mixed methods approach in this study far exceed the disadvantages of utilizing only one research method. The integration of research approaches is useful in some research topics, according to Sale *et al.* (2002: 6), because the complexity of phenomena requires data from a wide range of perspectives.

In qualitative research, data is typically collected from a smaller sample, which provides rich and deep insight into the research study. The goal of qualitative research is to build a holistic vision rather than a numerical examination of data in order to comprehend a phenomenon by focusing on the overall picture rather than breaking it down into factors (Ary *et al*. 2010: 29). The qualitative method was utilized in this study to assist the researcher to get clear insight into urban household water users living in the Durban metro suburbs. Semi-structured interviews were held with the city of Durban's water service providers (eThekwini Municipality and Umgeni Water) to analyse and co-create integrated sustainable policy responses and solutions. The goal of these focussed group discussions was to get water service authorities to think about their shared responsibility with the public and civil society in altering people's attitudes, behaviour and perceptions towards their water use.

According to Leedy and Ormrod (2005: 94), quantitative research is used to answer questions about correlations between quantifiable variables in order to understand, forecast, and control occurrences. According to Ary *et al.* (2010: 22), quantitative techniques use objective measurements to collect numeric data that is then used to answer questions or test hypotheses. A survey instrument was deployed to investigate the behavioural aspects of water consumption in various types of dwellings and families. The household surveys yielded detailed data and information about the sampled households' water consumption behaviour, as well as the types of dwellings they occupied, their socio-economic profile, the range technologies and facilities they used, including, their perceived water use, their perceptions of water-wise behaviour, and what they considered to be good water saving practices.

1.7.1 Research design and sampling

The researcher used non-probability sampling, which is a collection of strategies that allow researchers to select units from a population that are relevant to the study's goals and investigation. This explanation is backed by Sekeran and Bougie (2009: 252), who claim that this sample design is limited to specified target groups from which information is readily available. As a result, quota purposive sampling was used in this study to ensure that selected demographic groups were suitably representative for the study area (Sekeran and Bougie 2009: 253). Non-random or non-probability sampling, which is a technique in which samples are collected in a way that does not give all individuals in the general population equal chances of being chosen, or the elements in the population do not have any probabilities attached to being chosen as sample subjects, was the most manageable sampling strategy for this study (Sekeran and Bougie 2009: 252). This design and sampling approach enabled the collection and analysis of quantitative and qualitative data on urban household water use characteristics, such as dwelling type, water consumption, and use behavior, allowing for statistical data analysis and the testing of causal relationships between dependent and independent analytical variables.

1.7.2 Study area

A target population, according to Sekeran and Bougie (2009), is the total group of individuals, events, activities, or things of interest that the researcher intends to explore. The target audience for this study was designated as all urban people in the Durban metropolitan area who lived inside the eThekwini Municipality jurisdictional geo-spatial boundary. As part of the initial research design process and to finalise the target population for the study, the eThekwini Municipality Water and Sanitation (EWS) department was contacted and the purpose, aims and objectives of the research study was formally presented. These structured engagements were conducted such that the municipality could guide and advise on the suburbs for inclusion into the overall study target population as one of the intended outcomes of the research study was to develop guiding recommendations on future WDM policy interventions. The municipality was supportive and a series of further stakeholder engagement sessions were convened with senior EWS officials. The final outcome of the engagements culminated in eThekwini Municipality selecting five suburbs which were recommended for inclusion in the study. The Municipality advised that the selected areas would provide a good representation of the city residents located within the metro and therefore can be used to inform future decision-making based on the sampled population. Additionally, various other supporting criteria were also used in the determination of the final selected suburbs. Some examples of the key criteria, are summarised below:

- Geographical representation across the eThekwini metropolitan area, i.e. covering areas in the North Coast, South Coast and inner and upper highway areas of the metro.

- Consideration of housing types, property sizes and their associated property values (linked to actual and perceived water consumption).

- Population density and racial composition, with a view to understanding differing water use behaviour from various race groups within the metro.

- Income levels of residents, i.e. having representation of low-, middle- and high-income earning areas and considering their influence on water use behaviour.

Based on the process followed above, the target population identified for this study were the five suburbs of Phoenix, Durban North, Amanzimtoti, uMlazi and Pinetown.

1.7.3 Sample size

A total of 200 household surveys were conducted and completed in full. Based on the pre-identification of the suburbs mentioned above, a series of house-to-house surveys, were administered. Additionally, public spaces (e.g. libraries, parks, recreational grounds, etc.) were also identified and used in order to achieve higher response rates and to engage as many urban residents from that particular suburb as possible. Permission was also requested from several malls and for the use of public places, in advance, from relevant authorities. A total of 40 surveys per suburb were conducted over the 5 suburbs, resulting in the 200 surveys being administered. In addition, four semi-structured interviews with respective officials in water service provision at eThekwini Municipality and Umgeni Water were conducted to supplement the quantitative data collection with qualitative data as well.

1.7.4 Pilot testing

The study initially conducted a pilot test of the survey questionnaire to see if there were any errors, limitations, or other inherent defects in the questionnaire design. This enabled for any necessary adjustments to be made before the fieldwork began. A pilot test should be utilized to help researchers adjust research questions, taking into account faults, question skips, time, and respondent interest and attentiveness (Vaus, 2014: 116). The pilot test was also utilized to assess the validity and clarity of the questions that were asked. The questionnaire was evaluated based on a range of data required to meet the study's goals and objectives. The pilot questionnaires were given to 25 people who did not live in the study's proposed five areas. To conduct this task, the requisite number of respondents were readily available in the researcher's workplace environment. Additionally, employing scales

to gauge how respondents feel or think about something is a popular and valuable strategy in survey research (Pietersen and Maree 2007:15). In this study, the Likert Scale was used to determine how strongly individuals agreed or disagreed with items on a five-point scale, example, respondents' environmental awareness and perceptions of existing water wise behaviour in the City of Durban.

1.7.5 Data collection

Data collection is the process of gathering usable information on fundamental quality attributes from a research procedure (Sekeran and Bougie 2009: 212). In qualitative research, data is typically collected from a smaller sample, which provides rich and deep insight into the topic being examined. Qualitative data collection methods include one-on-one and/or focus group interactions with individuals to capture people's perceptions, interpretations, and descriptions of circumstances and reality constructions (Sekeran and Bougie 2009: 213). In this study, 200 households in Durban area were given survey questionnaires that included both closed and open-ended questions. In addition, four face-to-face semi-structured interviews with water service authorities were set up, with the recordings and written transcriptions serving as an additional primary data gathering sources.

1.7.6 Data analysis

In mixed methods research, the type of research strategy used has an impact on data analysis. Both quantitative (descriptive and inferential mathematical analysis) and qualitative (description and theme text analysis) methodologies are used in the analysis (Creswell 2009: 60-63). The quantitative data acquired for this study was analysed using the Statistical Package for the Social Sciences software program (SPSS) Version 24.0. SPSS is a widely used statistical data analysis software program that is extensively used in social science research. The software designed for initially for analysing data in the social sciences, but it has since spread to other

disciplines including, health sciences, management science, market research science, and data mining. The use of SPSS proved beneficial in the response data analysis and interpretation of specific numerical variables. Tables and graphs, as well as descriptions, inferential statistics, charts, and frequencies, were used to make the data accessible and explainable. The interviews were recorded and transcribed for qualitative analysis. The transcription records were prepared and uploaded to NVIVO 11.0 qualitative data analysis program. Because of its simple user interface, this online software program application has been frequently utilized to do qualitative research data analysis. The use of NVIVO helped the analysis of transcribed material in order to uncover common patterns and themes. Thematic analysis was used to code and analyse each of the transcribed interview records in order to find common themes that may be recognized. Thematic analysis was further utilized to discover common concepts and themes in relation to household water use behaviour, allowing for a better understanding of the complexity and rich description of urban water use policy, planning and demand management. Iterative data processing and analysis were carried out as follows: The data was rigorously coded, then categorized to reflect the broad ideas that the codes linked to; significant coding themes and correlations were then identified in order to recognize patterns; and conclusions or concepts were developed based on the patterns found in the data.Through the integration of the SPSS and NVIVO software data analysis tools, the researcher was able draw significant conclusions from both the quantitative and qualitative methodological approaches.

1.8 VALIDITY AND RELIABILITY

All research studies must include validity and reliability. It determines the authenticity, trustworthiness, and credibility of the information supplied. A valid research question, according to Vaus (2014: 95), is one that assesses what the researcher believes it does. The degree to which a data gathering approach and analysis produces the same result for different participants in the research process is known as reliability (Vaus 2014: 96). If given to the same person on multiple occasions, the question should be answered in the same way each time. Unreliable

or ambiguous questions get inconsistent responses, and unclear question wording can lead to unreliable responses because people perceive the question differently on multiple occasions (Vaus 2014: 95). The Cronbach Alpha Test can be used to improve the validity and reliability of a study. The Cronbach Alpha test, according to Mohsen (2011: 54), can be used to assess the reliability, correctness, and internal consistency of a questionnaire. To ensure the accuracy of the data, the researcher made certain that all respondents were given adequate time and were not pressured or influenced during the administration of the questionnaire or the interviews. Furthermore, through a professional peer review of the statistical analysis conducted for this study, the experience of a professional statistician was elicited as a means of establishing the reliability and credibility of the study findings.

1.9 ETHICAL ISSUES

According to Struwig and Stead (2001: 67), participants' rights, dignity, privacy, and confidentiality of information should always be maintained and managed in strict confidence. This study required that all research participants fill out and sign a consent form. The fieldwork and data for this study were collected as part of a wider research study on effective instruments for demand side water regulation, with a focus on urban household water use, at a national level. The Durban University of Technology (DUT) granted FREC ethical clearance to the study, and the letter of approval is attached as Appendix 3. All information as received from respondents who participated in the research study was kept strictly confidential and anonymous.

1.10 LIMITATIONS

A research study may be constrained due to the narrow segments of the entire population one desires to study, or it may be limited due to the research method one has chosen (Sekeran and Bougie 2009: 46). This study only concentrated on the

selected 5 suburbs within the City of Durban as described in the discussion on target population (section 1.7.2) above. There is potential to expand the geographical area and number of urban residents to cover a much wider geographical base within the Durban metro. This can be considered as a limitation to the current study. However, the selection process followed with the eThekwini Municipality was considered to be sufficiently robust to ensure an adequate sample size of water user profiles of the urban residents dwelling within the Durban metropolitan area.

1.11 CHAPTER DIVISION

This thesis comprises seven chapters organised as follows:

Chapter One: Introduction

This chapter serves as an introduction and covers the background and significance of the study. Information is also provided on the key research themes, objectives, limitations and research ethical considerations.

Chapter Two: Theories supporting water use and conservation behaviour

Chapter Two presents the theoretical framework and describes the relevance of the respective theories to this study which was the need to understand water use and conservation behaviour from a detailed review of available literature sources. The theoretical framework used within this study is discussed within three key theories of social/human behaviour, namely the theories of Planned and Reasoned Action, Socio-Technological Behaviour Change and Environmental Awareness. The chapter is structured to provide a review of the theoretical frameworks and then provides a clear justification for their use within this study. Specifically, information on the context of social behaviour theories and their relevance in shaping WDM and water use behaviour, is presented. The last section of the chapter presents a synthesis of the review conducted, along with an analysis of concluding reflections.

Chapter Three: International perspectives on water demand management and urban household water use behaviour

This chapter forms part of the analytical review of international sources of literature relating to aspects of global water scarcity, security, climate change, water demand management (WDM), motivators for effective WDM, drivers and barriers to urban household water conservation behaviour, technologies for water use efficiency, as well as recommendations on the key linking and enabling mechanisms for WDM. Furthermore, the chapter provides a critical analytical review of successful WDM policies, strategies and instruments as have been applied by other cities and countries from around the world**.**

Chapter Four: Water Demand Management: South African and City of Durban perspectives

The fourth chapter provides a review of water conservation and demand management (WDM) in SA and the City of Durban. Specifically, the chapter reviews and interrogates the current policy and legal frameworks for WDM by providing a status quo of water use and water demand in present day South Africa. The chapter then delves into an important research discussion on some of the key factors that are influencing urban household water use and conservation behaviour in the country. The last part of the chapter presents a similar analytical approach of the WDM policies and strategies relevant to the City of Durban. The last section of the chapter also presents current data and information on eThekwini Municipality's Non-Revenue Water (NRW) and Water Demand Reduction Programmes and also reviews the progress of the respective WC/WDM initiatives currently being undertaken by the Municipality. Concluding remarks are also provided to improve WDM policy and practice within the City of Durban.

Chapter Five: Research methodology

This chapter focuses on the research design, which was a mixed methods approach. This is done through a discussion of the methodological processes followed for data collection and the data collection instruments, including how the data was analysed and reported.

Chapter Six: Findings, analysis and interpretations

In this chapter, data was analysed, interpreted and reported. Quantitative and qualitative data was categorised and captured. The coded data was analysed using SPSS and NVIVO software.

Chapter Seven: Conclusions and recommendations

The study's final chapter focuses on reviewing the literature consulted and assessing if all the research objectives have been met by drawing on a number of core conclusions from the study findings. The key recommendations and suggestions for future research, are also presented.

1.12 CONCLUSION

The severity of SA's urban demand water challenges are well documented from the literature review conducted as part of this study. There is an immediate need for evidence-based decision support making tools to improve the WDM effectiveness in the country. This study strongly advocates that a deeper understanding of urban household water use behaviour is needed in a search for ways to reduce water consumption and domestic demand substantially. Several national plans and local government calls have already been made for policy solutions towards reducing urban water demand with the potential of a looming national water deficit of 17% in SA, projected by 2030.

This chapter has provided an overall orientation of the study. The following chapter, Chapter 2, examines reviewed literature related to the theories applicable to this study.

CHAPTER 2

THEORIES SUPPORTING WATER USE AND CONSERVATION BEHAVIOUR

2.1 INTRODUCTION

This chapter presents behavioural theories that relate to the research problem under investigation (i.e. the need to better understand the psychology of water use and water conservation behaviour in SA). The theoretical framework for the study encompasses a detailed review of three key theories of human/social behaviour, namely: the theories of Planned and reasoned action, Socio-Technological Behaviour Change and Environmental Awareness. The chapter provides an analytical literature review of the different theoretical frameworks and a justification for their particular use within this study. Specifically, information on the context of behaviour theories and their direct relevance in shaping water demand management (WDM) and water conservation behaviour, is presented. The last section of the chapter presents a synthesis of the review conducted, including concluding statements.

2.1.1 Study context

It is extremely important to have a clear understanding of the context within which the reviewed theories have been used for this study. Figure 2.1 provides a graphical representation of the situational context within which this research study has been framed. Overall, the research study aimed towards contributing within the 'internal context' as related to aspects such as household water usage, water saving technology use, behaviour and conservation practices, as well as understanding the

extent to which socio-demographic and other situational factors influenced residential water consumption patterns in the City of Durban.

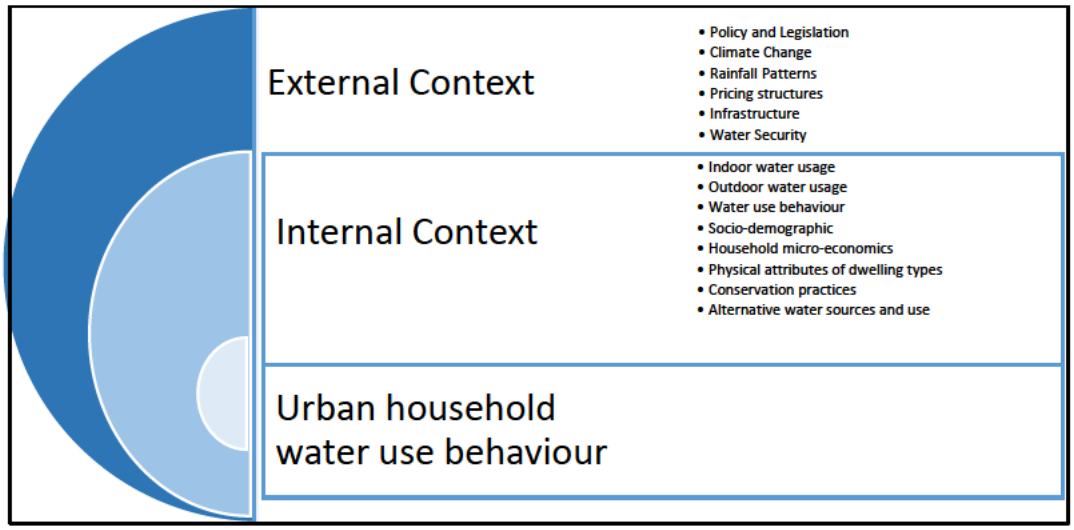

Figure 2.1: Situational context of study

Source: Self-generated by author (2022)

Although this study's focus was primarily on developing an understanding of the internal context of urban household water usage, the influences of the external context, should not be ignored. Changes in climate, rising water pricing structures, new infrastructure needs and ineffective policies and legislation on WDM interventions can also contribute towards the way in which household water use behaviour is shaped into the future in SA. Such factors should form part of future research studies on urban household water use.

2.2 THEORIES OF BEHAVIOUR

2.2.1 Defining the key theories and their links with water use behaviour

Several differing ideas and models of human behaviour have emerged from social science studies. This shows that a thorough examination of behavioural theories can prove to be difficult. However, attempts to develop multidisciplinary theories of

human behaviour have been conducted. Psychology and Sociology are the primary sources of these attempts to extract the key governing variables, processes, or causes of human behaviour. Anthropology has also provided useful insights, particularly in connection to characteristics of habits, rituals, and political influence. Human behaviour can be conceptualized and defined in a variety of ways, with the majority of research (mainly from the discipline of psychology) focusing on the individual as the 'locus' of behaviour (Morris *et al*. 2012: 12). According to Morris *et al*. (2012: 13), most behaviour theories posit a greater or lower impact of external variables such as society, but each believes behaviour to be the product of competing influences balanced and chosen by the individual, emphasizing individual agency. Individual conduct is viewed in this sense as either a point on a continuum or a first step in the adoption of a particular behaviour. These ideas can be used to forecast how often a person would perform a specific behaviour, such as watering the garden, or how often people re-use grey water. Other behavioural theories focus on the behaviour itself or links between behaviours rather than the individual. Theories of innovation, such as Diffusion of Innovation and Disruptive Innovation, place a strong emphasis on behaviours as key change agents (Morris *et al*. 2012: 3).

In addition, other studies in sociology, anthropology, and geography have tended to focus on behaviour as a result of complex inter-relationships and social practice (Shove 2010: 1275). According to Shove, people do or repeat behaviours that are the result of relationships between people, their surroundings, and the technology that surrounds them (2010: 1276). In this way, objects and environments become active in the evolution of behaviour. Furthermore, Goodwin *et al.* (2012: 85) claim that politics influences human behaviour in a variety of ways.

The next section of this chapter presents a review of the selected theoretical models that were used in this study. Spinks *et al.* (2011: 10), state that there is a need to understand the human behaviour drivers that determine the use of water by people, as well as how viable and feasible water usage can be accomplished and maintained.

2.3 THEORIES ON INDIVIDUAL BEHAVIOUR AND BEHAVIOUR CHANGE

2.3.1 Theory of Planned Behaviour (TPB)

The TPB is a widely used behaviour theory that is part of a larger family of theories that focus on individual attitudes and beliefs and adopt a cognitive approach to behaviour explanation. TPB has been around since the late 1980s and early 1990s, and various authors have looked at it (Fishbein and Ajzen 1975; Ajzen 1985, 1991; Ajzen and Madden 1986). The Theory of Reasoned Action (TRA), which asserted that the strongest predictor of action is intention to act, is widely credited as the origin of TPB. In TPB, the goal is the product of a combination of attitudes toward an activity. Subjective norms refer to the positive or negative evaluation of a behaviour and its projected effects as a result of social constraints placed on an individual. In effect, the perceptions of what others think they should do and their desire to conform (Morris *et al.* 2012: 5). The TPB has expanded to include a third set of factors that influence intention (and action), referred to as 'perceived behavioural control.' This is similar to self-efficacy (Morris *et al.* 2012: 6). It is the expected ease or difficulty with which the individual will be able to execute or carry out the behaviour. Several authors have made this argument (Bandura 1986, 1997; Terry *et al.* 1993). The key components of the TPB model is illustrated in Figure 2.2, whilst Figure 2.3 shows the application of TPB with some water-saving practices as examples.

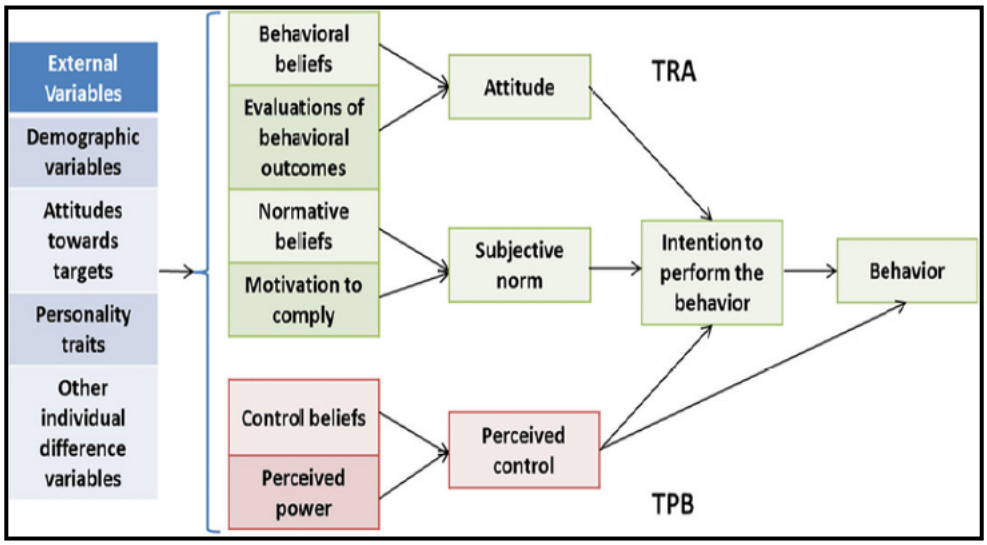

Figure 2.2: Theory of Planned Behaviour

Source: Adapted from Morris (2012)

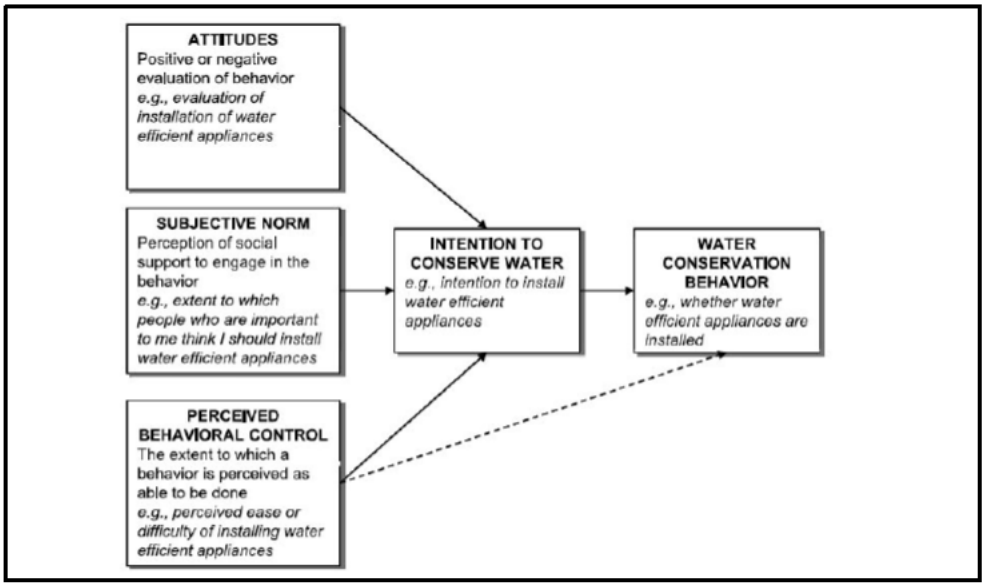

Figure 2.3: Theory of planned behaviour with water saving examples

Source: Adapted from Russell and Fielding (2010)

People's beliefs about water conservation are crucial in motivating water conservation intentions and action, as shown in Figure 2.3, and specific water-related beliefs are more predictive than generalized environmental worldviews (Russel and Fielding 2010: 5). The discovery that beliefs influence water prediction

is consistent with psychological theories such as TPB, which claim that people's environmental intentions and behaviour are influenced by their beliefs. Several reviews of the TPB's strengths and weaknesses are available in the literature. Armitage and Conner (2000), (2001), (2004); Hardeman *et al.* (2002); Rutter and Quine (2002); Munro *et al*. (2007); Nisbet and Gick (2008); Webb *et al.* (2009), (2010) are some examples of such literature sources and the majority of researchers agree that TPB is well suited to behaviour prediction and retrospective analysis. TPB has also been used in health sector studies and on healthy behaviour change to predict between 20% and 30% of the variability in behaviour brought about by treatment (Taylor *et al*. 2007: 5). According to the Taylor study, there are strong correlations between behaviour and attitudes concerning TPB's behaviour and the perceived behavioural control components. However, Taylor cautions that in the health-care studies, minimal relationships were found between behaviour and perceived norms (Taylor *et al.* 2007: 6). TPB can be used to explain and predict likely behaviour and is a useful technique to highlight specific behavioural consequences that can be adjusted. Even when the TPB is used to create sections of an intervention, Hardeman *et al.* (2002: 149) note that researchers seem to regard the theory more valuable in identifying cognitive targets for change, rather than presenting tangible suggestions on how these insights might be improved.

TPB was employed in this particular study to determine specific factors on behaviour that may be targeted for change, rather than to change the behaviour itself. When applied in the city of Durban, this theory suggests that making it easier for people to conserve water will increase their likelihood of doing so. Encouraging individuals to conserve water by installing smart water meters in their residences is one such example. This will enable residents to track exactly how much water they are consuming on a monthly basis (instead of the current practice of the local municipality, estimating the charges for them), and, in so doing, they will be able to change their water use practices based on real time actual water consumption data, which directly contribute to significant water savings in the metro. Using the TPB was of particular relevance to this study in terms of gaining a much deeper and more intimate understanding of the key drivers of water conservation behaviour in the city

in that TPB suggests that people want to be seen to be doing the right thing, i.e. conserving rather than wasting a precious natural resource such as water.

2.4 THEORIES OF SOCIO-TECHNOLOGICAL BEHAVIOUR CHANGE

2.4.1 Social Practice Theory (SPT)

Social Practice Theory (SPT) has been applied to a variety of research investigations, including social behaviour in the field of energy consumption. According to Reckwitz (2002: 243), the central premise of SPT is the recognition that human practices (methods of doing, repetitive behaviour, practices) are themselves collections of various interdependent parts such as cognitive and emotional activities, standards, interpretations, technology usage, and insight, all of which form part of people's behaviours and actions in their daily lives. The SPT approach emphasizes the influence of material environments (also known as socio-technical infrastructures) on their behaviour (Morris *et al.* 2012: 4).

In studies on socio-technical behaviour, Geels (2004) and Smith *et al.* (2007) validated this emphasis on the material context and technologies, as well as their relationship to social behaviour. It identifies the tenacity of existing practices that drive 'development pathways' in technological change, which are difficult to break away from (Smith 2007: 428). This resilience is described by Randles and Mander (2009: 16) as unwillingness, observing that people seldom or readily mirror on social behaviours and that their internal arrangements make them structurally apprehensive to change. Individual choices and attitudes, according to social practice theorists, are frequently subordinate to these contextual influences with people serving as bearers of practices or routines rather than autonomous agents (Reckwitz 2002: 245). SPT also recognizes the influence of both human and non-

human elements on behaviour. It consists of three fundamental components that drive behaviour: materials, meanings, and procedures: Figure 2.4 shows SPT in application, with a water saving example.

- **Materials**: Physical objects that enable or facilitate specific activities, such as the adoption of water conservation technologies, as well as devices and gadgets that can be used to carry out specific activities, such as using less water.
- **Meanings**: Determine how and when activities might be accomplished and include images, interpretations or concepts associated with that activity, such as awareness raising campaigns around water conservation and demand management.
- **Procedures** include the ability, skills or know-how that is applied to complete certain activities, such as the outcomes of environmental education campaigns.

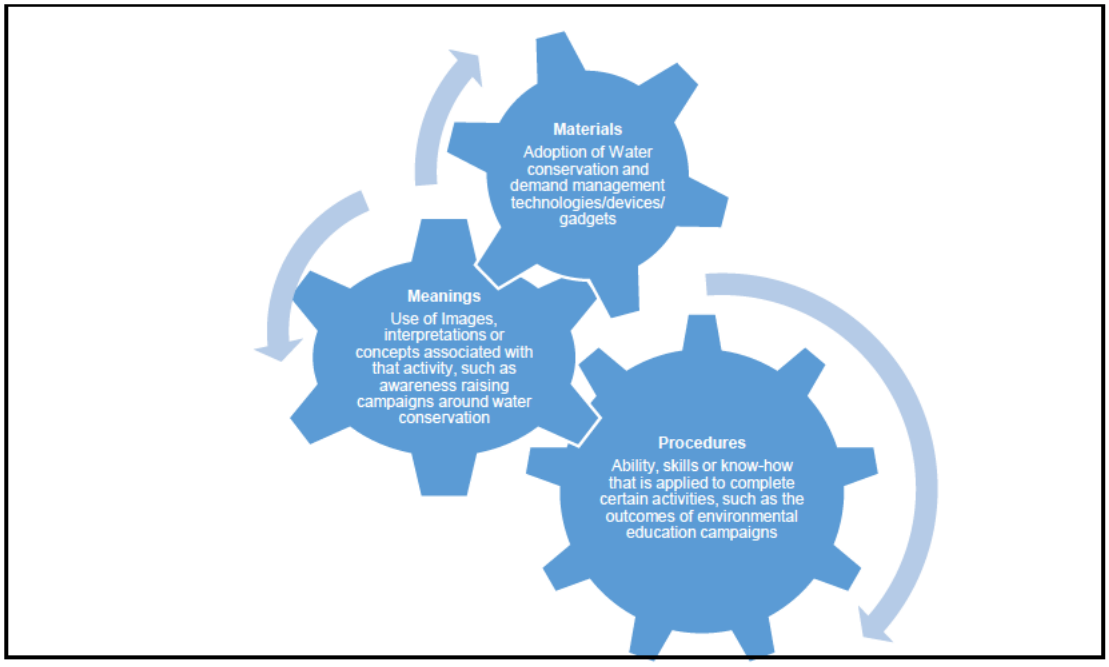

Figure 2.4: SPT model with water saving behaviour

Source: Adapted from Chatterton (2011)

SPT proposes a range of new approaches to understand and explain behaviour, as well as a wide range of possible solutions. The theory's central assumption argues that we should pay attention not only to individual behaviour but also to social practices, as well as the interconnects between people's practices and their material environments (Reckwitz 2002: 247). This shifts the focus away from meddling in decisions and more towards considering why certain behaviours are generated and re-produced, as well as how and why others are prevented from doing so. Despite SPT's individual focus, this reflection could be deemed elaborative in some models, such as the Elaboration Likelihood Model (ELM) created by Petty and Cacioppo (1986), where SPT is identified as an important component of behaviour change. According to the ELM, sustainable behaviour change is most typically the result of the individual/community's examination of the concerns and problems (Jackson 2005:32). Elaborative processes, according to Jackson (2005), are critical in behaviour change, particularly in navigating new social norms and unfreezing "old" habitual behavioural practices. A crucial theme of ELM is the transition from deliberation to elaboration as a viable paradigm of behavioural change (Jackson 2005:33).

In terms of how SPT was related to this study, the application of SPT model provided for a critical analysis of the current WDM policies, strategies, programmes and public communication interventions that were collected during the surveys from all respondents that participated in the study. These included extremely valuable recommendations for improved and effective communication methods with the general population of the city and the local municipality. It is widely recognised and acknowledged in current literature that the effective use of face-to-face, print media, press/TV, social networking websites, vlogs, blogs, advertising campaigns and municipal monthly bills all form part of a suite of critical influencers on water behavioural use and future water demand management. The use of SPT prompted critical thought on why and how specific water conservation initiatives are being carried out, in addition to promoting knowledge exchange.

2.4.2 Diffusion of Innovation theory

The Diffusion of Innovation (DOI) theory focuses on innovation as a key driver for behaviour change, with innovation defined as a "novel" idea, practice, or product. As a result, the perceived properties of an 'innovation' have a bigger impact on its rate of adoption than the characteristics of the adopters (Rogers 2003:12). The DOI theory has been widely applied in marketing, development, and health sector research (Greenhalgh *et al.* 2004: 581). Innovation, communication, time, and social systems are the four fundamental aspects of DOI behaviour change (Rogers 2003: 11). Diffusion, according to Rogers, is the process through which innovation is communicated to members of a social system over time. Because the message is about 'new' ideas, it's a unique type of communication (Rogers 2003: 15). The application of DOI theory highlights the distinctions between the roles of mass media and interpersonal channels, with the former being more effective at raising awareness among potential adopters and the latter being more effective at influencing adoption. It is stated that rather than relying on specialists or scientific assessments, inventions are judged based on the subjective opinions of close peers, hence close interpersonal communication is critical (Rogers 2003: 36). Overall, this theory can be described as an innovation-diffusion process that resembles stage models of behaviour development, such as that of trans-theoretical models. Individual adopters move through five steps: knowledge, persuasion, choice, execution, and confirmation. The process begins with the identification of a crisis or even need (and is hence problem-oriented) (Morris *et al.* 2012: 16).

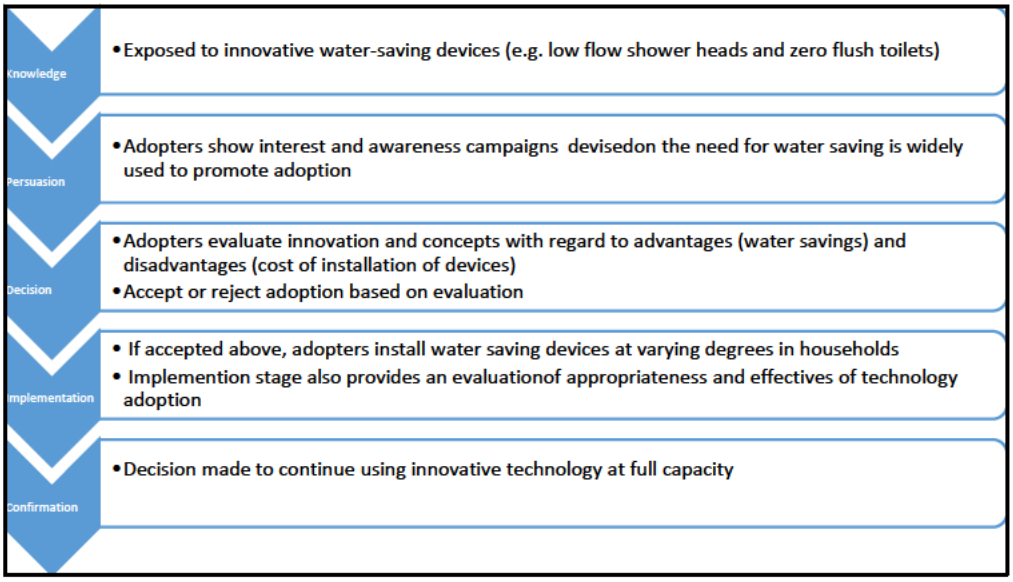

Figure 2.5: Five stages of the Diffusion of Innovation model, with a water saving example

Source: Adapted from Rogers (2003)

The field of innovation theory is vast. As a result, there are a number of excellent DoI theory descriptions, reviews, and criticisms available (Lyytinen and Damsgaard 2001; Wright 2004; Greenhalgh *et al.* 2004), with most authors arguing that the application of DoI theory should shift away from being historically motivated and implemented to address economic drivers and towards more application of non-economic considerations (Morris *et al.* 2012: 15).

In order to apply the DoI theory to this particular study, it was necessary to recognise and emphasize that in South Africa, innovation and technological instruments in the form of water-saving devices and technologies have been widely adopted during the last decade. Such practices have been a key pillar of WDM methods employed at the policy and planning levels in South Africa with the explicit aim of a reduction of household consumption of water in urban areas. However, many such WDM initiatives and instruments that have been used in South Africa have been underpinned by a framework driven by economic gains only, (i.e. focused on technology adoption and management innovation – purely economic drivers). It therefore appears that there is little to no research that has been done on the diffusion of innovation in other forms or non-economic benefits (i.e. water security,

resource conservation and ecological protection). As a result, the importance the DOI theoretical approach was used to clearly understand how water-saving strategies and technologies influenced respondents' household water use behaviour, beliefs, and practices and was also treated as an important 'non-economic' theory, worthy of application in the context of this particular study.

2.5 THEORIES ON ENVIRONMENTAL AWARENESS

2.5.1 New Environmental Paradigm (NEP)

The NEP has become a widely accepted theoretical approach for determining general beliefs about human-environment relationships and it has been widely used in current research as a measure of a person's general environmental beliefs and awareness. The NEP was created in 1987 by Dunlap and Van Liere (Anderson (2012: 261). The NEP scale uses a 5-point Likert scale measurement that can be used to measure an individual's environmental awareness and concerns (Anderson 2012:261). The respondent can rank 15 (environmental statements) items on the NEP scale using a Likert scale (Anderson 2012: 262).

When evaluated through a historical lens of NEP's history, there are a few research studies of the NEP scale, worth mentioning. In the early 1990s, the adoption and application of the NEP scaling was primarily used to deal with cross-border environmental challenges such as shared river basin groundwater pollution, land desertification, endangered ecosystem protection, and atmospheric deterioration (Dunlap 2008: 4). In the 2000s environmental beliefs were changed and framed as the psychological inclination to evaluate whether the natural environment is favourable or unfavourable, Hawcroft and Milfont (2010) indicated three key aspects of relevance in this regard:

a. a belief in the human ability to upset the balance of nature;
b. the existence of limits to population growth; and

c. human beings' rights to rule over nature and natural resources.

According to López-Bonilla *et al.* (2016: 224), the NEP scale is made up of two main perspectives: eco-centric and anthropocentric. The anthropocentric viewpoint holds that humans can manage nature and mitigate the negative consequences of civilization on it. The eco-centric viewpoint, on the other hand, posits that people recognize nature and natural resources, such as water, as a common good that requires collective protection due to its fundamental 'priceless' worth to all human survival.

According to other studies, the NEP scale is the most extensively used instrument to assess respondents' ecological worldview (Ntanos 2017). According to Ntanos (2019: 562), the NEP scale is a reliable decision-making instrument for analyzing citizens' perspectives and general environmental awareness. Because people's global environmental attitudes toward the earth-shared living place have improved, moving humans from an anti-ecological to mid-ecological, and finally to pro-ecological view, Putrawan (2015: 326) asserts that the NEP could also stand for the 'new ecological paradigm' rather than 'new environmental paradigm.' In other words, the new ecological paradigm is the sociologically evolving label for the original 'new environmental paradigm'.

In terms of the application of the NEP theory to this particular study, various environmental variables were evaluated on the NEP scale questions contained in the survey questionnaire that was administered. The NEP scaled statements probed key research questions such as: Is there sufficient water in SA and in the Durban metro? Is there an unlimited supply of water for each household to use as much as they want to use? and are there sufficient technology solutions available to meet SA's and Durban's present and future water needs? In analysing these key questions, a localised "ecological or environmental" viewpoint was obtained. These findings and suggestions supported effective policy recommendations on WDM

decision-making and advanced a clearer understanding of the localised (Durban) metro residents' views on:

(a) reducing the global and local water crises through growing citizens awareness on global and local water scarcity and demand challenges;

(b) the growth of a powerful bio-spheric and altruistic value of water, as opposed to the egoistically attested benefits of unsustainable water use behavior;

(c) the utility of environmental attitudes as psychological motivators to assess water use under the "favours" or "disfavours" that conform with environmental and behavioural psychology principles; and

(d) providing a wide spectrum of ecological viewpoints on water use behaviour and the environmental values to validate and verify present and future environmental planning and decision-making.

In conclusion, the NEP scale was directly applied to support the measurement and analysis of local respondents' environmental views and perceptions of water use and water behaviour in SA and Durban. The analysis also included the testing of different variables between the sample demographics and the NEP scaling statements for maximum statistical effectiveness.

2.6 REFLECTIONS ON BEHAVIOUR THEORIES AND WATER DEMAND MANAGEMENT

Based on the literature review conducted for this study, it can be concluded that there are many different and often contradictory theories and models of human behaviour and behaviour change. However, the review has provided some central cross-cutting insights into WDM and urban household water use behaviour which can be utilised to inform key role-players in water provision and water demand management policy making. The following section provides a reflective analysis of the respective theories reviewed in this chapter.

2.6.1 Individual and social theories

TPB and SPT critics are keen to point out many "social gaps" in their critiques of individualistically centred theories of behaviour and behaviour change. However, this does not mean that their assessments should be dismissed. Not only are such behavioural models intuitive and explicit, but they also imply that people have some control over how they behave (Morris *et al.* 2012: 20). Despite the fact that social influences and surrounds play a significant role in shaping water consumption behaviour, most models undervalue the impact of social conditions on individual cognitive processes and decisions. Society plays a key role and has an impact on the agency or power to affect water usage patterns and thus lower water demand. It can be considered as a public pressure perceived and processed by an urban water consumer, or as a social backdrop that unconsciously creates and chooses an individual's activities relating to everyday water usage. Most models of behaviour change that focus on individual cognitive processes and decisions vastly underestimate the impact of social contexts. This appears to be largely a consequence of the complexity associated with measuring social behaviour. However, social pressure does play a role in determining behaviour. Whether conceptualised as a pressure felt and processed by an individual decision maker, or as a context which unconsciously structures and determines individuals' actions, civil society does have a direct impact on the agency or power of individual behaviour. There are several gaps that exist in the extant literature regarding the prioritisation of WDM policies, interventions or responses needed to address both the individual as well as a decision-makers and the wider social context in which people live. Therefore, this suggests that a multi-interventional approach is likely to be required for the effective promotion of sustainable water use behaviour. This will constitute the weight of opinion emanating from the evaluative literature evidence regarding the interventions that affect sustainable water use behaviour change. As a result, treatments or responses to WDM must take into account both the public policy decision-makers and the larger societal context. This means that promoting sustainable water usage behaviour will almost certainly necessitate many concurrent interventions. Policymakers such as eThekwini Municipality, the Department of Water and Sanitation (DWS), and Umgeni Water (UW) can effectively

embrace this because they have the financial resources to influence both individual decisions and the larger social material context in terms of water consumption and supply in SA and the Durban metro.

2.6.2 Control

Control is a notion found in a variety of behavioural theories. Individuals are less likely to undertake anything unless they perceive they could do it, because of either their inadequate expertise or because of their limiting environment, or if individuals believe that a different activity would be easier. Although cognitive models provide this insight, it does not have to be limited to conscious notions of control. In many ways, the extent to which something is "doable" is related to how common it is in society and how much it is practiced. This suggests that WDM policy interventions are likely to be similar across the country. As a result, WDM interventions must maximize the perceived and actual "do-ability" of sustainable water use behaviour change. This entails making sustainable behaviours appealing and socially acceptable to every citizen, examples include providing tax incentives for the installation of rainwater harvesting systems or removing legal and policy barriers for retrofitting homes with smart water-saving devices or fast tracking the widespread adoption of water-saving devices/technologies to as many people as possible in South Africa.

2.6.3 Risks and threats

Threats are identified as a major effect on social behaviour change in some theories, such as SPT and DoI, whereas other theories are more problem-oriented. Most theories regard them as cues to act in a particular way, adjust behaviour, or at the very least, be indicated in actual behaviour. Threats or challenges must be "real" in the sense of "urgency" to have an effect on stakeholders, livelihoods, or incomes (Morris et al. 2012: 21). The concept of effectiveness is extremely important in this

study because WDM policy interventions or new "water behaviours" must effectively address the "actual" water scarcity crisis that South Africans are currently facing. Therefore, water insecurity and the associated WDM responses to this, must strongly focus on addressing such particular real threats and risks by explaining and effectively presenting them in a relevant, open and transparent manner to all South African citizens.

2.6.4 Technology and innovation

The DoI theory emphasises the role of innovation as a change agent and the impact of technology on social behaviour. In other words, present and extensively used water-saving technologies may in some cases perpetuate unsustainable water-use habits and the adherence to specific 'economic' water-saving models. As a result, innovation must support alternative behavioural responses, some of which may initially serve a niche need but later expand to replace dominant or historical water-saving technology and gadgets (i.e. disruptive technologies within the globally adopted phenomenon of the 4th Industrial Revolution).

WDM policy responses must therefore widely promote technological innovation and adoption. Increasing technology awareness can be a key component within the suite of WDM interventions that should be adopted in SA policy. Simplified ‘user-friendly’ information regarding currently available water saving technologies is lacking in SA. Most current WDM interventions and practices have been rather ineffective and inadequate in this regard. Therefore, there is a need to adopt ‘new’ WDM interventions and approaches which strongly encourage the adoption of water saving technologies (e.g. tap aerators, dual flush toilets, grey water recycling, rainwater harvesting systems or low-flow shower heads). This could lead to significant changes within SA’s urban household water use behaviour and consumption patterns and consequently, a significant reduction in water use and demand in the country.

2.7 CONCLUSION

This chapter presented several theories relating to individual, social, technological and environmental awareness. The relevance of the theories has been further explained in terms of their potential links and applicability to the wider concepts of WDM. The theories, as presented in this chapter, have been focused on advancing an understanding of water use and WDM against the backdrop of national water scarcity and security in SA. Therefore, this chapter provides a context on the key aspects of water demand management and water conservation behaviour as a public management response. These aspects are the key underlying topics that form the research framework for this study. The study findings suggests that it is imperative that all water users (especially domestic users) play an active role in sustainable water use and demand reduction in order to avert an impending future water crisis in SA. Lastly, it is prudent to indicate that the research area of behaviour theory and water conservation behaviour, particularly in relation to WDM, yielded diverse and contradictory findings. This suggests that theories on social and water conservation behaviour are extremely complex in nature. It is also important to indicate that it was very difficult to analyse and discuss the main influencers, drivers and barriers of water conservation behaviour separately or as stand-alone factors as a positive driver of water conservation behaviour can easily become a potential barrier, if implemented ineffectively. The next chapter discusses some of these complexities and nuances, in further detail. Chapter 3 also delves into the main drivers and barriers to water conservation behaviour change and its direct links to WDM at varying scales. The chapter also details some of the key lessons extracted from international experiences and global best practices in terms of the development of effective WDM policy, strategies, instruments and tools.

CHAPTER 3

INTERNATIONAL PERSPECTIVES ON WATER DEMAND MANAGEMENT AND URBAN HOUSEHOLD WATER USE BEHAVIOUR

3.1 INTRODUCTION

A study by Mekonnen and Hoekstra (2016: 1) suggests that globally, around four billion people currently experience severe water scarcity at least once during a twelve-month period, whilst half a billion people face severe water scarcity annually. The predicted global population living in urban areas will increase to 66% of the total population by the year 2050 and similarly, 1.1 billion individuals living in cities will face chronic water shortages by 2050 (Castonguay *et al*. 2018: 19). Similar studies have also suggested that the increase in the overall water demand from households, agriculture, industry, urbanisation, climate change, pollution and changing consumption patterns are posing serious threats to water security (Long and Pijanowski 2017: 503).

In response to some these global water scarcity challenges, this chapter provides a detailed analytical review of academic and non-academic sources of literature directly relating to the topics of global water scarcity; security; water demand management (WDM); policy motivators for effective WDM; drivers and barriers to urban household water conservation behaviour; technologies for water use efficiency; and some reflections on the key linking and enabling mechanisms for effective WDM policy implementation in SA. Furthermore, the review also provides information on international best practice policy, strategies and instruments.

3.2 GLOBAL WATER SCARCITY, SECURITY AND DEMAND MANAGEMENT CHALLENGES

The global community has been concerned about the problems posed by increasing demands on the world's water supply to meet humanitarian, economic, and environmental needs and requirements of climate change-related impacts for the past four decades, primarily under the auspices of the United Nations (UNWWDR 2020: 2).

The Millennium Development Goals (MDGs) established the foundations for the 2030 Agenda for Sustainable Development at the 2002 World Summit on Sustainable Development. In 2015, the MDGs were embraced globally. These worldwide policy frameworks marked a watershed moment in the fight against the globes most serious problems. While the 2030 Agenda recognizes the importance of linking the Sustainable Development Goals (SDGs) in spirit, this integration has yet to materialize, and issues such as mass poverty, inadequate sanitation, degradation of the natural environment, climate change, and disaster risk are still being dealt with in separate silos (UNWWDR 2020: 2).

Within the 2030 Sustainable Development Agenda, water often serves as an unacknowledged but essential connecting factor for reaching the SDGs. Water is essential for basic human needs as described in the SDGs on the human rights to water and sanitation for all (i.e. SDG 6). According to Bahri (2012:11), the world population has approximately reached the 7 billion people count and most people live in urbanised cities. This steady increase in population influxes into cities has placed a major strain on the provision of necessary basic services such as water. Furthermore, industrial, commercial, agricultural and residential usage of water resources has pushed many governments to revisit their water demand policies, strategies and interventions. Water scarcity has become a global issue and is aggravated by deteriorating water quality, compelling many countries to start exploring new WDM approaches and interventions (Meyer 2007: 22). Water scarcity

is defined as ‘the extent to which human needs for water, for both domestic and production purposes, remain unfulfilled in terms of quantity and quality’ (Schreiner *et al*. 2002: 128). Human usage of freshwater resources has increased more than 35 times over the past three centuries and four-fold since 1940 (Meyer 2007: 21). Gallopin (2003:15) points out that the most crucial task in the long-term is to seek the sustainability of the entire socio-ecological system. The interrelatedness of the systems needs to consider both focussing on the elements of sustainable environmental management and the human impact on natural resources, such as water.

Furthermore, the climate has been changing over recent years and it is widely accepted in the current extant literature that this change is impossible to reverse. Moreover, changing climatic conditions have a direct impact on the growing urban population. In support of this notion, Holtzhasen (2006: 17) posits that climatic change impacts on urbanised cities will peak in the next 20 years. It is evident from the review that climate change impacts and a rapidly growing urban population have placed global freshwater resources under significant pressure in many parts of the world. Bates *et al*. (2008: 56) concur by indicating that the global water supply will become even more variable due to rapid urbanisation; the salinisation of ground and surface water resources; and increased variability in precipitation that will be directly due to climate change induced impacts.

Hydrological changes caused by climate change pose a significant threat to community, not just directly through adjustments in the hydro-meteorological processes that control the water cycle, but also indirectly through dangers to power generation, food production, economic progress, and social inequalities (UNWWDR, 2020). Climate variability and change are already affecting five key socio-economic sectors, according to data from the United Nations World Water Development Report (UNWWDR 2020: 12). There is little room for expanding the quantity of water that is used to do irrigation, thus accounting for 69 percent of all withdrawals of freshwater globally, in the face of escalating climate change consequences on water shortages and competing water needs (UNWWDR 2020:

12). While the OECD countries predict a decline in future worldwide irrigation water withdrawals, the UN Food and Agriculture Organization (FAO) forecasts a 5.5 percent increase in irrigation water withdrawals from 2008 to 2050. (Food and Agricultural Organisation, UN Report 2018). There have also been discrepancies in worldwide water demand predictions, highlighting the difficulties of estimating global water demand growth. Water shortages and deficits are expected to limit economic growth during the next twenty years, regardless of future global and, more critically, local demand (WWAP 2016: 23).

As water demand rises in tandem with temperature, global warming will worsen this trend (Gato *et al.* 2007: 365). This will place a burden on water officials to keep supply and demand in check. As a result of the combined effects of growing populations, rising incomes, rapid urbanisation, changing consumption patterns, and expanding cities, water demand, will rapidly escalate in the next 20 to 30 years. Global assessments of the status of water resources and water-related risks have become more challenging because of the need to increase the evidence base to support planning and decision-making. Increasing the global hydrological network for research, monitoring and data collection (e.g. research studies on urban household water use behaviour to reduce water demand) is thus immediately required (UNWWDR 2020: 34). In addition to strengthening global monitoring networks, there is a need to explore the potential of new tools and novel approaches (e.g. participatory research or 'citizen science') in hydrology, water resources and wider ecosystem services management (Buytaert *et al*. 2017: 2). In support of this need for more 'citizen based' knowledge generation, this study has evaluated local perceptions and knowledge of water use behaviour and practices in SA and the City of Durban, and therefore draws direct links from the recommendation of the Buytaert *et al*. (2017) study.

3.3 WATER DEMAND MANAGEMENT: POLICY, STRATEGIES AND INTERVENTIONS: LESSONS FROM INTERNATIONAL EXPERIENCES

Water resources must be wisely managed in order to meet the demands for a steady supply of water for a growing human population, including the water required to produce food (UNWWDR 2020: 45). According to latest UN reports, metropolitan cities currently accommodate 55 percent of the world's population, with that figure expected to rise to 68 percent by 2050, with Asia and Africa accounting for nearly all of the expansion in the next decade (UNDESA 2018). Figure 3.1 shows the global projected rate of urban agglomeration growth by size class, whereas Figure 3.2 shows the global projected percentage of urban agglomeration by 2030.

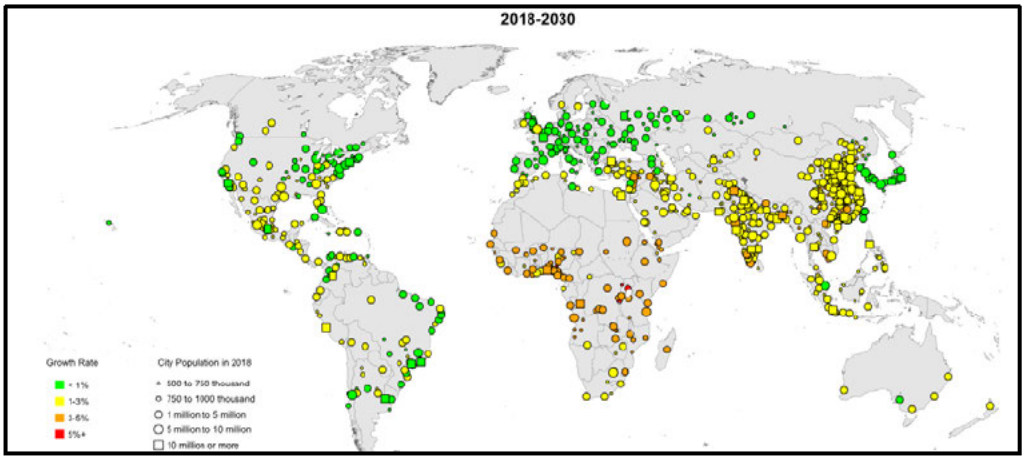

Figure 3.1: Global projection rate of urban agglomeration by size class between 2018 -2030

Source: Adapted from the UN World Urbanisation Prospects Revision (2018)

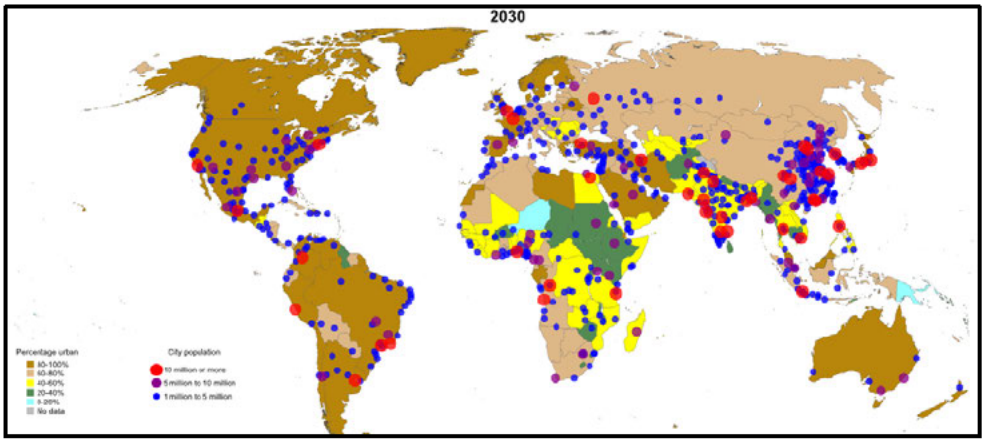

Figure 3.2: Projection percentage of urban agglomeration by 2030

Source: Adapted from the UN World Urbanisation Prospects (2018)

Closer to the South African context and in relation to the water challenges and urbanisation projections within the Southern African Development Community (SADC) region, studies have indicated that the urban population of SADC will exceed 180 million people by 2025. In addition, over half of the SADC countries are projected to become water stressed in that same year or shortly thereafter due to an increase in freshwater abstractions (Gumbo 2004: 1225). In addition, the urban population of SADC countries is expected to reach 50% by 2025, all of which makes effective WDM in the region's urbanised cities extremely crucial (Gumbo 2004: 1225). It is therefore essential that water resources are managed carefully and in an integrated manner. This means that not only must the supply of water for beneficial uses be managed effectively, but so should demand. De Lange (2016: 2) posits that implementing demand-side management strategies and practices is key to bringing about a reduction in water use, which is essential for achieving sustainable development in SA. Particularly in a developing economy context, such as in South Africa and other SADC countries, De Lange (2016: 2) further asserts that demand side management is necessary to prevent the need to develop expensive water supply infrastructure, such as new dams.

Effective WDM requires a combination of the implementation of national and local water conservation legislation, policies and strategies that are co-developed and applied by water supply organisations such as utilities and municipalities.

Furthermore, WDM also incorporates a range of WDM instruments (mechanisms) that can be implemented by utilities, municipalities and by consumers. WDM can be achieved through two mechanisms. The first is to improve the efficiency of water use through various structural provisions – including use of regulation and incentives; providing easy access to water saving technologies to enable water saving and thereby making it possible for consumers to save or use less water. The second mechanism is the curtailment behaviour of consumers (i.e. changes in water use behaviour that bring about an absolute reduction in water use – mandatory water restrictions).

With regard to the key motivators or drivers for WDM, Hoolohan and Brown (2016: 2) posit that motivators for WDM are extremely complex. They suggest that effective WDM is located within business and regulatory practice and is shaped by data, metrics and methods that respond to 'extreme' events. These 'extreme' events are often catalysts for improvements and changes in WDM policies, strategies and interventions. Therefore, the next section of this chapter provides a review of case summaries on motivators for the adoption of WDM from select international countries in respect of key drivers and response interventions. In particular, focus has been placed on providing a review of regulatory or market-based water demand management policies, strategies and instruments as these are considered to be most relevant to this particular study. The section concludes by arguing for the need to realign urban water demand management planning as a multi-dimensional and complex web of interconnecting activities and mechanisms requiring appropriate integration in order to meet its desired intent.

3.3.1 Motivators for the adoption of WDM policies, strategies and interventions

3.3.1.1 United Kingdom (UK)

Studies in the southern regions of England on water use and demand found that the urban population had steadily increased, resulting in an increased demand for urban water consumption. About 40% of water in England and Wales is used to meet domestic water demand. Water infrastructure has been ageing and rainfall patterns have continued to be variable with reduced rainfall (Hoolohan and Browne 2016: 3). In recent years, a combination of factors such as increasing concerns over water security and reflections on assumptions made about water availability and supply have prompted water management authorities to try to balance the water demand and supply sides to ensure water security (Hoolohan and Browne 2016: 4). Household water use efficiency has been the key focus area of the demand management agenda in southern England since 1991, when the Water Industry Act was amended (Water Wise 2015: 2). Domestic household water use has been the main target for WDM interventions by English and Welsh water utilities and local government authorities over the past two decades (Water Wise 2015: 3). Furthermore, amendments to the Water Industry Act in 1991 prompted water service authorities to also ensure that water demand management activities were consumer orientated and the first UK household water use efficiency targets were set in the 2010-2015 planning period (Hoolohan and Browne 2016: 8). As a result, many water utilities and manufacturing companies are now fully engaged in working to deliver against water efficiency targets to reduce water demand across all cities in the UK (Hoolohan and Browne 2016: 9).

3.3.1.2 Spain

A study conducted in the City of Alicante, Spain, indicated that the city has experienced increasing water demand due to tourism, population growth and irrigation-based water use. Conventional water demand policies in Alicante focused mostly on expanding surface water supplies through the provision of reservoirs,

water transfers and ground water sources (March *et al*. 2015: 2065). However, the costs of providing water in Alicante continued to increase, as did the environmental impacts of the large-scale infrastructure that was constructed, coupled with pollution issues in aquifers (March *et al*. 2015: 2065). From the 1980s to the 1990s, water management authorities started shifting focus from the supply side and embraced policies to deal with the demand side (Galan *et al*. 2009:2). This prompted the adoption of an integrated WDM strategy and the implementation of several interventions that were in line with European Water Directives, especially in terms of dealing with drought (Galan *et al*. 2009: 3). The WDM strategy that was adopted also acknowledged that social, economic and other such factors also influence urban water use across Spain. Water awareness campaigns were generally only implemented when drought conditions were being experienced in Spain, but often the campaign efforts did not reach all water users. This presented a challenge to fostering water saving attitudes amongst all household water users. From the City of Alicante's experience, it is acknowledged that there was definitely a shift from supply side to more demand side management approaches. However, Galan *et al*. (2009: 5) indicates that there was considerable room for improvement as water awareness campaigns were only implemented in times of drought and previous consumption patterns resumed after a short period of time.

3.3.1.3 Australia

In south-east Queensland, rapid urbanisation and an increasingly dry climate resulted in water restrictions being instituted by water authorities for unsustainable water use behaviour, especially in urban households. In response, water management authorities developed the Southeast Queensland Water Strategy (SEQWS) to curb unsustainable water use, especially at household level, by promoting water saving strategies whilst also prolonging the need to invest in alternative sources of water supply (Spinks *et al*. 2011:3). From the Australian strategy, there were five key themes that supported and guided the effective delivery of the water demand management policy and strategy, namely communication and education; finance and modelling; technology adoption; leadership; and customer

service. A combination of these strategies has resulted in significant water demand reduction in Queensland, Australia (Spinks *et al*, 2011: 3).

3.3.1.4 United States of America (US)

A study by Frost (2013: 1) describes the comprehensive approach that the US (federal, state and local) authorities adopted to encourage water conservation and water demand management (WCWDM). Water demand had been falling constantly in the US due to actions taken at all levels of the US government. Although these actions largely comprised retrofitting households with water efficient appliances and technologies, the changes occurred within a broader framework of structural WDM provisions (Frost 2013: 2). Several steps were taken at federal, state and local government levels, aligned with non-governmental organisations, private sector and environmental NGOs' (Frost 2013: 4).

Regulatory initiatives for water saving in the USA were in place since the 1980s and 1990s and included, for example, legally mandated standards for water efficient toilets, showerheads and other such water use household appliances. Federal standards for washing machines and tap aerators followed in the 2000s. All of the standards are written into local building codes, which in turn require manufacturers to respond by improving the water efficiency standards and ratings of their appliances and fittings. Also in the US, the worsening drought cycles on the West coast and impacts of climate change contributed to the promulgation of The State of California Water Conservation Act of (2009), which required municipalities to reduce their water consumption by 20% (Frost 2013: 6). The City of Los Angeles is a world leader in water demand management, having developed its WDM policy and strategy in response to the Act, and due to the numerous incidences of drought in the state (Bennett *et al*. 2015: 2). From the US experiences, it is recognised that the co-ordinated national government policy and strategy which was implemented effectively at federal, state and local agencies promoted an effective reduction in overall water use and demand in the US (Frost 2013: 6).

3.3.2 Water Demand Management: Policy, strategies and interventions (Africa and Southern African Development Community (SADC) perspectives)

3.3.2.1 African Union (AU) Agenda 2063

There are several African policy initiatives and frameworks that have currently been developed for the continent. However, the most important policy reviewed, and which was of direct relevance to this particular study, is the African Union Agenda 2063. South Africa is a full member state and has also chaired the union two times over the past two decades. The AU Agenda 2063 is a framework policy which seeks to develop a prosperous Africa based on inclusive growth and sustainable development. Its aspirations include developing an integrated continent which is politically united and based on the ideals of Pan Africanism with the vision of an African renaissance. The policy strongly advocates for an African continent led by good governance, democracy and respect for human rights, justice and the rule of law. The AU Agenda 2063 specifically addresses the linkages between the global SDG's and the AU Agenda in goal 7, which covers the topic of 'environmentally sustainable and climate resilient economies and communities'. This goal directly identifies biodiversity, conservation, sustainable natural resource management, water security, climate resilience and natural disasters preparedness as the top priority areas requiring action in Africa. The AU Agenda goals links with the SDGs as direct policy responses to achieving the goals of SDG's 6, 7,13 and 15.

3.3.2.2 South African Development Community

Strategies to manage and reduce water consumption at the household level and beyond are essentially combinations of various mechanisms or instruments that national governments, municipalities and water utilities use to manage water demand. Gumbo (2004: 1230) states that it is important to have a clear WDM policy and strategy endorsed by the responsible authorities, water utilities, customers and politicians, and must be framed within the context of a comprehensive national WDM policy. Gumbo (2004: 1230) further suggests that the slogan for a successful WDM plan should be "to measure is to know", emphasising the importance of conducting

water use audits. The Gumbo (2004) study includes examples and criteria for successful and unsuccessful city-level WDM implementation in several SADC cities. The study looked at WDM practices in the cities of Windhoek (Namibia), Maseru (Lesotho), Johannesburg and Hermanus (South Africa), Lusaka (Zambia), Maputo (Mozambique), Bulawayo and Mutare (Zimbabwe). The country selection criteria was simple: focus was placed on cities with readily available WDM data and information while maintaining a geographical spread across the SADC region partner states (Gumbo 2004: 1227).

The study's findings show that there are similarities and differences in the application of WDM in SADC cities. Windhoek, Bulawayo, and Hermanus all had significant successes in WDM, which can be roughly measured as a percentage of where: excessive consumption was detected early; water supply infrastructure was maintained to minimize water losses; waste water was re-used and recycled; new developments were planned appropriately with water demand in mind; and the informed prioritisation of smart metering systems was developed and implemented in times of drought (Gumbo 2004: 1230). It was also noted that the cities which invested in water awareness campaigns, customer education, NRW water loss projects, smart metering of consumers, water efficiency standards, informative billing and implementing latest billing management information systems, contributed significantly to improving overall WDM performance (Gumbo 2004: 1230). Through the adoption of water saving devices, the cities of Bulawayo, Hermanus, and Windhoek were also able to reduce their gross unaccounted-for-water (UAW) to under 20%. (e.g. increasing profitability or percentage of billed revenues that were collected for water supply areas). A specific dedicated WDM department was established to implement WDM measures in the cities of Bulawayo, Hermanus, Johannesburg, and Windhoek. The establishment of such a unit, as well as the city's continuous financial support for its continued operation, demonstrated the city's commitment to water demand–side management (Gumbo 2004: 1229). The study's conclusion clearly advocates that WDM can be utilized to solve water equality and access issues by introducing indigent rates and enhancing water access and service levels, for example. African and SADC cities should not lose out on this opportunity (Gumbo 2004: 1230).

To sum up this section on international, Africa and SADC WDM policies and strategies, Table 3.1 presents a summary of the various country reviews presented above. The table also reflects the contents of the various WDM policies, strategies and interventions implemented across the different countries and provides commentary from the researcher as well.

Table 3.1: Summary of international experiences in WDM policy, plans and strategies

Country	Governance structure / Level of Government	Key contents of WDM interventions	Researcher comments and insights
United Kingdom	Southeast England	• Sustainable Water Management Plan • Enhanced Capital Allowance (ECA)	**Sustainable Water Management Plan** The plan was developed to reduce a 1.5 billion litre daily deficit. Instruments that were adopted included the use of a domestic benchmarking system as an indicator of water used per person and the specific time periods. Benchmarks and set targets were assessed in terms of sustainable water use performance. In the UK, the success of benchmarking

			targets was based on the adoption of technology rather than water use. **Enhanced Capital Allowance** - provides incentives to the manufacturing sector to encourage the sector to manufacture water saving and high efficiency appliances.
Spain	Alicante Province	• Alicante National Hydrological Plan • EU Water Framework Directive • Nitrates Directive	**Hydrological Plan** Plan responds to increasing water demand that could be addressed by transferring water from the Ebro basin to the Levante basin but will likely result in major environmental degradation which is irreversible. The **EU Water Framework Directive** was developed to expand aquifer

			protection over all waters and defines a mandatory compliance objective to reach a ‘good condition of water state’. It also promotes the use of economic and demand management tools as opposed to an increase in the further abstraction of available water resources in order to avoid waste and reduce environmental degradation. **Nitrates Directive** Adopted to protect water quality by preventing **nitrates** from agricultural sources polluting ground and surface waters and by promoting the use of good farming practices.

Australia	Queensland	Queensland City Council Water Demand Management Strategy 2015-2025	There are five key themes that support and guide the delivery of the water demand management strategy in southeast Queensland, namely: communication and education; finance and modelling; technology adoption; leadership; and customer service.
US	New York City - New York City Department of Environmental Protection (DEP)	Water Demand Management Plan	The near-term goals of the NYC DEP are to reduce demand by 50 million gallons per day. They adopted a five-pronged strategy: 1.Municipal Water Efficiency Program 2.Residential Water Efficiency Program

			3.Non-Residential Water Efficiency Program 4.Water Distribution System Optimisation 5.Water Supply Shortage Management Extremely successful strategy with its focussed sub-programmes and has contributed to significant water savings and demand reduction in NYC. Several parallels can be drawn to the SA policy and strategy context in terms of current WDM practices and interventions.

Africa/Southern African Development Community (SADC)	Windhoek (Namibia) (WH); Johannesburg (JHB) and Hermanus (HM) (South Africa); Bulawayo (BL) (Zimbabwe).	WDM strategy (WH, JHB, BL) WDM policy (WH, JHB, HM) WDM legislation (WH, JHB, HM) WDM education and awareness programme (WH, JHB, HM, BL)	Several key successful WDM instruments and activities identified: • Early detection of excessive consumption, • Regular maintenance of water supply infrastructure to minimise water losses, • Wastewater reuse, and • Smart metering systems. It was also noted that the best WDM performing cities invested in water awareness campaigns, consumer education, water loss management projects and individual metering of consumers. The cities of Bulawayo, Hermanus and Windhoek managed to

			reduce their gross unaccounted-for-water (UAW) to less than 20% through commercialisation instruments. This contributed significantly to improving overall WDM performance.

3.4 WATER DEMAND MANAGEMENT: INSTRUMENTS AND INTERVENTIONS

From the analytical literature review undertaken for this study, several WDM instruments/interventions, drivers and barriers to urban household water use behaviour, as well as technologies for water use efficiency, were identified. A discussion of these various topics is provided in the section that follows and Figure 3.3 illustrates a representation of the various WDM instruments, drivers and technologies that have been discussed. Figure 3.3 also importantly reflects the key enablers and linking mechanisms for effective WDM policies in SA.

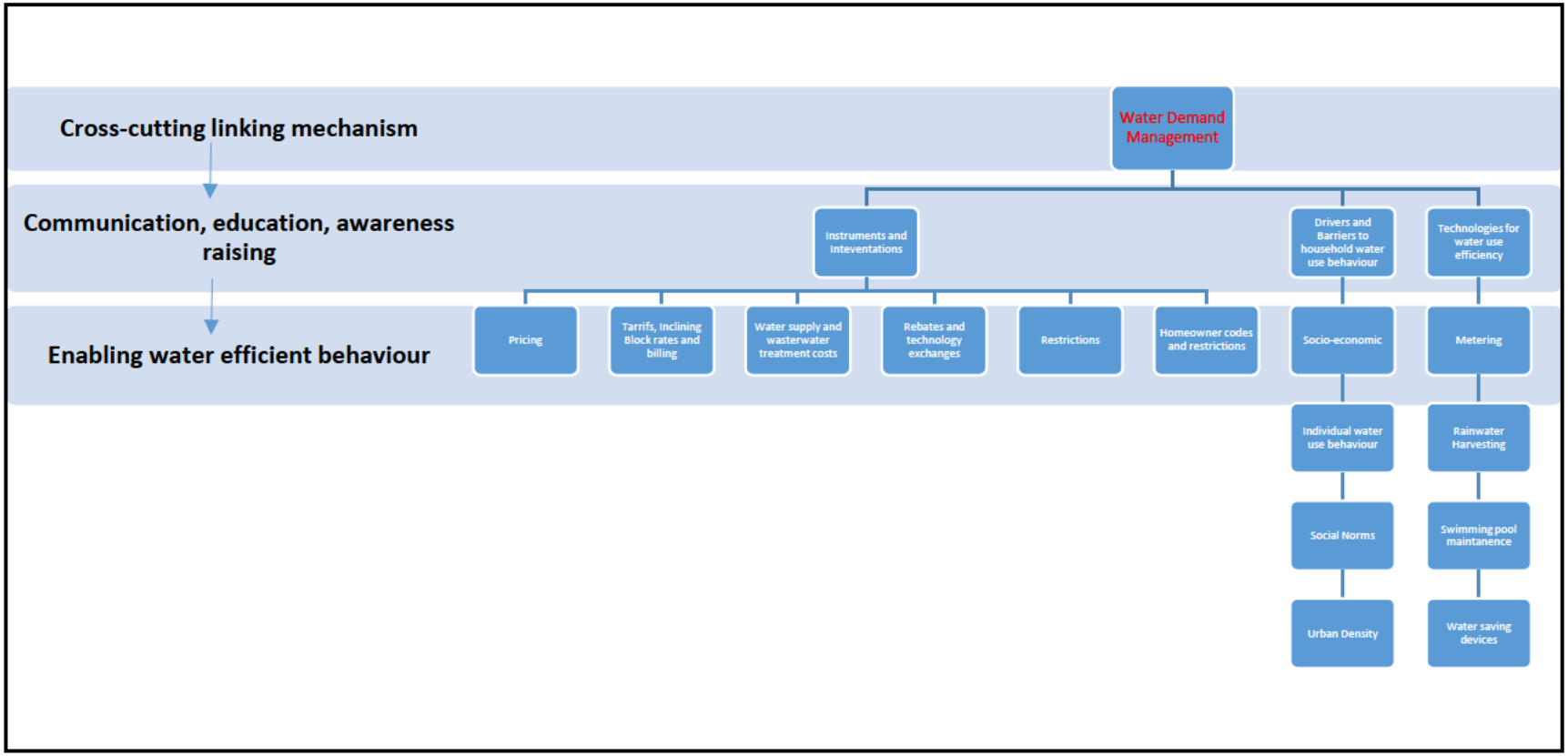

Figure 3.3: Instruments, drivers, barriers and technologies for effective water demand management

Source: Self-generated by the author (2022)

3.4.1 Pricing mechanisms and incentives

Hassell and Cary (2007: 5) suggest financially rewarding consumers with rewards for adopting a particular environmental behaviour or product. These rewards could also include credibility gain, which could help to motivate domestic or business-based water consumers to adopt water-saving behaviours and products in order to increase their levels of societal acceptability. Water pricing and billing can be used as a good example of an effective financial instrument to promote water conservation behaviour (Hassell and Cary 2007: 5).

However, the effectiveness of such economic instruments varies from one country and context to the next. Several authors argue that pricing is an effective WDM instrument for reductions in demand, whilst others argue that non-price related mechanisms are more effective (Willis *et al*. 2011: 1997; Worthington and Hoffman 2008: 1467; Darbandsari *et al*. 2017: 51). Authors have also suggested that using increased pricing to suppress demand can be punitive for the poorest of the poor (Muller *et al*. 2009: 5). According to Llausàs and Saurí (2017: 377), many researchers have incorrectly assumed that higher water prices will lead to a direct reduction in water demand. Although this assumption has been questioned by a number of authors and for a variety of reasons, it nonetheless seems to be valid and true for seasonal outdoor water uses. Moreover, it has been found that water pricing, together with certain effective rising water use tariff structures, can be extremely effective at controlling water demand (Renwick and Green 2000: 37). However, pricing alone is generally insufficient to persuade consumers to save lots of water (Partner 2012: 8). Pricing alone is not strong enough as leverage for changing water use behaviour in the water crisis that the world finds itself currently experiencing. Several other measures and interventions must be put in place, such as raising awareness through campaigns on saving water or installing smart meters and even seasonal bans on non-priority water uses such as filling up swimming pools, irrigating gardens and lawns or washing cars (Partner 2012: 8).

3.4.2 Tariffing, inclining block rates and billing

Frost (2013: 13) posits that stepped tariffs per volume of water used and even higher rates charged during times of drought, as has been applied in the States of California and Colorado in the US, have significant potential to reduce urban water demand. In their analysis of market-based (financial) and mandatory measures such as restrictions, Olmstead and Stavins (2009) found that price-based mechanisms were generally more effective. Maggioni (2014: 126) further suggests that increasing block rates or seasonal rates can also be a source of additional revenue for water utilities – and that these funds can then be used for beneficial uses in the community (e.g. improvements in infrastructure and services or climate change mitigation). Although water prices are considered to be very low in Zimbabwe for example, applying rising block tariffs enabled everyone to access some water while encouraging higher water users to use less water (Maggioni 2014: 126). Cities in Morocco have also had substantial success in demand reduction using a rising block tariff systems together with the rigorous implementation and monitoring of smart water meters (Partner 2012:10).

3.4.3 Linking water supply and wastewater treatment costs in billing

Lawton *et al*. (2008: 2) found that consumers who installed greywater re-use systems had their wastewater treatment charges offset against their costs for potable water in Auckland, New Zealand. Charges for wastewater treatment are tied to the amount of water used by a particular household. This resulted in less water use and reduced demand. The installation of a greywater and rainwater harvesting system at households also enabled further cost offsets to residents' bills (Lawton *et al*. 2008: 2).

3.4.4 Rebates and technology exchanges

Maggioni (2015: 12) asserts that subsidies and rebates for the installation of water saving technologies (e.g. retrofitting showers and toilets with low-flow toilets, low-flow shower heads and tap aerators) have been extremely effective in southern California's water demand management interventions. In another similar study in Florida USA, Lee *et al*. (2011: 3) found that rebates for installing water saving technologies brought about a significant reduction in water demand in southern California. However, unfortunately users did not maintain their lower levels of water use over time.

3.4.5 Water restrictions

Bennet *et al*. (2015: 5) and other authors have noted that prohibitions or water restrictions on lawn watering, car washing and filling swimming pools, or reducing the amount of water used in these activities, can significantly reduce water demand (Lawton *et al*., 2008; Dela Cruz and Gray 2012). However, restrictions are usually difficult to sustain and only effective for a short period of time (Maggioni 2015: 3). They also require intensive compliance monitoring (Datta *et al*. 2015: 9). In the US, the effectiveness of outdoor water use restrictions was found to vary across different classes of users, categorised according to whether the volumes of water they used was high, middle or low (rather than a socio-demographic classification) (Kenney *et al*. 2008: 1752). The greatest reductions in use were found amongst users of high initial water use volumes that were identified during the period of water restrictions being in place (Kenney *et al*. 2008:1752).

3.4.6 Home-owner codes and restrictions

Turner and Ibes (2011: 1167) discuss the efficacy and potential for homeowner organisations in controlling landscaping and gardening practices as a way to manage and reduce water demand. This was applied by private co-operative organisations such as home-owner associations (equivalent to body corporates in SA) in the US. As a governance structure, homeowner associations were intermediaries between water utilities and local authorities and consumers. They exercised an additional and directed (hands-on) level of WDM practice with the development and adoption of their own landscaping and water codes, as well as restrictions on water use for certain activities. However, despite the potential of these organisations to control water consumption and demand, Turner and Ibes warn that, depending on variability in geographical and social contexts, the influence of these homeowner associations, can vary significantly (Turner and Ibes 2011: 1170). Importantly, the potential does remain to use similar types of organisations to exercise an additional level of control of water consumption and thereby reducing water demand (Turner and Ibes 2011: 1172).

3.5 WATER DEMAND MANAGEMENT: DRIVERS AND BARRIERS TO URBAN HOUSEHOLD WATER CONSERVATION BEHAVIOUR

Effective WDM needs to address both structural and human behavioural mechanisms to regulate water consumption in order to be effective (Kayaga and Smout 2008: 1). Structural mechanisms are mechanisms employed by governments, water utilities and other organisational entities to manage demand and they are essentially the various regulatory structures and mechanisms that manage water consumption (Russell and Fielding 2010: 1). Technological changes enhance the efficiency of water use by installing fixtures and appliances such as tap aerators or smart water meters. Behavioural change, on the other hand, consists of

the practices and actions that reduce direct individual water use, such as a reduced frequency of toilet flushes and limited showering time (Russell and Fielding 2010: 3). Behavioural change is a key element of WDM policy and strategies, which are likely to be more effective if they are able to influence a community or household attitudes and behaviours (Turner 2006: 23). The next section discusses a few key 'drivers of and barriers to' urban household water conservation behaviour adoption. From the review conducted of available extant literature, it is prudent to indicate that it was very difficult to discuss some of these drivers and barriers independently of each other as a positive driver of water conservation behaviour change could easily become a (negative) barrier to water demand management, if implemented incorrectly. It is also important to highlight that the various studies reviewed on the topics of WDM, and urban household water conservation behaviour often yielded contradictory findings. This suggested that understanding WDM and water conservation behaviour is a complex area of social science research.

3.5.1 Socio-demographic factors

Studies on the causal relationship between socio-demographic characteristics and water conservation behaviour have produced a variety of contradicting results. Hamilton (1983), Berk *et al.* (1993), and De Oliver (1999) are three prominent studies in this area, all of which looked at characteristics like political affiliation, income, tenancy, family size, education, and dwelling type. Berk *et al.* (1993) found a positive relationship linking income and water conservation, whereas De Oliver (1999) found an inverse relationship for income, as well as an inverse relationship between education levels and water conservation. Water conservation practices were generally related with individuals in higher income categories, according to Hines *et al.* (1987). Russell and Fielding (2010) support this conclusion, claiming that there is a clear and direct association between water conservation behaviour and income levels, with conservation behaviour being more widespread in higher-income households (Russel and Fielding 2010: 3). De Oliver (1999), Hamilton (1983), and Berk et al. (1993), all agree that people who are more politically liberal, had smaller families, and own their homes, conserve water more.

It has been proposed that households that are more ecologically conscious and involved in conservation efforts consume less water. Water-wise behaviour includes things like planting less water-intensive plants in the garden and using other outdoor water-saving strategies (Domene and Sauri 2006: 1610). Other studies have also found that people with a higher level of education are more aware of their water use behaviour and are more diligent about applying conservation practices (Syme, *et al*. 2000; Hurd 2006; Worthington and Hoffman 2008). This can be contrasted with lower levels of education, which may result in wasteful water behaviour as consumers have restricted knowledge about the hydrological cycle and perceive water to be an abundant resource that is always available on tap (Gillins 2015: 10). However, the link between a higher level of education and water conservation is not as straightforward as it may seem at first glance and a higher consciousness about the need to conserve water seldom actually results in water saving practices as agreed to by many authors (Gregory and Di Leo 2003; Hassell and Cary 2007; Miller and Buys, 2008).

In relation to household water consumption based on the age of household members themselves, shower frequency, time and length can be used as key indicators to understand household water use behaviour. Studies have not been conclusive in attributing age to water consumption patterns as humans are complex social beings. A study in Australia noted that families with teenage and young children were amongst the highest water users (Troy and Randolph 2006: 441). Male adults and children, on the other hand, had shorter showers than female adults, according to research conducted in Greece and Poland. Teenagers in the Greek and Polish study also took fewer showers per week than adults, which is contrary to what the previous authors suggest (Beal and Stewart 2011; Makki 2011).

3.5.2 Individual water use behaviour

When studying the causal links between socio-demographic factors and water conservation behaviour, it is important to consider the individuals who form part of

a household, as water conservation behaviour is dynamic and variable, even within the same household (Domene and Sauri 2006: 1606). For example, some people within a household will only take action if they believe that others in their household or their community are doing so too. Whilst others might believe that engaging in curtailment activities is more effective than installing water saving and efficient technologies. Yet others might have negative beliefs about the need for conserving water at all. Therefore, WDM policies, plans, strategies and interventions must be informed and targeted towards determining the public attitudes, perceptions and beliefs of a range of water consumers (Russell and Fielding 2010: 15). Looking at the individual water user, Russell and Fielding further state that many researchers have found that water conservation behaviour may relate more directly to the stages of people's lives and what is happening in their life at a specific point in time, than age or education levels *per se* (Russell and Fielding, 2010:14). Dela Cruz and Gray (2012: 1810) refer to the importance of considering personal characteristics (such as subjective norms, behavioural control and attitude towards a behaviour) and ethical positions such as environmental values and conservation attitudes when studying water conservation behaviour. Specific ideas regarding water and its availability, rather than broad environmental attitudes, are important, according to Corral-Verdugo (2003), which may contribute to turning intentions into actions. Habits or routine behaviours in terms of water use are also important and can be both positive and negative (Gregory and di Leo, 2003; Russell and Fielding 2010), and the force of habit can make people resist even the most strenuous influences by others to change their water use behaviour. Another important personal trait is the institutional trust that people have in a water authority or utility, with people evidently first wanting to see that water supply authorities are doing everything they can to conserve water before residents are expected to do the same (Dela Cruz and Gray 2012: 1811). Additional important personal factors are people's comfort levels (e.g. the importance that people attribute to personal hygiene) and people's belief in the right to an unlimited supply of water that should not be curtailed (Koutiva 2017: 314). The idea of 'consumption without limits' is often inadvertently supported by supply side strategies such as, new dams, desalination or wastewater re-use. While these technology interventions are potentially crucial and even lifesaving for the residents of some global cities that are facing water shortages, unfortunately they also create the false impression that an unlimited supply of freshwater can continue

to be made available, without any impacts on water consumers or any need for them to change their water use behaviour (Bell 2015: 2).

A further focus on the individual water user leads into a discussion on socially conscious consumer behaviour. Interestingly, socially conscious consumer behaviour does not necessarily mean consuming less, but rather relates to socially conscious purchasing of 'green' products as opposed to unsustainable products or practices (Russell and Fielding 2010: 15). Frugal consumer behaviour, on the other hand, refers to the adoption of more frugal ways of living and a positive attitude towards frugality. While frugality may be valued and collectively facilitated in alternative consumption communities, there is still a long way to go before the same can be said for mainstream consumerist communities, with their associated reliance on consumption for the fulfilment of various social and psychological goals (Pepper 2009: 136). Related to frugality, De Oliver (1999: 394) posits that the intrinsic satisfaction is deemed as an enjoyable experience, which people may start to associate with a conservation behaviour, rather than associating this behaviour with benefits to the environment. In relation to water conservation behaviour, frugal consumer behaviour in all aspects of life is very likely to translate to more careful and wise water use, whereas this could (but may not necessarily) be the case for socially conscious consumer behaviour.

Lastly, in investigating the behaviour of the individual to water conservation, it is important to reflect on the factors that can turn an intention to conserve water into an action. It has been argued by many researchers that when an individual has a positive attitude towards water conservation; where social pressure or a moral obligation exists; and where it is perceived as relatively easy and possible to take a certain conservation action, then an intention can become an action (Russell and Fielding 2010: 16). Armitage and Connor (1999: 54) also speak of the importance of 'specific' water conservation related attitudes that are directly linked to a specific behaviour in order for intentions to be translated into actions. The example in their study focused on understanding attitudes towards the installation of rainwater tanks and how to use that collected water sparingly, rather than a general altruistic attitude

towards water conservation behaviour. The ability of individuals to develop positive attitudes towards ‘specific’ water conservation actions should therefore be seen as an important input and outcome for any successful WDM policy, strategy, plan or intervention (Russell and Fielding 2010: 15).

3.5.3 Social norms

Social norms are important factors when it comes to water conservation behaviour, and they symbolise the pressure of moral obligation (Russell and Fielding 2010: 8). Such norms can encourage people to either conserve water or to continue using water wastefully. In order to promote positive water conservation behaviour at the level of society or a community, it is important to develop a shared identity with a common interest to conserve water (Russell and Fielding 2010: 1). In terms positive water use behavior, it's worth mentioning the concept of social desirability, which is defined as the degree to which people believe they should act in ways that others will find also appealing. An example of social desirability is contained in the study by Corral-Verdugo *et al*. (2012) in Mexico, which showed that people often model their water use behaviour on the perceived behaviour of their neighbours and want to be seen to be complying with the water conservation targets and requirements set by local water utilities (Corral-Verdugo 2012: 247).

However, social norms can also encourage undesirable water use behaviour. For example, people can use the perceived excessive or wasteful use of water by others as an excuse to justify their own wasteful use as well. Furthermore, social norms often make it difficult for positive environmental behaviour to be adopted. Several behavioural theories have confirmed that individual behaviour is shaped by the society in which it exists (Troy and Randolph 2006: 9). The study by Troy and Randolph (2006) found that wasteful household members were not socialised to conserve water when they were growing up and therefore don’t feel the need or desire to save water at all (Troy and Randolph 2006: 9).

3.5.4 Urban density

Domene and Saurí (2006); Breyer *et al*. (2012); and Giner *et al*. (2013) suggest that a connection exists between urban density and water consumption in many parts of the world. Lower urban densities create the opportunity for people to reside on larger plots of land, which may lead to higher levels of per capita water consumption. For instance the presence of large swimming pools and irrigation of larger yards for gardens and vegetation (Garcia *et al*. 2013: 54). It has also been established that if homeowners place considerable value on their lawns and gardens, this can result in much higher levels of water consumption (Gregory and Di Leo 2003: 1816). These findings illustrate the complexity of the link between income and water conservation and shows that a higher income does not necessarily result in more water-wise behaviour, but that additional drivers, factors and influences are also required for high income water users to practice water conservation in order to reduce water demand.

3.6 WATER DEMAND MANAGEMENT: TECHNOLOGIES FOR WATER USE EFFICIENCY

3.6.1 (Smart) Water metering

Lawton *et al*. (2008:2) posit that water metering was a crucial instrument for demand management in New Zealand. Bell (2015) further states that smart water metering in the UK had resulted in a 10% to 15% drop in water demand, with 50% of households having pre-paid smart water meters installed (Bell 2015: 28). Effective water metering allows consumers to measure how much water they consume and pay for, real time. This system means that people can meet their basic water needs at a relatively low and controlled cost, whilst also penalising high-volume water users. Another water metering measure implemented was to change outdated tariff

billing models/systems to allow public utilities to charge more during droughts, thereby disincentivizing families from excessive water use. Smart water metering can establish a relationship between water consumption, water costs and household consumer behaviour. As a demand management intervention, it is anticipated that consumers will behave rationally and respond to more information about their direct water use, including pricing signals (Bell 2015: 18). While such a philosophy can be considered uncontroversial and compatible with much of engineering systems thinking, Bell (2015: 28) state that it does not account for the numerous complex and diverse behavioural factors that also influence the way in which people consume water.

3.6.2 Rainwater harvesting systems

Rainwater harvesting is one specialized and relatively new technology approach for WDM. Rainwater harvesting systems and water re-use is the collection of run-off that is stored in various ways to minimize evaporation and improve water supply. According to Kahinda et al (2010), if rainwater harvesting is implemented properly, it will save a significant amount of money and, more crucially, water in South Africa. The primary goal of this intervention is to collect rainwater from as many buildings as possible with considerable surface run-off roof areas. Rainwater harvesting, according to Buckle *et al.* (2002: 3), has numerous advantages, including providing water supply in urban locations thereby reducing municipal water reliance and lowering costs. Kahinda *et al.* (2010) also studied the rural environment in South Africa, where areas are placed in poor hydro-geological and topographical conditions and assert that rainwater gathering and re-use is a demand management strategy that should be seen as a feasible alternative water source supply option and could serve well as buffers against the effects of climate change and drought (Kahinda *et al.* 2010: 742).

3.6.3 Swimming pool maintenance

Siebrits (2012) as cited by Fisher-Jeffes *et al.* (2015) evaluated the influence of domestic swimming pools on water consumption in the City of Cape Town. Swimming pools increased household water use by 37.4 percent, or 8.85 kl on average each year, according to a study by Siebrits (2012). The findings of Siebrits (2012) are especially relevant in the wealthier suburbs of a city like Cape Town, where around 35% of residences have self-owned swimming pools. Fisher-Jeffes *et al.* (2015: 1) assert that using water in a "fit for purpose" manner (e.g., not using potable water to fill swimming pools or irrigating lawns) can help to defer more drastic and costly interventions like large-scale dams and desalination plants in South Africa. The study suggests use of pool covers to prevent surface water evaporation, adding advanced water filter recycling systems, and filling swimming pools with non-potable sources of water such as rainwater harvested or groundwater. These measures, when combined with limitations prohibiting the use of municipal water to supplement swimming pools (particularly during droughts), can dramatically reduce water demand at the urban household level.

3.6.4 Water efficient technologies and devices

The implementation of well-designed and appropriate household water saving technologies/devices resulted in a considerable water demand decrease in Florida, according to a study by Lee *et al.* (2011). From the study's findings, widespread adoption of devices such as smart water meters, low-flow showerheads and dual flush toilets, resulted in significant reductions in water demand (Lee *et al.* 2011: 6). Low-flow shower roses, dual flush toilets, toilet dams, water pressure limiting devices, tap aerators, and other such available technologies provided dynamic feedback to consumers on their water use consumption patterns and were all found to reduce water consumption, up to 35–50 percent in Australian cities (Inman and Jeffrey (2006: 143). Russell and Fielding (2010: 13) also mention the use of toilet cistern water displacement devices in their Australian study.

In another study done by Stewart *et al*. (2013) in Australia, the authors found residential households conserving water by engaging in more water-wise behaviour when showering and demonstrated a 27% reduction in shower volumes shortly after the implementation of shower monitors (Stewart *et al*. 2013: 710). These socio-technical infrastructure and devices have helped organise and structure water conservation practices more effectively across Australia (Stewart *et al*. 2013: 711). In this regard, it is important to note that the uptake and continued use of latest technologies depends on how well they fit into the lives of people on a daily and routine basis. Human beings are more inclined to use technologies that are efficient and easy to use, rather than those that are too technical and cumbersome to operate.

In a UK based study, the labelling of technologies as 'water use efficient' were also found to be an important method of allowing consumers to take mental account of water use efficiencies in such devices when making new purchases. However, according to Bell (2015: 28), one of the main barriers in terms of the widespread adoption of water efficient technologies, was that almost all current devices, appliances and household fittings have been designed in line with a promise of an 'endless supply of freshwater on tap', as embodied in 'big water' engineering systems thinking. Such thinking further translates to social and political support towards adopting policy responses of constructing new large-scale dams.

3.7 WATER DEMAND MANAGEMENT: LINKING AND ENABLING MECHANISMS

3.7.1 Communication, education, raising awareness and information

In many countries, water users are not aware of the true and total costs of water production and use (Russell and Fielding 2010: 2). This not only demonstrates that

water is commonly under-valued, but also directly points to the deeply entrenched human disconnect from nature, which presents a barrier to adopting water conservation behaviour. Another significant barrier to water conservation behaviour is a general lack of knowledge about even the most basic information about water, such as where the water in one's house comes from (Gregory and Di Leo 2003: 1820).

It is for the above-mentioned reasons that awareness raising campaigns regarding the importance of water conservation are considered critical, particularly in water scarce environments and countries like SA and Durban. The information needs of water users should generally include data on natural environmental water cycles and how water is affected by urban water management systems, as well as information on sources of urban water and the infrastructure that is needed to supply potable water to and remove wastewater from urban households (Department of Sustainability and Environment, 2005). Another useful line of awareness-raising is around communicating the threats that water shortages or pollution present to the population, which may lead to people adopting more water-wise behaviour (Perren and Yang 2015: 1454). When it comes to awareness raising, it is important for water users to actively engage with the information and to feel empowered and motivated by it (Perren and Yang 2015: 1454). There are several good examples of communication around water use practices that have been studied globally. In Los Angeles, USA, the Department of Water and Power has a dedicated online consumer engagement platform through which real-time communication with consumers can take place (Bennett *et al*. 2015: 5).

Moreover, an important question arises, which is the selection of the most appropriate communication platform (e.g. radio, television, social media). Here it is important to keep in mind that due to technological advancements in the last decade, with the boom in online social networking, the general public now has access to a wider range of communication channels (Smye *et al*. 2000: 539). Hassel and Cary (2007:5) suggest that locally - based social marketing content is a key communication intervention that can be used to change social norms and

community water use behaviour. At that level, it should start by providing an understanding of the barriers to behavioural change and draw on social psychological interventions to overcome the identified barriers (e.g. commitments, prompts and signals). Prevailing social norms can also be changed by public displays of the desired environmental behaviour. A study in Santa Cruz, USA, showed that public displays of people modelling a water saving action of turning off the water when soaping managed to change the prevailing social norm as the number of people who adopted this behaviour increased from 6% to 67% (Mackenzie-Mohr and Smith 1999: 15). Also in the USA, a study in Los Angeles indicated that adding water saving information and explanations of how water is priced to the utility bills of consumers improved water consumption knowledge levels (Bennett *et al*, 2015: 30). Furthermore, online communication and co-operation between consumers provided the opportunity to share knowledge and information, as well as for "moral persuasion" between members of a community, leading to a sense of ownership of the challenges and need for water conservation (Bennett *et al*. 2015: 31).

In another study by Aisbett and Steinhauser (2014), they suggest that voluntary environmental awareness programmes such as information campaigns that can be used in combination with other policies such as mandatory outdoor water use restrictions or water price increases, particularly in times of increased levels of water scarcity/drought, are extremely effective (Aisbett and Steinhauser 2014: 185). The authors further suggest that it is important to also document consumers' responses to environmental information from sources other than information from awareness raising campaigns (Aisbett and Steinhauser, 2014: 185). Furthermore, the authors assert that information campaigns generally have limited success in reducing water use and only have a small demand reduction effect, over time. They have also been found to have no lasting effect on long-term water use behaviour. Consumers who have been provided with information often revert to their prior water use behaviours after a period of time. This phenomenon has also been observed by a number of other authors, such as Campbell *et al*. (2004); Sofoulis (2005); Robbins (2007); Larson *et al*. (2013) and Llausàs and Saurí (2017).

Willis *et al.* (2011: 2009) in Australia discovered that knowledge of water management and awareness of water scarcity and over-consumption can have potentially positive effects on household water conservation attitudes and behaviours. Water management authorities and governments can leverage the link between water shortage knowledge and conservation attitudes to adopt a rhetoric of exceptionality and urgency to promote household water conservation and justify changes in water pricing and restriction laws (Willis *et al.* 2011: 2009).

3.7.2 Enabling water efficient behaviour

Dela Cruz and Gray (2012: 15) assert that consumers must have access to water efficient technologies if they are expected to reduce water use. Water saving devices should be available for purchase in retail outlets or supported for adoption by local authorities or water utilities. Experiences in several US cities have shown that where different demand management interventions have been combined, a greater reduction in demand was achieved as opposed to where single interventions were used on their own. For example, annual water rate increases were added to public information campaigns together with legally mandated restrictions, and these were found to perform better in demand reduction than any single one of the WDM policy or strategies on its own (Frost 2013: 5). The study also indicated that when interventions in consumer water demand were combined with municipal actions such as campaigns to repair leaks and maintain infrastructure in the supply reticulation system, water efficient plants being used in municipal parks and along highways/roads, then significant water savings were achieved (Frost 2013: 6). In the USA, the combination of several water demand approaches, and interventions has promoted a cultural behavioural shift, whereby saving water has become an ethical practice and in so doing, a gradual but constant decrease in demand was achieved (Frost 2013: 6). Similar experiences have also been recorded by Willis *et al*. (2010: 2009) for Australian residential water demand, whereby a combination of water metering, water restrictions and the widespread adoption of water efficient devices, behaviour change instruments and education campaigns were all combined together to reduce Australian water demand.

3.8 CONCLUSION

Increasingly, both current urban water infrastructure and technologies, as well as water use practices and culture, are in need of social and political reform. Such reform can be described as the need for a more ecologically sensible and socially just approach to water use in South African urban cities in order to question the deeply entrenched 'normal or current' practices and social norms in public and private life in terms of water use. What is further required is a move away from traditional consumerist and capitalist approaches to water supply and demand management, towards approaches which are based on sustainability and co-operative partnerships (De Lange 2016: 5). This needs to work concurrently with a general shift in focus away from material water consumption towards a greater emphasis on meeting non-material basic human needs. Regarding indoor water use in particular, a further paradigm shift is required to currently accepted intimate practices, habits and expectations linked to personal hygiene and cleanliness that demand high volumes of water, such water uses may need to be re-negotiated in future, if less water is available for domestic needs (Shove 2010: 50).

Increased ecological sensitivity and social justice are needed in terms of effective WDM if one wants to truly address the growing present-day challenges of urban water shortages, climate change uncertainties, rapid urban population growth and the persistent failure to deliver water and sanitation services to the global urban living poor. Implementing this requires radical social and political reform, which is a difficult task given the magnitude and capital intensity of replacing current water infrastructure that has been firmly entrenched into a modern consumerist society. However, this is something that needs to be achieved as current water services infrastructure are increasingly proving to be unable to address both current and future urban water demand projections and basic human needs.

Regarding WDM policy, strategies and planning, in particular, most authors suggest that it is not effective to develop a single catch-all WDM strategy for all water consumers in a particular municipality or city due to the variability of households in terms of income level, type of dwelling, level of education and the behaviour of household members themselves. Households will have different attitudes, beliefs, habits and capacity to implement water conservation behaviour, and it is these nuances that the developers and implementers of WDM policies and strategies need to take into consideration. One way of diversifying these strategies is through increased education and awareness-raising of the sensitivities associated with managing the water demand expectations of a wide variety of demographic and socio-cultural profiles of urban dwellers living within a particular city. A key focus area in terms of such education and awareness raising campaigns should therefore be tailored 'fit for purpose' interventions aimed at ensuring widespread adoption of sustainable water use behaviour practices.

It may also be appropriate to delegate some WDM responsibilities to more localised levels of governance by integrating bylaws, codes, measures and instruments into the practices of local neighbourhoods and/or homeowner/body corporates type associations. In this regard, an important research gap exists in terms of understanding the potential impact that such community-based initiatives may have on behavioural change in support of improved water conservation and demand management.

Interestingly, the current literature on WDM and urban household water use behaviour places a strong focus on reducing discretionary uses of water or reducing water wastage and increasing the efficiency of water use appliances and devices. Outdoor water consumption, such as watering gardens, filling swimming pools, washing automobiles, and hosing off driveways, is generally referred to as discretionary use (Mata *et al.,* 2018). By contrast, indoor water use is left rather unaffected by most policies and strategies internationally and locally, and most of them have not really questioned or analysed the cultural norms and social value systems that underpin indoor discretionary water use within South African urban

households. While it may be acceptable to suggest changes to water use practices that take place outdoors in the public or semi-public domain, such as washing one's car, filling up swimming pools, lawn irrigating or gardening, it is not deemed acceptable to suggest a control on 'private' on more intimate activities such as showering, bathing and laundry, that take place indoors, as these are considered to exist outside the realm of public discourse and debate.

Regarding the role of policy makers in developing effective WDM policies and strategies, the core questions that need to be addressed as immediately and comprehensively as possible, are the following: Who are our water consumers? How much water do they actually utilise? What economic, environmental, social and cultural aspects motivate or drive their water use (i.e. consumption externalities)? What policy and institutional framework is required to respond effectively to WDM? and lastly, what short-, medium- and long-term policy actions are needed to directly influence water consumption behaviour patterns to reduce urban water demand? This study on urban household water use within the city of Durban presents a starting point to providing researched solutions to some of these key questions. The next chapter (Chapter 4) provides a review of literature relating to the topics of water conservation and demand management (WCWDM) in SA and the City of Durban. Specifically, the chapter critically analyses and interrogates the current policy and legal prescripts for WCWDM in SA by initially providing a detailed status quo of current water use and water demand management practices. The chapter then delves into a core discussion on the key factors influencing urban household conservation behaviour in the country. The last part of the chapter presents a similar critical review of WCWDM policies, strategies and current practices being undertaken within the City of Durban. A review of eThekwini Municipalities Non-Revenue Water (NRW) and Water Demand Reduction programme, is also presented.

CHAPTER 4

WATER DEMAND MANAGEMENT- SOUTH AFRICA AND CITY OF DURBAN PERSPECTIVES

4.1 INTRODUCTION

South Africa (SA) is a semi-arid, water scarce country that faces a plethora of water supply and security challenges, amidst demand for water continually rising. This rising water demand is occurring in the context of a predicted national deficit in freshwater supply in the short, medium, and long term (South Africa, Department of Water and Sanitation 2018: 1). Freshwater supplies in South Africa have deteriorated during the last decade due to growing demands from agriculture, industry, and urban water use. According to Hedden and Cilliers (2014: 5), South Africa's water resource management is currently hampered by limited and inconsistent water supply schemes, increasing urban demands, and inefficient use of existing water resources. Most management responses have favoured increasing supply by building more dams. However, there is a growing understanding that a transition to stronger demand-side management options, notably lowering domestic demand, is equally important (Postel, 1992; White, 1998, Allon and Sofoulis, 2006; Corbella and Pujol, 2009; Parker and Wilby, 2013, Mata *et al.* 2018).

Additionally, SA's current available surface freshwater resources (dams and rivers) are under increased threat from mining activities, rapid industrialisation, rapid urbanisation and high surface area evaporation. Moreover, high levels of urban-rural migration have also put greater stresses on the available freshwater resources and failing urban water infrastructure that require urgent upgrading or replacement due to reaching the end of their operational life.

Therefore, the aim of this chapter is to provide a detailed review of existing literature relating the topics of water conservation and demand management (WCWDM) in SA and the City of Durban in order to unpack and start to address South Africa's complex water security, supply, and demand challenges. The chapter reviews the current policy and legal frameworks for WCWDM in South Africa by firstly presenting the status quo of water consumption and demand in the country. The chapter then details the most important factors that influence urban household conservation behaviour in South Africa. The chapter concludes with a similar review examination of relevant WDM policies, strategies and practices for the City of Durban.

4.2 WATER DEMAND MANAGEMENT: POLICY FRAMEWORK IN SA

4.2.1 Pre-Apartheid water management

Understanding the country's geographical, political, and social history is crucial to comprehending the need for WDM in SA. Water is a limited natural resource in South Africa due to its geographical location. In addition to the legacies of apartheid, as defined by a period of complete racial segregation, the resultant effect has been severe disparity in water distribution and access. Apartheid was also a period of basic services segregation, with the national government providing acceptable but insufficient basic water services to non-white South Africans. According to Giordano *et al.* (2002: 294), a significant portion of South Africa's population was intentionally excluded from the political and economic system. Apartheid also ensured that black settlements and native lands were blocked off from the state's major water supply projects and got poorer water and sanitation services than the ruling white population of South Africa at the time. Narsiah (2010: 374) summarizes the effects of apartheid on the majority of the black population by stating that black people were forced to live in "de-humanizing conditions" under apartheid. In addition, Naidoo and Constantinides (2009: 155) assert that apartheid influenced the country's access to

and development of freshwater resources and supply. The authors of the study give a historical review of water use in South Africa, arguing that under the apartheid era, all legislation was focused towards privatizing water for commercial agriculture, a sector dominated by white South African property ownership. Whites possessed 83 percent of the country's arable land and utilised more than 54 percent of the country's available water resources (Naidoo and Constantinides 2009: 155). Stein (2005) adds to this argument by suggesting that water was distributed racially during the apartheid era, and that distribution was tied to land access (Stein 2005: 2167). Furthermore, because important businesses were positioned distant from key rivers, apartheid regimes' social engineering resulted in costly inter-basin transfer schemes (Naidoo and Constantinides 2009: 158). The split of urban water supply infrastructure and services was apartheid's most evident and noticeable impact, resulting in adequate water facilities in former white suburbs and a complete lack of water infrastructure in black townships (Naidoo and Constantinides 2009: 158).

4.2.2 Post–Apartheid water management

In 1994, the democratically elected SA government inherited a tremendous challenge of providing 15 million additional citizens with a basic access to safe water and over 20 million people with sanitation. This was a direct result of the historical distribution and access to water resources (Stein 2005: 2170). The emergence of the new democratic SA in 1994 prompted the development of a new constitution for the country. According to The Constitution of the Republic of South Africa, 1996, the "rights to basic water" are defined as follows:

- That everyone has the right to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that:

i. prevent pollution and ecological degradation
ii. promote conservation; and

iii. secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

- That everyone has the right to have access to sufficient food and water.
- That the property clause may not impede the state from taking measures to achieve land, water and related reform to redress the results of past racial discrimination'.

The Water Services Act (Act 107 of 1998) and the National Water Act (Act 36 of 1998) were legislated in 1998 and these two Acts currently govern all water management policies and decision making in South Africa. The promulgation of these Acts also gave national government the authority to serve as the "custodians" of all water resources in South Africa. Under the National Water Act (Act 36 of 1998), the adoption of a public rights approach to water allocation, rather than the previous private rights system, has had a massive effect on the way water is distributed in the country, and has resulted in the abolishment of water ownership and water rights (Naidoo and Constantinides 2009: 156). Furthermore, the Acts required all South Africans to accept a new paradigm towards water conservation and demand management. The national government's mandate in terms of water use and demand management is as follows:

• Provide universal and equitable access to reliable water supply and sanitation services;

• Protect, manage and develop the nations water resources in a manner that supports justifiable and ecologically sustainable economic and social development; and

• Transform access to water to redress the racial imbalances created by apartheid

(The Constitution of the Republic of South Africa, 1996).

Over the past 30 years, national government has developed and implemented various water conservation and water demand management (WCWDM) policies, guidelines, strategies, and plans, under the prescripts of these two key pieces of

legislation. The following section of this chapter summarizes the most important relevant government policies, strategies, and programs in terms of their intent and mandates for water conservation and WDM in South Africa.

4.2.3 National Water Resources Strategy (NWRS)

The NWRS was developed in 2013 by the National Government's Department of Water Affairs to assist the adoption of an integrated water resource management (IWRM) approach for water usage and management in South Africa. The Department of Agriculture defined IWRM as "a process to promote the coordinated development and management of water, land, and related resources in order to maximize the resultant economic and social welfare in an equitable manner without jeopardizing the sustainability of vital ecosystems" in 2004. (South Africa, Department of Water Affairs 2004: 10). The goal of adopting an IWRM framework was to allow the national government to meet the people's requirements for water, job creation, and economic growth while also considering and protecting the natural environment (South Africa, Department of Water Affairs 2004:10). The NWRS was developed as a ‘blueprint’ to ensure that government achieves its IWRM objectives. The NWRS explains how water resources should be safeguarded, utilised, enhanced, protected, regulated, and controlled, in conformance with South African law (South Africa, Department of Water and Sanitation 2013b: 11). The NWRS comprised of four (4) key focus areas, supporting effective WCWDM. These are presented in Figure 4.1 below.

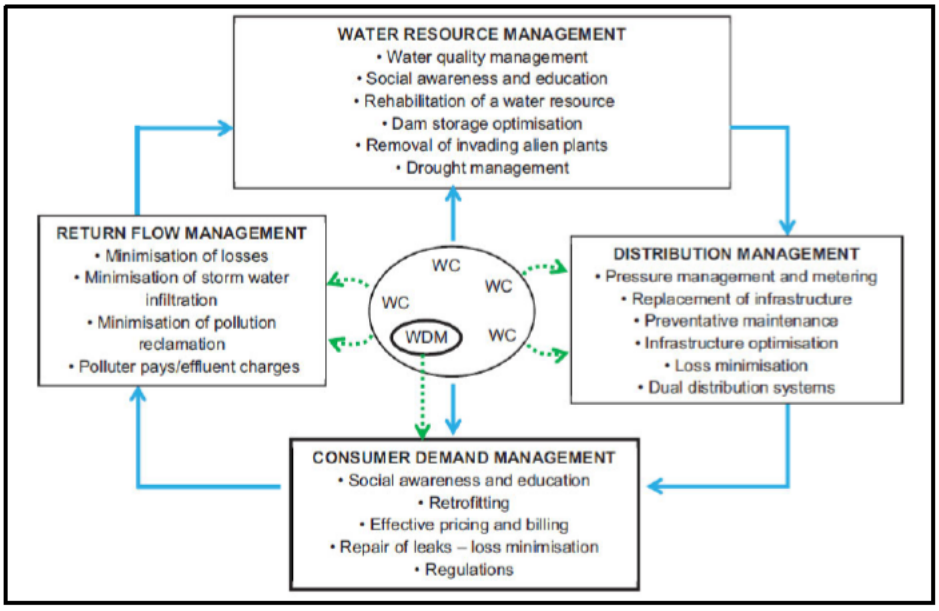

Figure 4.1: Elements of WCWDM

Source: Adapted from the Department Water and Sanitation (2013a)

A program of communication, social education and awareness creation, was a crucial component of the WCWDM approach. This component strived to instil a WCWDM culture and ethos among water consumers and other water user stakeholders. It also lists social awareness and education as a crucial WDM intervention for consumers and urban households. The NWRS includes a chapter on the efficient and effective usage of water at the household level, together with the reduction measures for non-revenue water loss and water wastage in South Africa. The addition of a dedicated chapter to the NWRS was intended to deliver sustainable and affordable water services to all South Africans (South Africa, Department of Water and Sanitation 2013a: 4). Education and awareness-raising are described as major mechanisms covered under the sub-themes of the NWRS to bring the need for WCWDM to the public's attention and to stimulate committed public actions and responses with water conserving behaviour. The strategy also lists the benefits of developing increased social awareness, including highlighting essential concepts of effective water usage at the household level and ensuring that the civil society/public receives updated and accurate water use information (South Africa, Department of Water and Sanitation 2013a: 52).

Since the release of the NWRS in 2013, national government has been steadily implementing WCWDM interventions in the country, primarily within the agricultural (bulk water users) and more recently domestic/urban sectors, respectively. These two sectors account as the largest consumers of water in SA. In 2018, government updated and revised its national policy/strategy and plan for WCWDM and a 'Call to Action' plan was published as the SA governments' strategic national plan of action for water resource management in SA for the next 10 years - till 2028. The National Water and Sanitation Master Plan (NWSMP) was gazetted and published in 2018, and the plan of action comprehensively details national government's policy and strategic intent for WCWDM for the next decade.

4.2.4 National Water and Sanitation Master Plan (NWSMP)

Currently, the NWSMP is national government's primary policy instrument for achieving the goals of the previous NWRS. The NWSMP defines and prioritizes the most important actions and responsibilities. The NWSMP aims to ensure that by 2030 and beyond, SA has a sufficient reserve water supply. The NWSMP prescribes the foundations for how SA will manage its available water resources and to meet its water and sanitation targets as outlined in government's National Development Plan (NDP) 2030, the Medium-Term Strategic Framework (MTSF), and Medium-Term Expenditure Framework (MTEF) (NWSMP 2018:11). The NWSMP also addresses the African agenda as out in the African Union's (AU) Agenda 2063: "The Africa We Want." The NWSMP is based on six key objectives (focus/thematic areas) that define the "plan of action" for sanitation and water management in South Africa, including a reliable national water supply system, basic sanitation provision, sustainable water allocation and use including future water demand reduction. These goals help to realize the Vision for 2030 in the National Development Plans (NDP): of "affordable and dependable access to sufficient and clean water and hygienic sanitation for socio-economic progress and well-being, while taking environmental considerations into account" (South Africa, Department of Water and Sanitation 2018: 10). The NWSMP is divided into two components, each with its

own set of targets, tasks, duties, timelines and accountabilities. The six primary focal areas of the NWSMP for water management in SA are depicted in Figure 4.2.

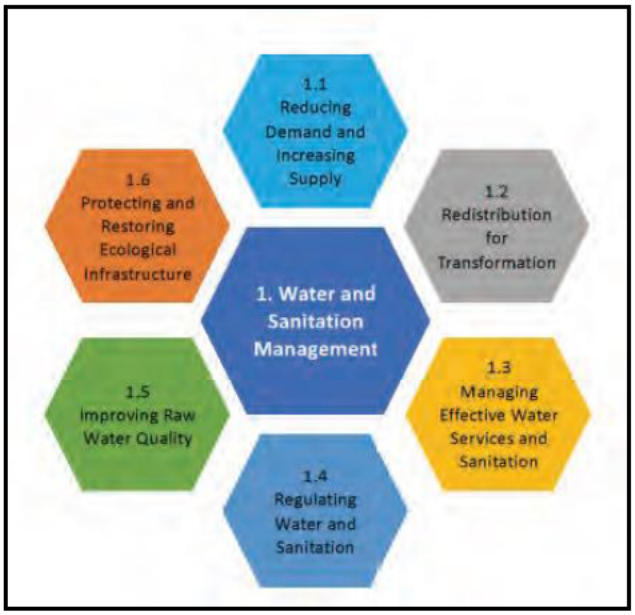

Figure 4.2: National Water and Sanitation Master Plan key focus areas

Source: Adapted from the National Water and Sanitation Master Plan (2018)

From the NWSMP focus areas above, area 1.1, "reducing demand and increasing supply" the NWSMP indicates direct relevance with this particular study as the study findings are linked to achieving the stipulated objectives for this key focus area of the national plan. The study findings have helped advance a deeper understanding of South African urban household water users' perceptions, behaviour and attitudes in support of influencing current WDM policies and interventions, whilst concurrently contributing to reducing water demand.

4.3 WATER DEMAND MANAGEMENT: SA STATUS QUO OF WATER USE AND DEMAND

South Africa has an arid to semi-arid climate with an average annual rainfall of 465 mm (less than 50 % of the world average) and a total yearly roll of over 49 000 million m3/a (South African Department of Water and Sanitation (2018). The current reliable output of surface water with an acceptable assurance of supply is roughly 10 200 million m3/a across the country. Large dams have a combined storage capacity of roughly 31 billion m3, while the available groundwater potential is around 4 billion m3/a, with only 2 to 3 billion m3/a currently being utilised (South Africa, Department of Water and Sanitation 2018: 9). The agricultural sector accounts for 61 percent of water use in South Africa, followed by municipal usage currently accounting for 27 percent, with mining, industrial, power generation, conservation and afforestation, accounting for 12 percent. Figure 4.3 depicts the national water use distribution. Agriculture has a lower level of certainty than other sectors when it comes to assurance of water supply (90 percent). Furthermore, water for power generation is regarded as critical, with the highest level of supply assurance (99.5 percent) (South Africa, Department of Water and Sanitation 2018: 11).

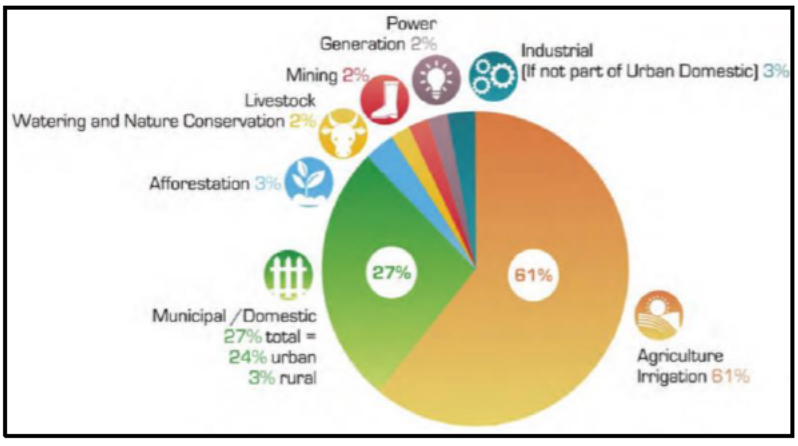

Figure 4.3: Water use in South Africa

Source: Adapted from the National Water and Sanitation Master Plan (2018)

According to the South African Department of Water and Sanitation (2018: 11), agricultural use is largely unmetered, and there are many concerns about unlawful abstraction and water system losses. Agricultural users also pay a significantly lower rate than other untreated water users, and the cheap cost of water hasn't stimulated the adoption of water-saving and demand-reduction in agricultural and irrigation practices.

South Africa's domestic water use is over 237 litres per capita per day, which is 64 litres per capita per day more than the global average of 173 litres per person per day (South Africa, Department of Water and Sanitation 2018: 12). The inflated water use is also attributable to municipal non-revenue water (NRW) losses, which are estimated to account for between 40 and 50 percent of system losses. Although estimates vary by municipality and service authorities, typical physical losses in South African municipal supply systems are believed to be averaging 35 percent, compared to global best practice recommendations of 15 percent (South Africa, Department of Water and Sanitation 2018:11). The country's rapidly expanding urban population is another significant contributor of rising municipal water demand in South Africa (Hedden and Cilliers 2014: 5).

As a result, there is a significant opportunity to reduce water use in the agricultural and domestic sectors, which are presently South Africa's largest and second largest water users. The Department of Water and Sanitation (DWS) recently installed a Bulk Water Administration System Release Module (WAS) across all national water irrigation schemes to reduce agricultural sector water use. With the WAS in place, government is now able to discharge the appropriate amount of water from source based on actual demand thereby minimizing overall water wastages in any national water supply system (South Africa, Department of Water and Sanitation 2018: 105). The results of an analysis of water demand management at the domestic level proved somewhat contradictory. For the period 2012–2016, Figure 4.4 depicts the water use targets and actual achievements for municipalities in eight of SA's main water delivery systems.

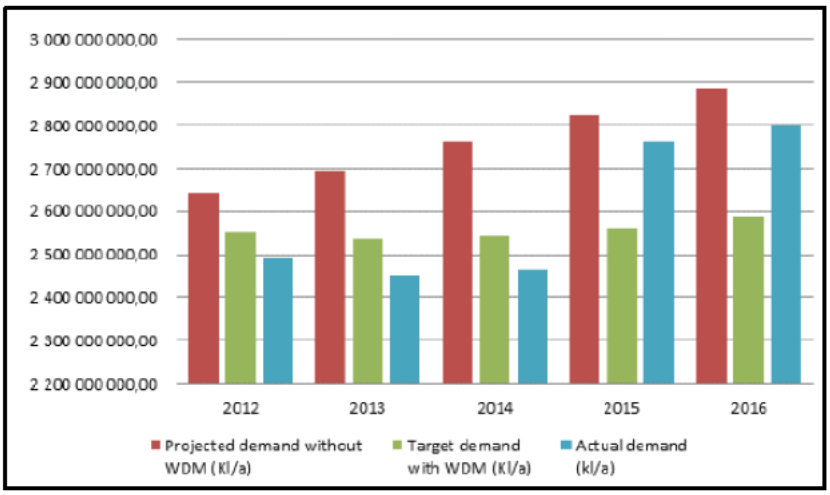

Figure 4.4: Municipal water use demand targets and actual in eight large water supply systems, 2012 – 2016

Source: Adapted from the National Water and Sanitation Master Plan (2018)

According to the data, actual water demand has consistently exceeded the intended demand volume from 2015 to 2016, implying that SA will definitely face a national water deficit in the medium term if WDM targets are not being met at the municipal level. As a result, increasing the immediate use of multiple WDM interventions, is critical. This is an important justification for this study which provides 'citizen-based' scientific evidence on urban household water use attitudes, perceptions and behavior practices to support of improved decision-making on WDM policy interventions that a particular municipality (e.g. eThekwini Municipality) can implement to reduce overall water demand.

4.3.1 Drivers of water supply and demand

SA will need to reduce water usage while increasing supply in order to balance supply and demand needs for its rapidly growing population and economy (South Africa, Department of Water and Sanitation 2018: 108). The National Government's Industrial Policy Action Plan (IPAP) lays out the country's plans for increasing its manufacturing sector, which will inevitably raise water demand. Low water charges,

excessive consumption, inadequate water and wastewater re-use, leakage, ineffective infrastructure, inadequate planning and implementation and a rapid population rise, including economic expansion, are all significant factors contributing to the forecasted water supply and demand deficit. According to the South African Department of Water and Sanitation (2018:110), water awareness and strict regulation, cost recovery, and incentives should be used to reduce 'individual water use' requirements by improving efficiency, adopting new technologies, and reducing losses, especially in the agricultural and municipal sectors. By 2025, average household water consumption must be lowered to around 175 litres per person per day. The National Development Plan (NDP 2030) aims to reduce water demand in metropolitan areas by 15% below baseline levels by 2030 (South Africa, Department of Water and Sanitation 2018: 106). The implementation of Phase 2 of the Lesotho Highlands Water Project, the uMkhomazi Water project phase 1 in KZN, and the augmentation of the Western Cape overall water supply and delivery systems, have all experienced significant delays. These delays have had a substantial impact on the national water security and the local economies of South Africa's largest metropolitan cities. The water crisis in Cape Town (day zero scenario in May 2018) provides a constant reminder of the consequences of further delayed WCWDM action and solutions in SA.

4.3.2 State of water losses and efficiency

There are high percentages of water losses and efficiencies in the country's water supply delivery systems, particularly at the municipal level. This is one of the main problems restricting the adoption of water conservation and water demand management actions and programmes in SA. The NDP 2030 lays out the priorities for managing water consumption and forecasts the need of reducing demand. As indicated, the NDP requires a 15% drop in urban household water consumption in all metropolitan areas by 2030. However, attaining such demand reductions will necessitate multi-disciplinary and active programs to eliminate water leakages in all major distribution networks while also increasing the efficiency of water usage by households, industrial and other commercial water users. To ensure future water

security in SA, all water supply schemes (primarily operated by municipal water service authorities and utilities in SA) have to strengthen their current efforts to meet the targets set forth in their water reconciliation strategies (South Africa, Department of Water and Sanitation 2018: 106). The national department tracks and analyses progress with WCWDM implementation, against reconciliation targets that have been specified in system reconciliation strategies in eight of SA's main water supply systems on an annual basis. Figure 4.5 shows the results of the target vs actual water savings obtained in these eight systems from 2012 to 2016.

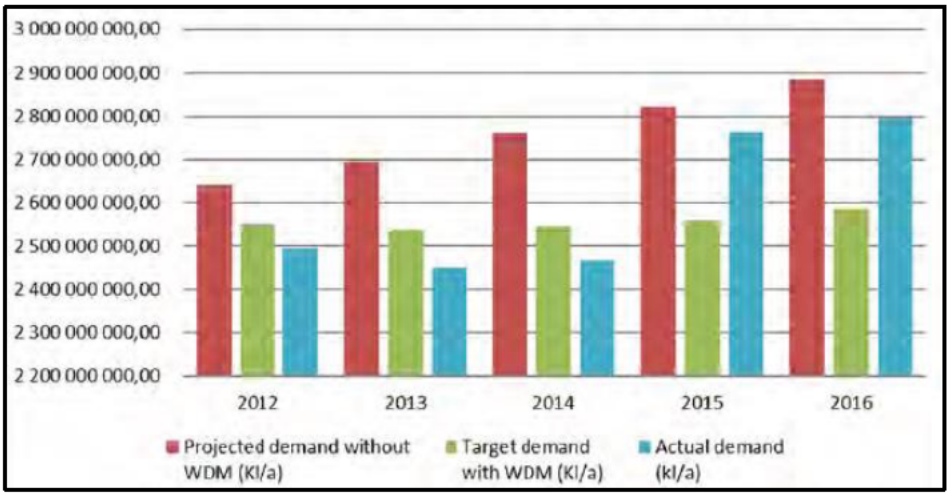

Figure 4.5: Historical trend of water use efficiency within the eight largest water supply systems in SA (2012 – 2016)

Source: Adapted from the National Water and Sanitation Master Plan (2018)

The data indicates that from as far back as 2015 and 2016, actual demand volumes have been far exceeding the target demand reductions. Therefore, water use efficiency targets at the municipal scale are not being met. This strengthens the importance of ensuring that all WCWDM efforts and interventions, particularly at the municipal level, are rapidly increased in order to maintain a sustainable water supply and demand balance in SA. Hence, this study aims to support the call for increased efforts at the municipal level by providing evidence-based data to eThekwini Municipality on the most effective WDM tools, instruments and approaches to support the municipality in achieving their water reconciliation strategy targets.

4.3.3 ‘No Drop’ programme

A set of programmes that are important for any discussion on WCWDM in SA, particularly at the local/municipal level, has been the Blue Drop, Green Drop and in particular, the No Drop programmes. While the Blue Drop and the Green Drop programmes review and manage drinking water and wastewater quality respectively, the No Drop programme aims to assess and specifically report on water efficiency losses and Non-Revenue Water (NRW) in SA. All three programmes allow for national government and local municipalities to target areas where the need for improvements or assistance may be greatest, almost down to the plant or facility level (South Africa, Department of Water and Sanitation 2015: 5). From the 'No Drop' audit results of the 2015 report, which included data from eight metropolitan municipalities across South Africa, annual demand was estimated to be 2 158 million kl, supplying a population of 21.5 million people (South Africa, Department of Water Sanitation 2015: 15). Metropolitan cities account for 40% of the population of South Africa and 47% of total urban water usage, which is why only metropolitan municipalities are chosen for the No Drop audit assessment. According to the report, none of the metros obtained No Drop Certification (i.e. scored <90 percent grade). The City of Cape Town performed well, closely followed by Ekurhuleni, eThekwini and the City of Tshwane, which all had above average scores. Nelson Mandela Bay, the City of Johannesburg, Mangaung and Buffalo City had below the average of 69% (South Africa, Department of Water and Sanitation 2015: 27). An International Water Association (IWA) study undertook an assessment on the national water balance for all metros in SA for the 2013/14 FY and their data indicated a total System Input Volume (SIV) of 2 158 million kl/annum (South Africa, Department of Water and Sanitation 2018: 107). The City of Johannesburg, with the largest urban population in SA, accounts for 27% of the total metro consumption and is the largest urban water user, followed by Ekurhuleni that accounts for 16% as a result of the concentration of intensive water consuming industries that are located in the area. The combined Metro SIV is 2.4 % above the available supply from the available water resource, which means that all the metros combined, are actually extracting water way above their allocations.

With regard to the NRW loss for the metros, the overall NRW for South Africa is estimated to be 1,580 million m3 /annum which is approximately one-third of the total water supplied in SA. Conservatively, this represents a loss of over R7 billion (almost $1 billion) based on an average bulk water tariff of approximately R5/m3 ($0.50) (Bhagwan et al, 2014: 7). The average infrastructure leakage index (ILI) value for all of South African municipalities was estimated to be 6.8 which was in line with the world average and is above average when compared to most other developed countries and well below average when compared to most developing countries (Bhagwan et al, 2014). Effectively, the ILI value of 6.8 tends to support the perception created from the percentage for non-revenue water for South Africa of (36.8%) however, there are clearly much higher levels of wastage and water losses in the country and considerable scope for improvement (Bhagwan et al, 2014: 7). In previous years, an estimated 923 million kl/annum (34% of the SIV) has been reported. Within the six metros, 4 had NRW estimates in excess of 35% (South Africa, Water Research Commission 2012: 5). This clearly demonstrates that on average, all SA metros are not performing well compared with an international benchmark of between 10% - 15% for NRW (South Africa, Water Research Commission 2012: 5). The average litres/capita/day within metros is 267. The average consumption is above the international benchmark of 180 l/c/d and many metros need to target an average consumption of below 200 ℓ/c/d as soon as possible (South Africa, Water Research Commission 2012: 5). By comparing potential savings on a municipal level, it has been observed from the No Drop reports that the majority of potential water savings (84%) can be achieved by investing in WCWDM in metropolitan municipalities and secondary cities (South Africa, Department of Water and Sanitation 2018: 106). The data above also suggests that NRW is a significant challenge for SA's public water sector management. The NWSMP strongly advocates that effective WDM initiatives at the municipal level can yield significant reductions in current water consumptive habits and behaviour. It can also be argued that water use behaviour change may not be well received in the context of such large volumes of water being wasted in system losses by government, however, the expressed national need to conserve water in every water use activity is an imperative action immediately needed in order to ensure SA’s water security in the future.

4.4 WATER DEMAND MANAGEMENT: SA'S MUNICIPAL STATUS QUO

According to Hedden and Cilliers, South Africa will have the highest growth in water demand by 2035. Municipal water demand is predicted to increase from 5.5 km3 in 2014 to 7.2 km3 in 2035 (Hedden and Cilliers 2014: 5). As a result, WDM requires diversified interventions for the water sector to narrow the expanding water supply and demand gap. Increased rural-urban migration, particularly in the provinces of Kwa-Zulu Natal, Gauteng, and the Western Cape, has resulted in rising income levels. This has translated into rapid increases in municipal water demands (Go et al. 2013: 13). According to the 2011 national census, the three major metropolitan cities in South Africa, houses over 35 million people (over 54% of the country's population) (Statistics SA, 2014). The overall water demand is currently predicted to increase substantially per year, while the total water supply is lagging behind (see Figure 4.6). Furthermore, by 2035, the gap or national deficit between demand and supply is expected to widen by 3.2 km3, thus increasing water stress and competitiveness across all water-users in South Africa (Hedden and Cilliers 2014: 5).

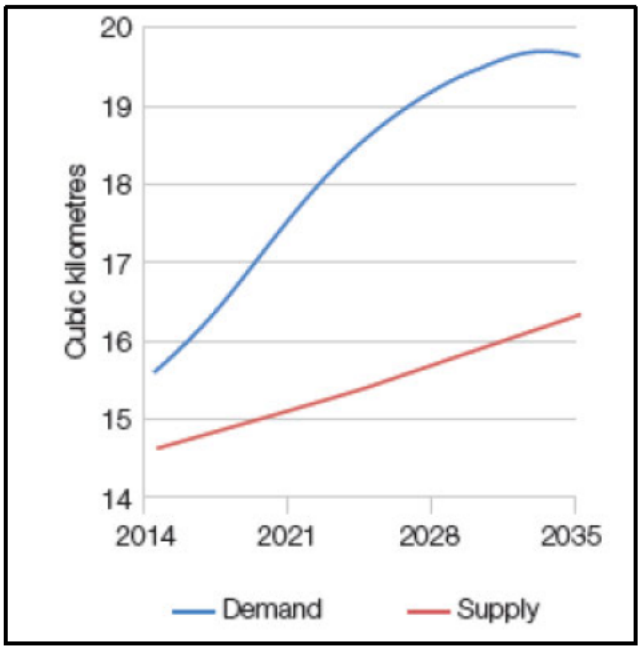

Figure 4.6: Increasing gap between water supply and demand in SA

Source: Adapted from Hedden and Cilliers (2014)

Hedden and Cilliers (2014: 6) also assert that increasing supply will not be adequate to meet rising demand, and strongly advocate for water demand interventions such as reducing the volume of water lost through physical system leaks as well as improving urban residents' water use behaviour. Therefore, urban households and water services authorities in SA must collectively collaborate to reduce overall water demand. It is imperative that WSAs' take the lead on public research and discourse regarding water conservation and demand management behaviour change. Metropolitan municipalities in SA must take immediate and swift actions to remediate the massive NRW water losses including co-developing and devising strategic long-term solutions for the wide spread adoption of urban household level water saving practices.

4.4.1 Profile of water supply and use in South African municipal households

Potable water is primarily provided to consumers in South Africa by water service authorities/providers. In SA, local municipalities are the water service providers/authorities in charge of delivering water to city residents. Water service provision also involves providing proper water quality testing and infrastructure maintenance. Residential water services are delegated by some water service authorities to other water service authorities or private utilities and enterprises (e.g. Umgeni Water in KZN). Water enters individuals' dwellings via a conventional water meter from the municipal main supply line. Outside the property line, the water service provider is responsible for managing the water reticulation system. This responsibility entails identifying and repairing leaking pipes. The property owner is responsible for both the water reticulation system and water use management, inside the property boundary. Water demand in single-family homes can be divided into two categories: indoor and outdoor. Baths, showers, toilets, and Laundry (washing machines) all account for around 80% of total indoor water usage, according to Jacobs (2008: 3). The use of water for irrigating lawns and gardens, on the other hand, contributes to a greater proportion of outdoor water utilization. Although it is difficult to determine the exact amount of outdoor water consumption,

some studies have suggested that lawn and garden watering could account for up to 70% of total household water use in some households (Jacobs 2008:3). Reducing water use for watering the lawn, toilet use, baths, showers, washing machines, and leaks have the greatest potential to help SA homes save more water. Because of this, many water demand management interventions have only targeted recreational outdoor use. According to Jacobs (2008), understanding the nature of water usage by local water consumers at a higher resolution (i.e. per individual end-use for indoors and outdoors) is crucial for local authorities to improve their WDM policies and interventions and, as a result, also improve their water service delivery, to their consumers.

4.4.2 Factors influencing household water demand

Water demand management in South Africa is influenced by a number of factors. Property value (which is commonly used as a proxy for income), rainfall, household size, price, age of household members, income, presence of a swimming pool, water efficiency devices, and stand size are all relevant variables in SA (Jacobs 2008: 4). The most important variables that have been reviewed and investigated for the purposes of this particular study, are explained below.

4.4.2.1 Price

Water cost is regarded as the most common factor influencing water conservation and demand management behaviour in South Africa. Water is typically assumed to be price sensitive, especially for indoor water uses; however, outdoor water use demand in South Africa can significantly increase consumer price responsiveness (Jacobs et al. 2006: 4). According to Kashian *et al.* (2012: 100), most water consumers are rather ‘uninformed’ of marginal water price increases. Kashian *et al.* also reference further studies from numerous industrialized countries that expand on why an individual's monthly water cost is such a small fraction of their entire

monthly living expenditure. As a result, unless water prices become exorbitantly higher month after month, very little attention is paid to the price of water consumption per month. Therefore, pricing may have limited impacts on reducing overall water demands as a single or stand-alone strategy (Kashian *et al.* 2012: 100).

4.4.2.2 Income

Income levels and water demand management behaviour are extensively covered in the extant literature and income is generally defined by the property value or stand sizes (Jacobs *et al.* 2006: 4). High end property values imply higher income levels and therefore consequently results in higher water consumption. Several authors have studied peak demand for household water users, without including outdoor consumption and the research indicates that consumers rarely exceed 1500 l/h, but it might be much higher for users with larger incomes and who own big houses or stands (Inman and Jeffrey 2006: 127; Van Zyl 2011: 27).

4.4.2.3 Metering

Metering (or smart metering) is regarded as a key incentive-based approach for water consumers to participate in WDM by increasing their day to day understanding of household water consumption practices. It provides consumers with real time data and information to calculate the actual cost of consumption by measuring consumption quantity regularly. According to Katchmark *et al.* (2011: 5), the mere presence of smart water meters and monitoring, discourages water wastage. The DWS states that without effective metering and billing, consumption in urban and rural areas could rise by up to 7.3 km^3/annum, resulting in an increase in total water usage of close to 20 km^3/annum (South Africa, Water Research Commission 2018: 16). In this respect, both the NWRS and the NWSMP highlight the urgent need for

the implementation of an effective smart water metering and monitoring system as a specific national action to manage the rising water demands in SA.

In order to track water use effectively in SA, updated service connection metering is critical in notifying customers about how much water they are using (Inman and Jeffrey 2006: 128). Water meters come in a variety of technology options, and their placement on SA properties is determined by the needs of the customer. Table 4.1 below summarizes the various types of meters and metering procedures currently available.

Table 4.1: Summary of metering types and strategies for WDM in SA

Metering Type	Strategy
Conventional	This strategy entails installing water meters on all consumer connections and sending monthly water bills based on the actual or projected water consumption. When water meters are not read every month, the consumption for intermediate months is estimated based on factors such as historical consumption and seasonal patterns. Errors in the meter reading process can cause excessive bills for the consumer (Van Zyl 2011: 26).
Prepaid	Prepaid meters are water meters with built-in processing units and a mechanism that can automatically close a water system valve to cut off a consumers' water supply. Consumers purchase water in advance and the amount purchased is transferred through a token or

	electronic signal to the pre-paid meter. Once the available credit on the meter has been exhausted, the prepaid meter automatically cuts off the water supply. In some cases, the supply is stopped completely, while in other cases a small flow is maintained through the meter (Van Zyl 2011: 26)
Other metering strategies	Installation of flow restrictors that incorporate trickle feed systems which reduce the flow to a trickle collected by the user in a container such as a rainwater harvested roof tank systems (Van Zyl 2011: 26).

Source: Adapted from Van Zyl (2011)

In most SA municipalities, standard (or conventional) water meters are used. In cities and towns, the majority of meters are domestic meters that serve single residences (Van Zyl 2011: 25). Water is metered in flats (including multi-storey) buildings as well; however, the meter specifications may differ from those of single-family households. Because dwelling units in flats share one master meter, meter sizes for flats are often bigger than meter sizes for single households. As a result, the meter is large enough to enable more water flow into the flat or building and for water to flow at a rate of not less than 10 l/minute from taps into the residences home (South Africa, Water Research Commission 2018: 16). In this regard, the chosen meter must be capable of handling the projected flow rates and operational conditions at that specific site (Van Zyl 2011: 25).

4.4.2.4 Water tariffing

Water tariffing or payment for water services is an important component of WDM for South Africa. Maintaining and building new water infrastructure is typically expensive and the costs of such new mega infrastructure is generally recovered through increased water rates and the sustainability of water services is also directly proportionate to revenue collection. Tariff structures have long been utilized as a WDM management tool to ensure that water infrastructure and services are managed efficiently, effectively, and sustainably (Renwick and Green 1999: 35). Water tariff models are designed to recoup the net expenses of providing water, as well as the costs of operation, maintenance and investments needed for 'new' water infrastructure (Hosque and Wichelns 2013: 472).

A rising block-rate tariff structure is used in most of SA's municipalities, with rates of payment increasing for consumption on a sliding scale. The use of the current tariff model instrument provides all citizens with their free basic amount of water of 6Kl, after which, water usage costs are directly proportional to the amount of water consumed on a monthly basis (Hosque and Wichelns, 2013: 473). Narsiah (2010: 374) describes the eThekwini Municipality application of the sliding block-rate tariff model. The first tariff block provides water for free. Subsequent blocks are then charged on an incremental billing system. Despite the fact, that the introduction of the baseline tariff appears to contradict the intent of WC and WDM, it has resulted in some reductions in water demand in a number of South African communities. Poorer communities now have a reason to manage their monthly water usage to keep it below the free 6 kilolitres per month allocation (Naidoo and Constantinides 2009: 156; Swistock et al. 2010: 5). The second block has a set charge for users of six to twelve kilolitres, whereas the third block has a higher fixed rate for users of more than twelve kilolitres (Narsiah 2010: 375). A predetermined charge equivalent to the free water is levied in the second block when a user utilises more than six kilolitres of water, acting as a cross-subsidization mechanism (Narsiah 2010: 375). Consumers who consume more than six kilolitres of water, on the other hand, are in effect denied their basic 'free' water allocation, which they pay for in the second,

and more expensive tariff block. This raises issues of water equity, as customers who use more water than the allotted amount must pay for the entire amount used, which is contrary to South African law's free basic water policy. Many authors believe that the rising block-rate tariff system/instrument is inequitable because families with more than four people in their homes, regardless of their socioeconomic levels, are always at a disadvantage (Hosque and Wichelns 2013: 491).

Water use and tariffs within multi-residential units or housing complexes are another illustration of the injustices inherent in the use of the current tariff billing systems. Most residents in South African residences pay a fixed price for water services rather than based on their actual monthly water usage. In this case, there could be an inequitable payment for water services provided to residents in flats or multi storey buildings (South Africa, Water Research Commission 2018: 17). Households that use far less water than the free basic water allocation of 6 kl, for example, would nevertheless be charged for water and sanitation services, i.e., they will share costs with other households that used more than the free basic water allocation of 6 kl. This system of payment for water 'utility' hinders efficient water demand management, particularly among flat dwellers, because residents can be motivated to increase the water usage because they pay a monthly water bill regardless of their actual consumption.

In summarising this section on SA landscape and WDM, it has become evident from the extant literature that there are several competing factors shaping, influencing and impacting on water conservation and WDM practices and behaviour in SA. The review suggests that more research is perhaps required to further unpack some of the subtle nuances and influences of the main factors influencing water conservation behaviour in an attempt to understand the complexities associated with effective WDM implementation and practice in SA, particularly at the urban household level.

Therefore, this section has aimed to provide an overview context to the policy and legal framework supporting WDM, as well as provide a status quo analysis of water use and water demand management policy. The profiling of a typical SA urban household including their water consumption influences and drivers are also central objectives of this study investigation. Interestingly, it was noted from the literature review that a strong emphasis has also been placed on reducing discretionary uses of water or reducing water wastage and increasing the efficiency of water use practices at the household level via regulatory and technological instruments and mechanisms only (i.e. metering, rising-block tariffs and pricing).

The South African empirical study review also revealed that little to no research has been done on aspects such as behaviour-driven water demand reduction as a key instrument to reduce water demand in SA. Additionally, discretionary uses, which refer to water uses such as watering gardens, filling swimming pools, washing cars and hosing down driveways, are mostly discussed and analysed in South African literature. By contrast, limited to no research has been done on indoor water use and this topic is left rather untouched by most current SA policies, strategies and plans. Moreover, most present day WDM interventions have not questioned the social and cultural norms that underpin indoor water use in SA urban households. While it is acceptable to suggest changes to practices that take place outdoors in the public and semi-public domain, such as washing one's car or gardening, it appears that it is deemed unacceptable to attempt to control 'private' activities, such as showering, washing, bathing, and toilet use, that take place indoors. Such activities are generally considered to be beyond the limits of the public research discourse. Such discourses will need to be carefully considered in the context of being key limiting factors, but SA water users can also be categorised as extremely resilient, emanating from the lessons learnt from the City of Cape Town example, whereby residents who were faced with a looming 'day zero' scenario, responded to directed calls from water services authorities and the Cape Town was able to achieve significant success in reducing overall water demand (by up to 50%).

4.5 WATER DEMAND MANAGEMENT: CITY OF DURBAN

This section of the chapter discusses the WDM policies, practices and usage in Durban, as well as present findings from prior studies that help to understand the city's specific water use setting. The first section delves into the history of the city's WDM planning, as well as how WDM fits into the metro's overall water management policy framework. Following that, various specific WDM programs undertaken by eThekwini Municipality are introduced and discussed, including a discussion and critical analysis of the municipality's NRW loss reduction.

The eThekwini Municipal Area (EMA) is located on the eastern seaboard of South Africa, within the Province of Kwa-Zulu Natal, and encompasses an area of 2 297 square kilometres (eThekwini Municipality's Water Services Development Plan (WSDP) (2011: 18). While the EMA covers only 1.4 percent of the province's total territory, it is home to little over a third of the province's total population and houses 60 percent of local economic activity. A number of positives emerged from the analysis of information on the state of water and water resource management in the EMA. Firstly, the amount of capital investment into water and wastewater infrastructure, was second only to that of the Nelson Mandela Bay metro, on a per capita basis. If compared with other South African metropolitan cities, the city has the highest metered connection coverage and technical skill capability (WSDP 2011: 18). This is reflected in the city's Blue Drop assessment findings, which suggested that the city's water treatment plant management is on average, adequate, and that the quality of the drinking water supplied to consumers meets all regulatory and national standards. However, numerous water challenges remain, including the significant impact of growing urban and agricultural expansion needs on freshwater ecosystems. This has resulted in a ‘poor’ condition status requiring urgent management intervention to mitigate future water scarcity challenges within the city (WSDP 2011: 11). Rivers and wetlands are impacted by changing flow regimes, poor land management, invasive alien plant species, wastewater pollution, effluent return flows, sewage and over-abstraction from freshwater sources (WSDP 2011: 11). As a result of these influences, many freshwater habitats' abilities to deliver

natural ecosystem products and services, have been compromised. This means that the municipality is well aware of the immediate need to prevent future harm to these freshwater systems so that the metros' residents can continue to benefit from natural ecosystem goods and services as offered by the metro's limited available freshwater resources.

4.5.1 Water Conservation and Water Demand Management Strategy

The eThekwini Municipality launched a 10-year water security master plan in 2017, including providing details of their NRW loss reduction and WDM plans. This master plan covers the major components of the Durban metros' water security long term strategy. At the first tier a dedicated reaction team will respond to water pipe bursts and leaks promptly. The key objective of the strategy places growing emphasis on improving the financial sustainability of the Municipality's 'water business' through protecting and enhancing revenue streams by optimising the usage of available water resources, thereby ensuring security of water supply and to improve on accountability and governance in the metro" (Infrastructure News and Service Delivery, 2017). Moreover, the city hopes to reduce unrestricted average domestic water consumption (wastage) by 25% by 2026 and to install smart meters on all water connections (100%) by 2027. The strategy has a two-pronged approach to water conservation, namely demand reduction from the consumer side and demand reduction from the utility side (Infrastructure News and Service Delivery, 2017).

Furthermore, the municipality aims to reduce its current NRW water loss of approximately 40% to 25% in the next five years and down to 17% by 2037 and also intends to reduce apparent water losses, which presently account for 10% and include incorrect meter readings, billing system issues and illegal water connections, to 5% in the next five years and down to 3% by 2027 (Infrastructure News and Service Delivery, 2017). Finally, the municipality also aims to reduce unbilled water use to include billing in semi-rural areas, unmetered use in informal dwellings and previous RDP houses, by 5% in the next five years and down to 3% in the next ten. The municipalities master plan/strategy is estimated to generate R1 489 000 000 in

additional revenue per annum for the city. The municipality is also aware that water conservation and demand management at the household level has received little to no attention in the past, notably, in terms of how individuals conserve water, as well as their levels of education and awareness of water conserving behaviour. As a result, it intends to develop such targets and regularly monitor progress against the set targets in the future (Infrastructure News and Service Delivery, 2017).

4.5.2 eThekwini Municipality's Non-revenue water reduction programme

The reduction of non-revenue water (NRW) is a priority emphasis area in the 2011 WSDP. Evidence given by Naidoo (2021, pers. comm. 18 March) suggests that because other bulk water supply schemes are urgently needed to augment the uMgeni water supply system (primary water supply scheme to the city of Durban) the city is currently facing a reduced assurance of water supply from Umgeni Water (bulk water service provider to the Durban metro). The assurance of supply has been fluctuating between 90 percent and 95 percent. As a result, achieving success in reducing NRW loss in the city is a key part of attaining the targets set for itself in its 10-year strategy. In 2008, the municipality began the first large-scale implementation of its NRW reduction program. The goal of the initiative was and continues to be, to reduce NRW levels from 36.4% by volume to a targeted and sustained level of under 25% by volume (420 litres/connection/day total water losses) (WSDP 2011: 44).

4.5.3 Status quo: Ethekwini Municipality WDM and NRW loss reduction interventions

Since the development and adoption of the 2017 - 2027 (10-year) WDM strategy, the eThekwini Municipality has been monitoring and reporting on its achievements, against targets. The information is presented to the City Council as an official annual performance report on all WDM activities and interventions undertaken by the

municipality. These council reports were reviewed for the period from 2018 - 2020. The NRW and WDM mandate primarily sits within two branches of the municipality, namely the Water Design and NRW Branch (WDNRW) and the Customer Services Branch (CSB). However, there are other branches (such as the Water Operations Branch (WO), Water Services Branch (WS) and Auxiliary Service Branch (AS) that also support NRW reduction and form part of the primary task team. The data presented in the next section has been reviewed and analysed from the eThekwini Municipality's final council reports on NRW reduction and WDM in the metro. This section also provides details of the main WDM focus areas and key initiatives that the respective branches undertake in support of NRW reduction and WDM in the City of Durban.

4.5.4 NRW loss reduction statistics and results

The overall bulk water System Input Volume (SIV) for the 2018/19 fiscal year was 938.2 ML/day, which increased by 6.6 percent from the 2016/17 fiscal year, which averaged 880.3 ML/day (eThekwini Municipality, 2019). This was ascribed to a substantial increase in water demand for the Tshelimnyama and Kwandengezi water supply systems, which the municipality addressed by commissioning new supply pipelines. There was a total decrease of 13% in the volume of water produced by eThekwini's internal water treatment plants from 5 ML/day in 2017/2018 FY to 4.3 ML/day in the 2018/2019 FY (eThekwini Municipality 2019). When interviewed on October 2021, Mahabeer of the Ethekwini Water and Sanitation Department, stated that, unfortunately due to internal system data extraction challenges, the municipality did not report on any consumer sales and reconciliation figures or the total percentage of NRW reduction by volume for 2018/2019 fiscal year. However, it was also duly noted that overall, there was a marginal net reduction in total NRW reduction for the fiscal year.

4.5.5 WDM and NRW reduction initiatives

4.5.5.1 Establishment of dedicated NRW loss task teams

The city has an established and dedicated water design and non-revenue water (WDNRW) task team within eThekwini's Water and Sanitation Department. The task team meets fortnightly to monitor and evaluate progress and the core focus of the task team sessions are on reporting monthly progress against the various NRW and WDM initiatives, interventions and targets that have been set out in the WCWDM 10-year strategic master plan for the metro. The task team is primarily made up of several senior officials from the Water Design Non- Revenue Water (WDNRW) department and Customer Services departments (CSD) and are collectively accountable for all NRW and WDM planning and activities within the city. The various NRW reduction policies and initiatives undertaken by the respective branches directly impact on the net reduction of NRW losses, by either promoting increases of billed metered consumptions (BSC) or the reduction of system input volumes (SIV). The task team also uses the regular meetings to facilitate the escalation of bottlenecks and issues that require additional upper management and political support in order to fast-track critical action items for NRW loss reduction.

4.5.5.1.1 Water Design Non-Revenue Water Branch NRW reduction initiatives

The Water Design and Non-Revenue Water (WDNRW) Reduction Department is responsible for executing the capital expenditure on all water-related projects in the municipality. Table 4.2 below highlights the impact of each of the current NRW water loss initiatives the department undertakes and also provides details of the target and actual performance, against NRW loss reduction.

Table 4.2: Key interventions: Water Design and Non-Revenue Water Reduction Department

Task	KEY FOCUS AREAS	EST VOL RECV kl/day	Targets FY 18/19		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
WD NRW 1	Pressure Release Valves installed	1037	40	PLAN	0	2	4	8	12	16	20	24	27	31	36	40
				ACTUAL	0	0	0	0	0	0	0	0	0	0	0	0
WD NRW 2	Reservoir Inlet and Outlet Meters Programme	N/A	30	PLAN	2	4	6	8	10	14	18	20	23	26	28	30
				ACTUAL	0	0	0	0	1	1	1	1	1	1	1	1
WD NRW 3	Pipe Replacement Programme	434	20km	PLAN	0	0	0	0	0	0	0	0	5	10	15	20
				ACTUAL	0	0	0	0	0	0	0	0	0	0	0	0

Source: Adapted from eThekwini Municipality Non-Revenue Water Reduction Council Report (2020)

In terms of the current status or progress for each of the key focus areas as listed in Table 4.2, the WDNRM department reported the following:

WDNRW 1: There have been significant delays with the finalization of contracts with contractors and site work permits. Tenders for PRV installations are yet to be awarded after verification issues with the recommended supplier(s) resulted in disqualification by not meeting the minimum claimed 70% local content in the tender bids received.

WDNRW 2: The active Professional Services Contract for the installation of reservoir inlets/outlets is progressing well and the department has already completed tender evaluations for new civil works for the installation of reservoir inlets/outlets per operational area within the city. The final tender documents are being circulated for final approval and results will be advertised in the first quarter of the 2021/2022 FY. The installation of reservoir meters by the internal construction services branch has been hampered due to challenges experienced with the arrangement of shuts for tie-ins into the main water supply schemes and systems.

WDNRW 3: The Pipe Replacement project has been significantly delayed. A revised tender was advertised in February 2019 and closed in March 2019. The tender report was deferred twice due to BBBEE compliance issues with the recommended tenderers. It was expected that pipe replacements would commence in June 2021, with expected completion of key areas in the city by the first quarter of the following financial year.

Unfortunately, this department has not performed well in the 2018/2019 FY. Several issues around delayed tenders, procurement and funding have hampered the achievement of targets for NRW loss reduction. Finances and funding are a key constraint to the effective implementation of NRW reduction and WDM. Therefore, this study advocates that more efforts in WDM should be placed on instruments for changing household water use behavior as a key alternative WDM instrument, rather than just focusing on and using technological fixes such as PRV’s, pipe replacements or metering, which are often quite expensive and time-consuming to implement.

4.5.5.1.2 Customer Services Department: NRW reduction initiatives

The Customer Services Department (CSD) is responsible for executing all projects in line with reducing apparent water losses to increase the billed metered consumption (BMC) for the metro. The impact of each initiative is shown in Table 4.3 below, as well as the progresses made against targeted and actual NRW reduction performance. The key types of projects undertaken by this Department include the installation of bulk meters for informal housing settlements; the installation of meters in rural and semi-rural areas; the installation of meters in new housing development project areas; and upgrades to existing industrial, commercial and institutional (ICI) water meter installations. The CSD reports the following in terms of progress with regard to NRW loss reduction as of mid - 2019:

CS1: All applications received from the Housing Department were completed and the Housing Department is currently experiencing many system related challenges with finalising property key codes, which has resulted in difficulties and delays for CSD to install household meters.

CS2: There are ongoing challenges of capturing new water connections on the metro's billing system (RMS) which has also delayed the installation of smart water meters by CSD. The issue has now been resolved and a revised plan to fast-track smart water meter installations is in place.

CS3: There have been major delays in the appointment of contractors due to internal SCM procurement and tendering processes.

CS4: All applications received for rural areas were installed. The number of applications received was not enough to meet the FY NRW reduction targets.

CS5: There have been major delays in the appointment of contractors due to internal SCM processes.

CS6: Target was met. Resources were co-ordinated from various departments and sections within the branch to increase the number of investigations conducted. This was done in order to ensure that most maintenance issues were attended to and resolved in order to meet targets.

CS7: Community resistance from business forums has significantly delayed progress.

CS8: Target met.

CS9: Target met.

CS10: Target met.

The CSD branch has performed relatively well in the 2018/2019 FY, having met several of its targets. However, similar to the WDNRW branch, tenders, SCM and procurement-related challenges have also significantly hampered progress in some areas. A strong emphasis is also placed on smart water metering as a key NRW reduction measure and a core part of this department's key interventions and activities. This study therefore advocates that the CSD branch should also consider diversifying its NRW reduction and WDM programme by including activities and interventions such as public awareness-raising campaigns and information-sharing on actual vs perceived household water saving practices to support the overall goal of NRW reduction in the Durban metro. The CSD branch is ideally positioned to do this as they directly interact with consumers and local communities, on a daily basis.

Table 4.3: Key interventions: Customer Services Department

Task	Key Focus Areas	Est Vol Recov. kl/day	Targets FY 18/19	Jul	Aug		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
CS 1	**Install new connections in Housing Projects**	**3800**	5000	PLAN	420	840	1,260	1,680	2,100	2,480	2,900	3,320	3,740	4,160	4,580	5,000
				ACT	125	169	174	174	174	224	278	292	346	381	396	450
CS 2	**Install new CABS connections (15mm diameter water meter)**	**2400**	200	PLAN	17	34	51	68	85	98	115	132	149	166	183	200
				ACT	11	38	38	38	38	46	66	67	109	129	144	166
CS 3	**Install Meters in Informal Settlements (including bulk meters)**	**7000**	280	PLAN	24	48	72	96	120	136	160	184	208	232	256	280
				ACT	46	77	77	92	101	101	113	133	148	156	173	187
CS 4	**Install Meters in Rural Areas (Ingonyama Tribal Land)**	**250**	1900	PLAN	170	340	510	680	850	880	1,050	1,220	1,390	1,560	1,730	1,900
				ACT	85	127	208	224	271	401	434	522	664	698	765	851
CS 5	**ICI Upgrades**	**3500**	345	PLAN	30	60	90	120	150	159	169	199	229	259	289	319
				ACT	0	0	0	21	57	57	57	72	87	88	98	103
CS 6	**Investigate Properties/Connec**	**-**	22400	PLAN	2,000	4,000	6,000	8,000	10,000	11,000	12400	14,400	16,400	18,400	20,400	22,400

	tions with Zero/ Unchanging Consumption>90days			ACT	5,265	11,026	15,982	22,812	26,910	30,096	34,279	38,090	43,450	47,050	49,915	53,546
CS 7	**Metering of historically unmetered properties in Housing Projects.**	**3040**	4000	PLAN	350	700	1,050	1,400	1,750	1,950	2,250	2,600	2,950	3,300	3,650	4,000
				ACT	0	41	41	73	123	239	322	738	993	1,093	1,224	1,258
CS 8	**Follow up on Properties with Inactive/Disconnected Connections**	**-**	15000	PLAN	1,250	2,500	3,750	5,000	6,250	7,500	8750	10000	11250	12,500	13,750	15,000
				ACT	3798	7236	10,242	14,132	18,031	20,087	22,777	25,495	27,393	29,497	30,485	31,247
CS 9	**Data Cleansing. Investigate Unmetered Properties/Connections (including NOT on billing system)**	**-**	22500	PLAN	1,875	3,750	5,625	7,500	9,375	11,250	13,125	15,000	16,875	18,750	20,625	22,500
				ACT	8,905	17,058	24,239	31,939	39,059	44,062	50,463	56,243	63,649	69,295	76,010	82,950
CS 10	**Replacement of domestic water meters**	**700**	1085	PLAN	100	200	300	400	500	535	585	685	785	885	985	1,085
				ACT	109	235	248	284	684	684	738	1003	1,293	1,546	1,800	2,000
	TOTAL	**20690**														

Source: Adapted from eThekwini Municipality Non-Revenue Water Reduction Council Report (2020)

4.5.6 Barriers and challenges to effective NRW reduction and WDM

The eThekwini Municipality's annual council reports clearly suggests that there are several challenges and barriers to achieving NRW loss and WDM targets in the Durban metro. An analysis of the main challenges experienced during the 2018/19 financial year are summarized below:

Work stoppages - Several delays were experienced during construction and installations for not following proper workflows as required in standard SCM contracts and procedures. Delays were also caused by some business fora and local communities not allowing internal operational and maintenance teams to carry out their work on site.

Radical Economic Transformation (RET) – Delays were experienced during the tendering and procurement processes. The SCM delays were a result of the integration of a new RET framework, which was not informed by an approved policy for the metro on RET.

Social compliance – There is a general lack of social compliance with respect to the use of water within the eThekwini area of water supply. Many consumers illegally connect to the municipal system, bypass and tamper with meters and are dissatisfied with the level of services being provided. It is against this backdrop that the control and regulation of NRW loss reduction becomes extremely challenging. Enforcement of the department's illegal connection policy has also been difficult to execute due to numerous internal and external legal challenges.

Supply contracts – There have been lengthy delays with significant contracts that are pivotal to the smooth operating of water service provision in the metro, which include, but are not limited to, the supply of pipes, water fittings, meters, service vehicles, protective clothing and bulk water control valve systems. These have collectively led to delays in implementing initiatives linked to the WCWDM plan and strategy.

Billing information – There are constraints with extracting water sales data from the metro's data warehouse repositories. This impacts the WCWDM drive towards

combating NRW loss reduction as it is not possible to benchmark the impact of initiatives being undertaken by the department in the absence of having a full understanding of total water sales for the entire metro.

Capacity and staffing – There are lengthy delays to appoint staff into critical scarce-skills positions, which are vital for the roll-out and management of key capital and operational projects in the metro. This has contributed to the significant delays in achieving NRW reduction targets. The lack of appointments of key operational staff significantly affected both the work-load management and general team morale.

Security – There are operating budget challenges with security needs on key water supply sites where pipe replacements are required for NRW loss reduction. An insufficient budget has been allocated for the security of plumbers in high-risk areas, which negatively affected response times for repairs, reported bursts and leaks.

Rural area strategy - eThekwini Municipality is a unique metro as approximately 60% of the area that it services is rural. Consequently, there is an urgent need for the city to develop and adopt a rural area policy for rolling out essential water services in such areas. These areas do not have a formal cadastral and housing developments and associated water use in these areas, remain largely uncontrolled. The current policy for water services in such areas are also not aligned to the requirements of consumer expectations. This has had a direct impact on the performance of the department as the majority of the new water supply systems being rolled out fall within these areas and metering becomes very challenging as there are no geo-spatial references to link the meters to the metro’s current tariff billing system.

In summary, from the review of relevant literature related to NRW reduction and WDM in the City of Durban, it has become apparent that the water use landscape in the metro is constantly evolving. WCWDM in the city is influenced by a number of causes and effects, such as increasing water shortages, climate change, and existing global and local water demand trends, all of which will have an impact on the metro's long term water security. While some progress is being made through current policy interventions, the measures taken by eThekwini Municipality as part

of its reporting indicates that there is significant opportunity for improvement in various areas. The obstacles and barriers outlined above also suggests that successful implementation of NRW loss reduction and effective WDM in the Durban metro is hampered by a number of economic, technological, political, social, legal, and environmental issues. The 'social compliance' barrier was equally identified as one of the most significant obstacles as there is a general lack of understanding among eThekwini residents about the importance of water conservation and demand management. There is also a general lack of understanding and adequate information regarding how residents should be conserving water.

Current literature studies reveal that most WDM policies and interventions place a strong emphasis on activities within the agricultural sector in SA as they are the regarded as the country's largest water users presently. It can be argued that more research is needed on WDM policy interventions for the domestic/urban sector as well. Lastly, it was also noted that similar to international WDM practices and experiences, most of the current SA's WDM policies, practices and interventions being undertaken in the Durban metro involve the use of 'technological/infrastructure fixes' in support of NRW loss reduction and to achieve WDM targets. There is a clear and immediate need for a more diversified interventional strategy. The immediate inclusion of a 'local user level' participation and contributions in support of more holistic WDM practices, is urgently needed in the City of Durban. In this regard, the municipality needs to develop and implement social media drives, public awareness campaigns and knowledge-sharing sessions about basic water saving tips and practices. These can be regarded as key instruments for moving towards more effective adoption of WDM tools and practices within the Durban metro.

4.6 CONCLUSION

It can be argued that South Africa's old or "traditional" approaches to water demand management, requires urgent reform. WDM policy and interventions should take a more "social" approach, aiming to influence demand and hence improve present levels of water consumption and water use efficiency. A comprehensive range of WC and WDM actions are needed in the country.

The extant literature review revealed that many WDM instruments have a good policy and legal foundation for implementation, and that these instruments are also interdependent. Water billing rates that are effective, political support, and the formation of dedicated task teams (as in the eThekwini Municipality) are all essential factors for success. Other structural, operational, and technological elements, in addition to public knowledge and engagement, are equally crucial tools and instruments to promote the overall success of effective WDM in South Africa and the City of Durban. The national Department of Water Affairs and the eThekwini Municipality, as water custodians, have already implemented several positive interventions and actions to achieve WDM objectives and targets. These are regarded as important first steps in the right direction toward providing benchmarks for measuring WCWDM success in SA. As previously stated, SA has a well-established policy and legislative framework for WDM, and an assessment of these national policies and programs has indicated that existing awareness-raising initiatives, have yielded mixed results. This highlights the significance of not just informing the public about the importance of water conservation, but also on how to preserve water within urban households. The literature revealed important elements influencing water demand, such as conventional metering and how inclining block tariff models are extensively used as the primary WDM instruments across the country. Also, implementing the South African government's constitutional right of 6 Kl of free basic water to every citizen, is a fiercely contentious water policy. As a result, other tools, such as dedicated awareness campaigns on retrofitting water-saving technologies and water-saving devices within urban households, must be co-created and implemented as part of ongoing WDM plans by all municipalities in

South Africa, including the City of Durban. Having focussed on the South African and City of Durban WDM perspectives, the next chapter, Chapter 5, discusses the research methodology followed for this study.

CHAPTER 5

RESEARCH METHODOLOGY

5.1 INTRODUCTION

The research methodologies employed in this study are described in this chapter. The numerous research procedures are discussed, as well as the case study methodology and the explanation for the methodological approaches chosen. The most appropriate methodology for this study, as well as data collection and design methods, are also presented. The chapter concludes with a summary of the measures followed to assure the validity and reliability of the research findings, as well as a discussion of how research ethics have been dealt with.

Research methodology, according to Leedy and Ormrod (2005: 12), is the broad strategy a researcher takes when conducting a study, and it determines the research instruments the researcher uses. In this study investigation, the interpretative approach was employed to investigate a research problem, namely the constructive-interpretative paradigm. This method entailed gaining a better grasp of the context in which respondents live and use water in a city. Individuals create a variety of subjective interpretations for their life experiences (Creswell 2009: 8). The researcher was able to learn more about people's attitudes, behaviours, and perceptions of urban household water consumption, and in so doing, help reduce water demand in the Durban metro. The researcher was also able to generate new ideas and identify challenges and solutions, inside the subject phenomena (Leedy and Ormrod 2005: 134).

5.2 PURPOSE OF THE RESEARCH

According to Coleman and Briggs (2007: 128), research should seek to understand cause and effect linkages. The goal of this study was to better understand household water usage and water-wise behavior in the Durban metro by analyzing behavioural traits, attitudes, perceptions, including the effectiveness of WDM policies, strategies and interventions. The following research objectives guided the study purpose:

- To analyse the impact that socio-economic, attitudinal and behavioural factors have on water saving and consumption practices;
- To identify the key drivers of responsible urban household water use behaviour in support of effective WDM policy reform;
- To identify and evaluate the effectiveness of WDM awareness tools, instruments and interventions targeted at changing water use behaviour for reduced water use; and
- To develop strategies that inform public policy on water demand management and to support effective decision-making on urban household water use demand reduction.

These objectives guided the selection of the chosen research design for this study investigation.

5.3 RESEARCH DESIGN

Research necessitates repeating a search for something and assumes that previous research was insufficient and incomplete in the sense that there is still opportunity for improvement (Yin 2009: 10). As a result, research is an investigation based on prior information. Yin 2009, defines research as a systematic approach of asking questions followed by a detailed process of investigation. Therefore, research is a

methodical examination aimed at increasing the total amount of information on the subject being investigated. The ideas and techniques of logical thought processes that are applied to a specific study are well known in research design (Yin 2003: 11). The research design is an inquiry plan, framework, and method for obtaining solutions to research questions. It also demonstrates the logical sequence of processes that connect the empirical facts to the research questions and, ultimately, backs up conclusions (Yin 2009: 23; Silverman 2006: 17). In agreement, McMillan and Schumacher (2006: 31) define research design as the consideration and creation of methods for obtaining reliable data that may be used to validate or refute claims about the phenomenon. Yin (2003: 5) further suggests that researchers must also clearly decide on what methods they will use to collect and analyse the data.

According to Punch (2005: 10) there are three main sorts of research strategies: qualitative, quantitative, or a mix of both, commonly known as triangulation or a hybrid method. Research strategies can be roughly categorized into two types. The scientific empirical method (quantitative method) and the naturalistic phenomenological method (qualitative approach) (Punch 2005: 15). In their application, both quantitative and qualitative methodologies have strengths and limitations. The accuracy attained through quantitative and trustworthy measurements and controls, which is achieved through suitable sampling and design, is one of the quantitative approach's key strengths (Blaxter *et al.* 2006: 20). However, there are several drawbacks to this method, such as the data providing insufficient detail on unquantifiable human social behaviours, attitudes, and motivations (Silverman, 2006: 16; Bryman and Bell, 2011: 312). Gilham (2000: 5) also advises that quantitative methods may not always be appropriate for real-life events due to their complexity, embedded nature, and specificity.

According to Yin (2009: 15), qualitative research is best used for study aims such as understanding the depth of human behaviour and identifying underlying motivations, feelings, values, attitudes, and perceptions. The findings of qualitative research cannot be statistically projected to the target audience (Blaxter *et al.*, 2006: 25). Furthermore, qualitative research can be too context specific at times, thus the

relevance of generalized theory is unknown until data is gathered and assessed, necessitating a more inductive research approach (Gilham 2000: 8).

Furthermore, most authors recommend that, within reason, a combination of quantitative and qualitative research approaches, can be effectively employed in research. The triangulation, mixed, or hybrid technique is extensively employed because it provides more thorough viewpoints on the phenomena under investigation (Smith et al., 2002: 11). The triangulation methodology was adopted for this study investigation. Semi-structured interviews, questionnaire surveys, direct observation and pilot testing, were used to obtain data. The research used the non-probability sampling method, which is a collection of strategies that allow researchers to select units from a population that are of direct relevance to their research study. Such an approach is supported by Sekeran and Bougie (2009: 252), who asset that this research design is limited to select populations from whom information is readily available on the subject matter under investigation. This design approach enabled the collection and analysis of both quantitative and qualitative data on urban household water use characteristics, such as urban dwellers perceptions, dwelling types, water consumption patterns, and their general knowledge of water-saving practices. The data collected was then statistically analysed and the testing of causal relationships between dependent and independent variables, undertaken.

5.4 HYBRID METHOD APPROACH

Integration of research methodologies is advantageous in some research domains, according to Sale, Lohfeld, and Brazil (2002: 43), because of the complexities of social phenomena and levels of detailed information that is required. Mixed research methods, according to Creswell (2009: 8), is a suitable way of gathering, analysing, and utilising both qualitative and quantitative data within an established design approach. Mixed method approaches, according to Somekh and Lewin (2011: 259), entail the deliberate deployment of two or more different types of data collection and

analysis techniques. The simplicity with which findings can be reconciled and presented is one of the major benefits of hybrid methods of research. Mixed methods approach to social inquiry, according to Somekh and Lewin (2011: 260), are uniquely equipped to provide a greater understanding in various circumstances than research constrained by a single methodological one. This research study used the mixed method approach, which included both, qualitative and quantitative data collection and statistical analysis. The survey questionnaire, for example, included both quantitative and qualitative data collection questions. It was not enough to know how much water was used in a household (quantitative data) without also knowing and explaining why and how that water was utilized by urban dwellers, and how that translates into water conservation and reduced demand policy (qualitative). Secondly, both qualitative and quantitative data was collected during the semi-structured interviews with the water services senior officials. Triangulation, complementarity, development, initiation, and expansion are five methodological purposes for mixed method approaches as identified by Somekh and Lewin (2011). However, the mixed methods technique was adopted for this study primarily for triangulation and complementarity reasons. This was done to give meaning to the data from multiple primary and secondary sources, as well as to supplement quantitative data (ratings and coded closed question responses) with qualitative data (open-ended responses from respondents). The qualitative review also included critically analysing relevant literature on policies, technical reports, published journal articles and other scientific data sources.

Triangulation was used in this study because it sought the integration and substantiation of results from many approaches, improving the validity and plausibility of inferences generated from the data. This study was aided in reaching convergence and corroboration of results by a content review of the entire survey questionnaire administered to urban household water users. Quantitative data were supplemented with qualitative discoveries to achieve complementarity. Interviews with water service providers and water and sanitation officials from eThekwini Municipality and Umgeni Water supplemented the survey questionnaire's water user behavior aspects, making it much easier to understand how water use behavior characteristics should be considered within WDM policy making by the respective

water authorities in KZN. This was achieved by combining a variety of lenses and methodologies to generate a thorough and complete understanding of a complex social phenomena (Somekh and Lewin 2011: 260).

5.4.1 Qualitative research

According to Hays and Singh (2011:15), the earliest origins of social science research may be seen in the studies of different theorists as early as the 15th century, when they sought to understand the "other" (outsider) viewpoint. The goal of qualitative research is to understand a phenomenon by focusing on the complete picture rather than breaking it down into variables; and to create a holistic image rather than a numerical or analytical view only (Ary *et al.,* 2010: 29).

According to Leedy and Ormrod (2005: 133), all qualitative research methodologies share two fundamental characteristics. Firstly, they focus on phenomena that occur in natural settings (the real world), and secondly, they explore those phenomena in all of their intricacies. Leedy and Ormrod (2005: 134-135) further indicate, there are four key goals of qualitative research application:

- **For description**: it reveals the nature of certain situations, settings, processes, relationships, systems or people;
- **For interpretation**: it enables the researcher to gain new insight into a particular phenomenon; develop new concepts or theoretical perspectives about a particular phenomenon; and discover the problems that exist within the phenomenon;
- **For verification**: it allows the researcher to test the validity of certain assumptions, claims, theories or generalisations within real-world contexts; and
- **For evaluation**: it provides a means through which the researcher judges the effectiveness of particular policies and practices.

Qualitative research has several distinguishing characteristics. Purposive sampling, detailed descriptions, including interactive and adaptive research study design (Hays and Singh 2011: 5). These qualities were ideal for this particular study since the researcher was interested in learning more about the phenomena of urban household water use in a natural environment and how it relates to effective water demand reduction (for example, suburb-specific socio-economic characteristics which may impact on WDM planning and policy).

The qualitative research approach used in this study allowed participants to characterize the nature of their situations in terms of the contexts, processes, and systems related to household water use in their own words. These circumstances included how much water they used and for what purposes, as well as whether any water conservation efforts were being made in the households. The presence of various descriptive literature documents on WDM added to the study's qualitative approach. Furthermore, the researcher was also able to analyse the data qualitatively, gaining insight into conditions previous to and after, the evaluation.

Ercikan and Roth (2006:15) also note the following qualitative research contributions to mixed methods studies that are directly relevant to this study:

- Considering how people experience and construct their feelings;
- Developing surveys based on qualitative findings and distributing them to a bigger sample;
- Determining the meaning of scale points (such as categorical judgments);
- Interpreting quantitative findings (e.g., what ratings signify and how to interpret the amount of agreement and disagreement from questionnaire closed questions); and
- Investigating unknown constructions or variables.

The qualitative research approach used in this study allowed participants to describe the nature of their socio-economic, attitudinal, and behavioural characteristics on water consumption; the drivers of responsible urban household water use

behaviour; and their perceptions of the effectiveness of awareness tools, instruments, and interventions aimed at changing water use behaviour at the household level, in their own constructs. Through the open - ended questions in the questionnaire, the qualitative technique was applied in both the household surveys and the semi–structured interviews. A review of applicable national, provincial, and local legislation, as well as the individual water service authorities' policies, strategies, and plans pertaining to water conservation and demand management, were also part of the extensive primary data gathering conducted for this study. These were used to determine if indeed water use attitudes and behaviours had any impact on water consumption in urban households, as well as what that impact might have on future policies and strategies on water demand management and decision-making.

5.4.2 Quantitative research

The quantitative approach is based on the logical positivist ideology, according to Welman, Kruger, and Mitchell (2005: 6), and it underpins the natural scientific method in human behavioural research, which posits that studies must be limited to what can be observed and measured objectively. In order to comprehend, forecast, and regulate occurrences, quantitative research is utilized to answer inquiries about quantifiable variable relationships (Leedy and Ormrod 2005: 94). It also states that what one sees and measures exists despite of one's personal feelings and ideas. According to Ary *et al.* (2010: 11), positivists believe that basic principles or laws govern the social world in the same way that they govern the physical world, and that researchers may discover and use these principles to understand human behavior using objective methods. Quantitative research uses objective measurements to collect numeric data in order to answer questions or test numerical hypotheses (Ary *et al.*, 2010: 22).

This study contains several examples of quantitative data analysis. Using survey questionnaires that were administered directly to urban household residents, the study was able provide the frequency of agreement or disagreement of respondents to various water consumption and behaviour-related statements. Bless and Higson-Smith (2000: 156), argue that the quantitative approach should be carried out utilizing a variety of approaches that use measurement to record and analyse aspects of social reality. The goal of the quantitative research approach was to find explanations and predictions that could be applied to other South African metropolitan cities, with the goal of establishing, confirming, or validating any causal links and developing generalizations that add to theory (Leedy and Ormrod 2005: 95). Quantitative approaches necessitate the definition of concepts, variables, hypotheses, and measurement procedures before the start of the study and also requires application consistency, throughout. The qualitative approach, on the other hand, aims to gain a deeper knowledge of complex situations and is exploratory in nature, allowing observations to build theory from the ground up (Leedy and Ormrod 2005: 95).

5.4.3 Benefits of the mixed methods approach

Mixed research approaches, according to Creswell (2009: 8), provide a research pathway to gather, analyse, and use both qualitative and quantitative data within a structured research design framework. The main benefit of mixed methods research is the simplicity with which results can be reconciled and analysed (Hammond 2005: 241). This study benefited from the hybrid approach because both qualitative and quantitative data were collected and analysed, ensuring the results' validity and dependability. Coleman and Briggs (2007: 31) summarise the advantages of mixed methods research as follows:

- The method allows for increased triangulation of quantitative data from questionnaire ratings and qualitative data from interviews and focus group discussions about the factors that influence water conservation behaviours and perceptions (secondary data).

- The approach allowed for the analysis of a large number of variables because there was no influence over the topic under study;
- The method allowed for the use of a variety of qualitative and quantitative research techniques that were both relevant and useful for this study.
- Finally, the combination of methodologies allowed for a better comprehension of the dependent drivers' relationship (water conservation behaviour) and the independent variables, allowing the research to adapt to changing contexts and circumstances while also acting as a means of triangulation (policy, strategies and plans for water conservation and demand management).

However, there are challenges when employing a mixed methods approach to research. Among the main obstacles is the extent to which techniques can be integrated when they begin from different epistemological viewpoints; the accessibility of information resources for integrated approaches; and the researcher's competence and education to function in that fashion (Coleman and Briggs 2007: 31). Such issues were overcome in this study since both the quantitative and qualitative data were integrated into software programmes that supported the final reported findings and results.

5.5 SAMPLING

Sampling refers to the method used for rationalizing the gathering of data and to select the group of things, people, and events from which the actual data will be drawn from (Bless and Higson-Smith 2000: 83). The majority of research refers to two types of sampling techniques. Firstly, there is probability sampling, which is a sample in which a researcher can specify that each segment of the population will be represented in advance (Leedy and Ormrod 2005:199). The different types of probability sampling are simple random sampling, interval or systematic sampling, stratified random sampling, and cluster or multi-stage sampling. Non-probability sampling, on the other hand, is characterized as a sample in which the researcher

has no way of assuring that all aspects of the population are represented (Leedy and Ormrod 2005:206). Random or accessible sampling, deliberate or judgemental sampling, and quota sampling are all examples of this method (Bless and Higson-Smith 2000: 87).

In this investigation, the non-probability quota sampling method was used. This method is a collection of sampling approaches that aid researchers in selecting units from a population that are relevant to their research. This explanation is backed by Sekeran and Bougie (2009: 252), who claim that this sample design is limited to specified target groups from which information is readily available. As a result, quota purposive sampling was used in this study, which ensured that the selected groups were appropriately representative of the study area by assigning a quota (Sekeran and Bougie 2009: 253). For the first time in KZN, this sample strategy enabled the gathering and analysis of quantitative and qualitative data on urban household water use parameters, such as housing type, water consumption, and usage behaviour. The information gathered allowed for statistical scientific analysis and the examination of causal linkages between the dependent and independent variables.

5.5.1 Target population

According to Sekeran and Bougie (2009: 253), the complete group of individuals, events, activities, or objects of interest that the researcher expects to investigate is referred to as the target population. For the purposes of this study, the target population was defined as all urban household residents dwelling within the City of Durban and more specifically, the residents residing within the 5 case study suburbs located within the metro. The selection of the City of Durban itself was appropriate as this was one of several metros in South Africa that have imposed Level 2 and Level 3 water restrictions during the recent drought periods (2016/2017/2018). Currently, water demand and water restrictions remain a major news item and are strongly debated in SA's national print media. Respondents therefore revealed a heightened sense of awareness of the water-saving issues relating to the need for

more effective WDM and reported many concerns about unsustainable water use, reflecting that concern. As part of the initial research conceptualisation and design process, and to determine a target population for the study, the eThekwini Municipality's Water and Sanitation department was contacted to discuss the purpose and aim of the research. The engagement sessions were co-ordinated by the researcher such that the municipality could strategically advise on the suburbs for selection in the study, since one of the intended key outcomes of the research was to develop guidelines for future WDM policy/strategy interventions for the municipality. Having representation of the different socio-economic and cultural demographics of the city, was equally important. The final outcome of the engagement sessions culminated in eThekwini Municipality proposing 5 suburbs which were recommended for inclusion in the study. The municipality noted that these selected suburbs were representative of the Durban metro in terms of area (extent) coverage as well as key socio-economic and demographic considerations. Additionally, some of the other criteria utilised to determine the final selection of the 5 suburbs were:

- Geographical representation across the metropolitan area, i.e. covering areas in the North Coast, South Coast and inland/upper highway;

- Consideration of housing/property sizes and their associated property values (linked to actual vs perceived water consumption patterns);

- Population density and racial composition with a view to understanding differing water use behaviour; and

- Income levels of residents, i.e. having representation of low, middle and high-income earning areas, and the influence thereof on water use behaviour.

Therefore, the 5 suburbs which formed part of this study were as follows: Phoenix (Metro North); Durban North (Metro North); Amanzimtoti (Metro South); uMlazi (Metro South); and Pinetown (Metro Inner/Upper highway West).

5.5.2 Sample size

A total of 200 household survey questionnaires were collected as part of this research study. Based on the pre-identification of the suburbs indicated above, a series of public spaces (e.g. libraries, parks and recreational grounds) were identified in order to achieve a higher response rate and engage as many community members from that particular suburb as possible. Permission was requested and obtained from home-owner associations to walk from house to house. In addition, tables were set up at shopping centres and malls in order capture as many resident responses in the respective suburbs. A total of 40 survey questionnaire interviews per suburb were conducted over the 5 suburbs, resulting in the 200 surveys. In addition, four semi-structured interviews with senior municipal officials (2 eThekwini Municipality) and water utilities (2 in Umgeni Water) were conducted to augment the quantitative data collection with qualitative data. Tables 5.1 and 5.2 provide further details of the sample size for both the quantitative and qualitative approaches adopted for this study.

Table 5.1: Quantitative sample size

Suburb	**Participant category**	**Number of households**	**Data Collection Method**
Phoenix	Urban household residents	40	Survey Questionnaire
Durban North	Urban household residents	40	Survey Questionnaire
Amanzimtoti	Urban household residents	40	Survey Questionnaire
uMlazi	Urban household residents	40	Survey Questionnaire

Pinetown	Urban household residents	40	Survey Questionnaire
Total		200	

Table 5.2: Qualitative sample size

Organisation	**Participant Category**	**Number**	**Data Collection Method**
eThekwini Municipality Department of Water and Sanitation	Senior Managers – Water Conservation and Non-Revenue Water Branch Water Use and Pollution Control Branch	2	Semi - structured interview
Umgeni Water – Water Use Planning and Business and Strategic Support	Senior Managers –Strategic Support	2	Semi-structured interview

5.6 DATA COLLECTION METHODS

Data can be categorised based on how it was obtained or its inherent characteristics (Bless and Higson-Smith 2000: 97). Primary and secondary data, both quantitative and qualitative, were collected. Primary data is information gathered by the researcher themself. Secondary data is the layer closest to the researcher's impression of the truth, and it is generated from primary data rather than the truth

itself (Leedy and Ormrod 2005: 89). Although both primary and secondary data are acceptable sources of knowledge, primary data is the most reliable, illuminating, and truth-revealing (Leedy and Ormrod 2005: 89). Interviewing senior officials involved in WDM at eThekwini Municipality's Water and Sanitation Department and Umgeni Water (thus obtaining data on NRW strategies, WDM initiatives, water tariffs, billing, and meter management) as well as the household questionnaire surveys on water users' knowledge, perceptions, and attitudes toward water conservation behaviour and practices, provided a comprehensive primary dataset. Numerous publicly available literature documents on WDM and urban household water consumption behaviour made up the secondary data sources of the study. They mostly consisted of prior published research studies and reports, conference proceedings, academic theses, journal articles, newspaper articles, books and the internet, as well as informative images and graphs. To strengthen the credibility of this research study, all of these distinct sources and methodologies were merged. The following sections describe the various tools or instruments used to collect data during the fieldwork.

5.6.1 Questionnaire survey

Surveys are one of the most commonly used quantitative social science research tools. In survey research, a researcher selects a sample of respondents from a population and presents them with a structured questionnaire (Creswell 2009: 29). Participants are asked to answer the identical set of questions in a specified order on a questionnaire. Questionnaires are one of the most widely applied methods for gathering primary data, and they remain the sole method that involves direct contact with people who may be considered representative, based on numerical and statistical criteria (Berestord and Corft 1986; Creswell, 2003 cited in Cavill 2005). When the study objectives (scaling) are accomplished, according to Gray (2004: 12), surveys should be used. In research and statistics, measuring scales refer to the many ways in which variables can be defined and categorized. The term scale of measurement comes from two research keywords: measurement and scale. The process of recording observations obtained as part of a research investigation is known as measurement. The assignment of things to numerical value, is known as

scaling (Creswell 2009: 30). A 5-point Likert scale was employed in this investigation. This scale provided a straightforward scoring system analysis. In a survey, one common use of the Likert scale is to ask respondents to express their thoughts on something by indicating how much they agree or disagree with assertions. The NEP scale is a tool that uses comments about the environment to assess people's environmental awareness and concern. Participants were asked to use the NEP scale to rate their feelings about water use consumption in this research. Surveys can be ‘self–completion questionnaires’ or ‘interview surveys,’ in which the questions are asked face–to–face with participants by someone else, an enumerator. In interview surveys, standard, prepared questionnaires are utilized, which the researcher goes through with the participant. A total of 220 household surveys were conducted for this investigation. Only 200 surveys were completed in full, and therefore only 200 surveys were included in the final dataset for analysis. The survey questionnaire can be found in Appendix 1, and more information about the survey instrument design and fieldwork execution can be found in section 5.7 below.

5.6.2 Semi-structured interviews

One of the most important sources of case study information is the interview (Yin 2009: 21). According to Gray (2004: 15), a well-conducted interview is a powerful tool for extracting rich data about people's beliefs, attitudes, and the meanings that drive their lives and activities. In this research project, interviews were used to acquire primary data on the city of Durban's water conservation and demand management situation, as well as urban household water consumption behavior. Interviews were important sources of confirming evidence as well as providing relevant institutional information. The interview questionnaire used in this study was semi-structured. Four interviews, each lasting about two hours, were done.

5.6.2.1 The interview process

For interviews, key personnel from eThekwini Municipality and Umgeni Water were identified. The researcher personally contacted officials, who confirmed a meeting time and location for the interview. The purpose of the study and the major areas to be addressed by the interview were explained to each official. Interviews were scheduled between January and June 2019 to meet participants' schedules and availability. The participants were told that the interviews would be taped and that all responses would be transcribed. The researcher performed all the interviews, which were then transcribed the next day. Transcription ensures that the most important concerns raised during the interviews are captured as soon as possible. All interviews were conducted in English and respondents were able to express themselves openly.

5.6.2.2 Interview questionnaire

Specific research questions and extra probes were included in the questionnaire, which were integrated and utilized to lead the interview's main topics. The semi-structured interview questionnaire used in this study can be found in Appendix 2. The order of the questions was adjustable, and alterations were made during the interview itself. The survey asked about organizational water demand strategy, WDM policy, regulation, and systemic concerns, public/customer education and awareness, particular instruments and interventions for household water demand management, alternative water source utilization, and learning and collaboration. Officials were chosen based on their previous expertise or specialized knowledge of WCWDM in the metros' water management system. By interviewing multiple employees from the same organisation with similar roles and responsibilities, the sample of respondents was carefully selected to avoid any biases. This guaranteed that all insights into eThekwini Municipality and Umgeni Water's research, education, and awareness programs, as well as the various water-saving interventions/devices being implemented at the household level, were consistent

and standardised. Overall, the interviews yielded adequate qualitative data to provide a complete overview of the key WDM policies, strategies, challenges, and practices in the City of Durban as implemented by the various water services authorities. The findings, as well as some of the significant challenges identified during the interviews, were systematically incorporated into the data analysis portion of this study.

5.7 INSTRUMENT DESIGN

This study utilised the interview survey questionnaire method and the section below provides a detailed breakdown of the key themes and questions that were asked in each section of the survey. The first two sections of the survey related to water-saving practices that the respondents implemented. Depending on the response to such practices (i.e. if they did or did not try to save water), further probing questions were then posed for a better context of the household practices that were used to save water.

The third section focussed on water use perceptions, where the respondents needed to organise various options from most to least effective. The third section also included the New Ecological Paradigm (NEP) scale, as discussed in chapter 2. The NEP scale is an instrument used to determine the environmental awareness and concern of individuals using statements about the environment on a 5-point Likert scale (Anderson 2012: 261). The original NEP scale has 15 items that the respondent can rank using a Likert scale (Anderson 2012: 261), whereas the one used for this study included 19, four additional items from the original NEP scale, dealing specifically with water use attitudes in SA, KZN and the City of Durban.

The fourth section gathered information on perceived household water usage. It also identified the proportions of total water consumption the respondents thought went into various types of household water uses. The categories included drinking and cooking water, grey water, black water, irrigation usage, filling water features or

swimming pools and washing vehicles. Section five probed if households had any additional or supplementary water sources such as rainwater harvesting or ground/borehole water use.

The sixth section related to water use curtailment measures that could already be in place or were intended for implementation in the future. The seventh section related to water-sensitive design and increasing water use efficiency, to distinguish what was currently in place and the possibility of future installations or modifications in the household to save water. Section eight gathered information on whether individuals knew about any current or past water restrictions or regulations, and what these entailed for their household water use. It also provided respondents the opportunity to explain where they had heard about previous water restrictions (if applicable) and how they would like to hear about it in the future. Section nine gathered data on how frequently, or if at all, the respondents experienced leakages on certain water devices ranging from pipes to taps toilets or geysers.

The tenth section gathered information on actual water usage, where/or if water utility bills were readily available. This was directly linked to the municipal bill to determine how much was being paid for water. Section eleven gathered information through questions related to recycling patterns for water and waste management.

Section twelve gathered crucial data on the situational (including socio-economic) factors of the household, which provided the opportunity to understand the City of Durban's water usage and user profiles. The questions were related to property type, property size, erf size, occupants residing in the household, education levels, ages of individuals, gender, race groups, political beliefs, whether the property is owned or rented, as well as what type of water meter was being used. The enumerators also had the ability to note the race and sex of the respondent on the top of the page where the control information was entered. As recommended by Oppenheim (1993: 53), to increase the validity of the data collected from the survey questionnaire, the following activities were taken:

- Other water professionals, including all co-investigators in the study with a social science background, reviewed the questionnaire;
- No biased or suggestive questions were asked;
- The language was straightforward and easy to understand; and
- Questions were worded in a way that allowed them to be easily translated into a local language without losing their meaning.

The fieldwork was carried out by questionnaire enumerators who had received adequate training.

5.7.1 Selection and training of survey questionnaire enumerators

Enumerators for the survey questionnaire were recruited through internship programs at the University of KwaZulu Natal and the CSIR. The students were all Honours and Masters graduates with an environmental and social science undergraduate qualifications background. These students were recruited as volunteers and actively participated in the fieldwork. The UKZN student involvement was part of a wider strategic research collaboration partnership between UKZN and the CSIR Durban office. Students were provided with all meals and transport and were also given formal training, including letters of references for their participation in the fieldwork component of the study. Post-graduate students were only chosen on the basis of their educational levels, as they had already completed undergraduate degrees and had a few years of research study experience on environmental and water-related topics. The students were familiar with the study's five suburbs and were not intimidated by administering the questionnaire by visiting on people's homes on a door-to-door basis. The student enumerators were instructed on the study goals, the nature of the duties, and the logistics that would be involved in the fieldwork. During a full day training program, the recruited students were also formally trained and guided through the entire questionnaire, with the significance and relevance of each topic being clarified. There were also discussions about the obstacles that might be encountered and possible on -site solutions.

5.7.2 Administration of questionnaires

The questionnaires were administered over the course of three months. The research team were in the field for one week at a time. The five suburbs were covered over the period, with enumerators administering 220 door- to-door surveys. However, only 200 were later found to be fully completed and usable for further data analysis.

5.7.3 Fieldwork

Fieldwork was facilitated by the researcher, whereby students were driven around in teams. Two mini-bus vehicles were used to transport each team (called Team A and Team B) to various mapped out routes that had been planned beforehand by the researcher. The survey procedure was to use two teams, where each team comprised 5 students per day. This in turn provided a greater scope and range, thus allowing for a greater number of data recordings. Each day would include visiting the suburb for and doing door-to-door surveys with individuals who resided there.

5.8 DATA ANALYSIS

Data analysis was carried out in order to find consistent patterns in the data (Bless and Higson-Smith 2000: 137). In mixed methods research, data analysis refers to the sort of analytic strategy used in the study. The analysis occurs both within and between the quantitative (descriptive and inferential numeric analysis) and qualitative (descriptive and thematic text analysis) techniques (Creswell 2009: 60-63). Babbie (1998: 465) suggests that there are several things to think about while doing data analysis, including:

- Does the purpose and design of the study call for qualitative, quantitative or mixed analysis?
- Are the statistical techniques used in the analysis of data appropriate to the levels of the measurement of the variables involved?
- Has the researcher undertaken all the relevant analyses and have all the appropriate variables been examined?
- If statistical significance tests were used, are they correctly interpreted?
- Does a particular research finding make a difference and does it really matter?
- Has the researcher gone beyond actual findings in drawing conclusions and implications?
- Are there logical flaws in the analysis and in the interpretation of data? and
- Have the empirical observations of the study revealed new patterns or relationships, thereby providing the bases for new grounded theories?

The quantitative data gathered in this study was analysed with the Statistical Package for the Social Sciences software program (SPSS) Version 24.0 to support compliance with Babbie's framing data analysis list of questions. SPSS is a widely used software package in the social sciences for statistical data analysis. SPSS Inc. developed it, and IBM bought it in 2009. IBM SPSS Statistics was the new name for the product. The software was designed for data analysis in the social sciences, but it has since spread to other sectors including as health sciences, management science, market research, and data mining. The usage of SPSS proved beneficial in the response data analysis and interpretation of specific numerical data. Tables and graphs, as well as explanations of inferential statistics, charts, and frequencies, were used to make the data accessible and explainable. The interviews were recorded and transcribed for qualitative analysis. The transcriptions were then prepared and submitted to the open-source NVivo qualitative data analysis software programme. The use of NVivo helped in the analysis and reduction of transcribed material in order to uncover common patterns and themes. Thematic analysis was used to code and analyse each of the transcribed interview records in order to find

common themes that may be recognized. Thematic analysis was utilized to discover common concepts and themes in relation to household water use behaviour, allowing for a better understanding of the complexity and rich description of urban water use planning and demand management. Iterative data processing and analysis were carried out as follows: The data was rigorously coded, then categorised to reflect the broad ideas that the codes linked to; significant coding themes and relationships were then identified in order to recognize patterns; and conclusions or concepts were developed based on the patterns found in the data. The researcher was able to draw appropriate findings from both quantitative and qualitative methodological techniques using the SPSS and NVivo software data analysis tools.

5.9 AUTHENTICITY OF THIS RESEARCH

It is critical to guarantee that research is authentic. Reliability, validity, and triangulation can all be used to measure this. Authenticity, according to Coleman and Briggs (2007: 91), firstly aids in judging the quality of the researcher's study and, secondly aids in identifying the most appropriate research approach and methodology. The mixed methods approach was chosen as the preferred method in this investigation.

5.9.1 Reliability

According to Jackson (2010: 81), dependability happens when a research instrument measures the very same way each time it is used, and it refers to the probability of getting the same or comparable results by repeating the research procedure or method. According to Dhingra & Dhingra (2012: 51), high reliability and dependability are achieved when a sequence of data measures are repeated and produce identical results. A standardised questionnaire instrument, according to Coleman and Briggs (2007: 92), should be utilized. For the purposes of this study,

all data was collected using a standardised questionnaire instrument. The questionnaire was pilot-tested with residents outside of the five study suburbs, who were not part of the target population, ensuring that the questionnaire would be reliable when used in the field.

5.9.2 Validity

Validity is a criterion for determining if a research study accurately represents the phenomenon that it's designed to explain, inclusive of the research design, methodology, and research results that are meant to take the validity of the process into account (Coleman and Briggs) (2007: 97). Internal and external validity are two types of validity. Internal validity, according to Denzin and Lincoln (1998: 186) is the degree to which study findings accurately represent the subject under inquiry. Internal validity, according to Jackson (2010: 85), is the precision or genuineness of the descriptions (i.e., a measure of accuracy) and if they reflect present reality. Internal validity refers to the impact of urban household water usage behaviour (as a tool) on WDM practice, in this research. External validity refers to the extent to which the findings can be transferred to the larger population reflected by the sample, or to other similar contexts (Dhingra and Dhingra 2012: 48). It's a metric for determining whether or not results are generalizable and reproducible. (Dhingra and Dhingra 2012: 48). The external validity of this study was centred on how the findings could be implemented in other South African metropolitan areas. Furthermore, the terms validity and trustworthiness are often used interchangeably. Trustworthiness, according to Holland and Campbell (2005: 8), can be achieved in research when observers can assess findings based on credibility (internal validity), transferability (external validity), dependability (reliability), and confirmability (confirmability) (for objectivity).To establish internal validity and confirmability of the study investigation, the researcher used national government policies and acts (NWA), guidelines and strategies (NWRS), plans (NWSMP), and reports (council report), as well as pilot-tested questionnaires.

5.9.3 Triangulation

Several authors define triangulation as the gathering of data using a variety of methodologies and from a variety of sources in order to improve the validity and reliability of a research study by adding scope and depth to the research findings and explanation (Creswell 2009; Silverman 2000).

- Data triangulation – triangulation of data sources;
- Investigator triangulation – triangulation amongst different evaluators;
- Methodological triangulation – triangulation of methods; and
- Theory triangulation – triangulation of perspectives on the same data set.

To support the study's eligibility, the first three types of triangulation procedures were applied. Each data gathering method took a different approach to WDM and produced distinct types of data. At the same time, each dataset had its own set of strengths and weaknesses. Triangulation was employed to compensate for gaps in data collection methods and all methods were complementary. The most crucial aspects of WDM were determined in the study by using many sources of published evidence, which is the essence of triangulation. This was the most effective way to improve the research's validity and dependability. Documents, literature, and field results were used to triangulate the conclusions from the semi-structured interviews. To achieve data convergence, data from diverse sources was employed. Triangulation was accomplished using the following methods: (i) survey interviews with diverse urban residents in the 5 suburbs; (ii) documents from various published data sources (see section 5.6 for sources); (iii) semi-structured interviews; and (iv) field notes and observations. Triangulation was done in this study in several steps. Each semi-structured interview was first translated and checked for any claims that were inconsistent (investigator triangulation). The second step involved cross-checking with several sources of data (data triangulation), which included reviewing observations and field notes. Questionnaire surveys were employed as additional source of information to assess public awareness of WDM, and the responses were compared to the context of urban household water usage behaviour to ensure

convergence. Finally, data analysis was conducted using methodological triangulation, which included both quantitative and qualitative methodologies.

5.9.4 Pilot testing of survey questionnaire

A pilot test is used in a research study to see if the questionnaire design has any problems, restrictions, or other flaws, and allows necessary adjustments to be made before the actual fieldwork begins (Vaus 2016: 10). The researcher can use the pilot test to adjust study questions, considering faults, question skips, timing, and respondent interest and attentiveness (Vaus 2014: 116). A pilot test was performed in this study to assess the validity and clarity of the questions being asked. Questionnaires were assessed using a range of information on the study's goal and objectives, as described in section 5.2 above. Questionnaires were given to 25 persons from the five other suburbs, who were not part of the survey's target group. The requisite number of pilot respondents were readily available within the researcher's office/work environment. The primary finding of the pilot test was that the survey should be reduced in length because there were too many questions. As a result of the overlap with other questions in the pilot survey, six items were eliminated. The researcher was able to scrutinize the pilot questionnaires using a redesigned, much shorter questionnaire, ensuring that the final survey questionnaires suited the researcher's requirements, and that each question related to the research topic (Leedy and Ormrod 2005: 192).

5.10 RESEARCH ETHICS

According to Struwig and Stead (2001: 67), participants' rights, dignity, privacy, and confidentiality should always be respected and managed with strict confidentiality. Before participating in any interviews or surveys, all respondents were given a letter of information and then requested to fill out and sign a consent form.

5.10.1 Approval to conduct research

The fieldwork for this study was part of a larger CSIR research study investigation on efficient instruments for demand-side water management in South Africa, with an emphasis on urban domestic water usage at a national level. The Durban University of Technology (DUT) assigned the study full ethical approval, and the FREC letter of approval is attached as Appendix 3.

5.10.2 Informed consent

Informed consent is a technique in which participants choose whether or not to take part in a research study after being informed of information that may impact their decision (Ruan 2005: 21). When dealing with consent difficulties, Leedy and Ormrod (2005: 102) outline crucial information to examine. These were analysed and used to inform the Letter of information (Appendix 4) and consent form (Appendix 5) that were written and utilized for the household survey participants and water service authorities. The following details are included:

- a brief summary of the study's purpose;
- a statement that engagement is optional and that participants may leave at any time without penalty;
- an explanation of what participation would involve in terms of activities and duration;
- a list of any probable dangers;
- a guarantee of privacy and anonymity; the researcher's name and contact information;
- a promise to provide thorough information about the study's findings once it's finished; and
- a place for the participant to endorse and sign the informed consent letter, indicating their willingness to participate in the research.

The enumerators informed all participants of the research objectives and advised that they might choose to participate or decline participation. In other words, participation was totally voluntary. All participants were given an information letter consent form to sign. Consent documents, according to Creswell (2009: 64), should include information about the purpose, the procedures, the ability to ask questions, and how to obtain a copy of the results. As a result, the researcher made every effort to ensure that all of these clauses were included in the letter of information and consent form, and that all participants signed the consent form before starting the interview.

5.10.3 Confidentiality and anonymity

Any research project, according to Leedy and Ormrod (2005: 102), must respect a participant's right to privacy. The researcher used a simple numbering system to classify the participants from the five suburbs examined to ensure total confidentiality and anonymity in this study. To aid thematic coding analysis, each semi-structured interview with eThekwini and Umgeni Water was assigned a letter. Umgeni Water responders, for example, were assigned codes such as member A and B. The information gathered about the participants, according to Pedroni and Pimple (2001: 11), should be kept confidential. This ensures that no one except the researcher has access to any personal data or participant names (Keats 2000: 30). All study participants were promised that their addresses, identities, names, or any other contact information would not be used or disclosed to any third parties in any way. The researcher will keep the data from the questionnaires administered in this study for 5 years, before discarding it.

5.11 CONCLUSION

The chapter has examined the interpretative approach, particularly the constructive-interpretative paradigm, in examining the research problem. A mixed methods

technique was adopted as the main study design during this process. The respondents for the qualitative and quantitative data were chosen through purposeful sampling. Questionnaires were used as the major data collecting method, eliciting information that was confirmed, corroborated, and supplemented by a detailed literature review. The researcher segmented and classified data inductively throughout data analysis to produce themes, categories, and sub-categories. Finally, ethical considerations such as informed consent, confidentiality, and anonymity were considered and applied consistently throughout the study.

The empirical data is presented and analysed in the following chapter.

CHAPTER 6

PRESENTATION AND ANALYSIS OF DATA

6.1 INTRODUCTION

This chapter provides the results of the quantitative analysis of the questionnaire used in this study and examines the findings. The primary data collection instrument was a survey questionnaire, which was completed in full, by 200 respondents. SPSS version 26.0 was utilised to analyse the data received. The descriptive statistics for the data obtained in the form of graphs, cross tabulations, and other figures will be presented in this chapter. Inferential approaches include the use of correlations and chi square test results, which are evaluated using p-values. In the traditional technique of reporting a result, a statement of statistical significance is necessary. A p-value is calculated using a test statistic and "$p<0.05$" denotes a statistically significant outcome.

6.2 SAMPLE

As part of the study, 220 questionnaires were administered across the five suburbs of Phoenix, Durban North, Pinetown, Amanzimtoti, and Umlazi. A total of 196 questionnaires were completed in full and were included in the data set that was further analysed.

6.3 RESEARCH INSTRUMENT

There were 52 items in the research instrument, each with a nominal or ordinal measurement level. There were 12 sections to the questionnaire, which were then organized into four core topics that guided the study's main goals. The four study objectives were to investigate:

1. Socio-economic, perceptions, attitudinal and behavioural factors relating to water saving and consumption practices.

2. Key drivers of responsible urban household water use behaviour in support of effective WDM.

3. Effectiveness of WDM awareness tools, instruments and interventions targeted at changing water use behaviour.

4. Strategies that inform public policy on water conservation and demand management and effective decision making.

The analysis of the data as presented in this chapter is reflected within these 4 study objectives and a number of sub-themes have been analysed in support of investigating the overarching objectives. The sub-themes are as follows:

a) Situational/Socio/Economic and Demographic factors (Obj 1)
b) Water Source/Use/Saving and Consumption Practices (Obj 1)
c) Water use Attitudes/Perceptions and Behaviour (Obj 1)
d) Drivers of Water Saving behaviour (Obj 2)
e) Environmental and Water use behaviour beliefs and perceptions (Obj 2)
f) Tools and Instruments (Obj 3)
g) Effectiveness of tools, instruments use for water saving (Obj 3)
h) Water Demand Policy and Strategy (Obj 4)
i) Public / customer education and awareness (Obj 4)
j) Specific instruments and interventions for household water demand management (Obj 4)
k) Alternative water sources and practices (Obj 4)
l) Learning and collaboration (Obj 4)

6.4 RELIABILITY STATISTICS

Reliability and validity are the two most significant components of precision. Several measurements on the same subjects are used to determine reliability. For a newly developed construct, a reliability coefficient of 0.60 or above is "acceptable." The Cronbach's Alpha scores for each of the questionnaire's items are shown in the tables below.

Table 6.1: Cronbach's Alpha Score: Q16

Cronbach's Alpha	N of Items
0.673	16

Table 6.2: Cronbach's Alpha Score: Q31

Cronbach's Alpha	N of Items
0.801	6

All of the sections' dependability scores are higher than the recommended Cronbach's alpha value. This suggests that the rating for these portions of the research is appropriate and consistent.

6.5 ANALYSIS OF QUESTIONNAIRE

6.5.1 Objective 1 - Sub-themes (a,b,c) - Situational, socio-economic, perceptions, attitudinal and behavioural factors relating to water saving and consumption practices

This section summarizes the respondents' situational, biographical, and socioeconomic factors. The second section of the analysis examines respondents' perspectives on water sources, consumption patterns, and conservation methods, while the third and final section examines water users' attitudes, perceptions, and general water conversation behaviour.

6.5.1.1 Gender distribution by age

The researcher intended to determine how the gender distribution of the respondents differed by age to understand if age influenced responses to water use and conservation activities. The gender distribution by age is shown in the table below.

Table 6.3: Gender distribution by age

What is your age in years?		Gender		Total
		Female	Male	
< 20	Count	1	1	2
	% within What is your age in years?	50.0%	50.0%	100.0%
	% within Gender	1.2%	1.2%	1.2%
	% of Total	0.6%	0.6%	1.2%
20 – 29	Count	26	37	63
	% within What is your age in years?	41.3%	58.7%	100.0%
	% within Gender	31.7%	45.7%	38.7%
	% of Total	16.0%	22.7%	38.7%
30 – 39	Count	29	19	48
	% within What is your age in years?	60.4%	39.6%	100.0%
	% within Gender	35.4%	23.5%	29.4%
	% of Total	17.8%	11.7%	29.4%
40 – 49	Count	11	10	21
	% within What is your age in years?	52.4%	47.6%	100.0%
	% within Gender	13.4%	12.3%	12.9%
	% of Total	6.7%	6.1%	12.9%
50 – 59	Count	8	5	13
	% within What is your age in years?	61.5%	38.5%	100.0%
	% within Gender	9.8%	6.2%	8.0%
	% of Total	4.9%	3.1%	8.0%
60 – 69	Count	4	6	10
	% within What is your age in years?	40.0%	60.0%	100.0%
	% within Gender	4.9%	7.4%	6.1%
	% of Total	2.5%	3.7%	6.1%
70 – 79	Count	2	3	5
	% within What is your age in years?	40.0%	60.0%	100.0%
	% within Gender	2.4%	3.7%	3.1%
	% of Total	1.2%	1.8%	3.1%
80 – 89	Count	1	0	1
	% within What is your age in years?	100.0%	0.0%	100.0%
	% within Gender	1.2%	0.0%	0.6%
	% of Total	0.6%	0.0%	0.6%
Total	Count	82	81	163
	% within What is your age in years?	50.3%	49.7%	100.0%
	% within Gender	100.0%	100.0%	100.0%
	% of Total	50.3%	49.7%	100.0%

Overall, the ratio of males to females is approximately 1:1 (50.3%: 49.7%) (p = 0.568). This reflects an even distribution of males and females in the study. The majority of the respondents in the count fell within the age category of 20 to 29 years. In the age category 30 – 39 years, 60.4% were female and 39.6% were male. Amongst the females only, approximately a third of the respondents were between 20 - 29 years (31.7%), and 30 - 39 years (35.4%). A little less than half of all the

males (45.7%) were between the ages of 20 - 29 years. More than two thirds of the sample (69.3%) was younger than 40 years of age. The age distributions were extremely useful as it indicated a fair proportion of the study respondents were in the prime years of their working careers. Therefore, the nature of the water use responses would have a direct bearing in terms of financial aspects relating to water usage within the households.

6.5.1.2 Total respondents

The Table 6.4 below indicates the total number of respondents from each of the areas that constituted the sample for this study.

Table 6.4: Number of respondents in sample areas

Phoenix	Durban North	Umlazi	Amanzimtoti	Pinetown	Total
40	39	39	42	36	196

There was a similar number of respondents from each of the five selected study areas (p = 0.975). This distribution provided for a good mix of racial and geographical representation of the Durban metropolitan area. The sampled mix of respondents from across the area was also consistent with the racial profiles and demographics of the KZN province in general, e.g. majority Indians in Phoenix, Africans in Umlazi and a mix of Indian and Whites in Durban North and Amanzimtoti, respectively (StatsSA, 2014).

6.5.1.3 Gender distribution and water use behaviour

The gender distribution across the 5 suburbs investigated in this study are presented in Table 6.5 below.

Table 6.5: Gender distribution

		Phoenix	Durban North	Umlazi	Amanzimtoti	Pinetown	Total
Female	Count	22	16	29	21	14	102
	% within Area	55.0%	41.0%	74.4%	50.0%	38.9%	52.0%
Male	Count	18	23	10	21	22	94
	% within Area	45.0%	59.0%	25.6%	50.0%	61.1%	48.0%
Total	Count	40	39	39	42	36	196
	% within Area	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

The data indicates that the Umlazi area had nearly 3 times more females than males and also of significance was that the Pinetown area had more males (61.1%) compared to females (38.9%) ($p = 0.015$). Overall, the distribution indicates that most of the areas contained a similar number of male and female respondents in the study.

The main reason(s) for saving water cited by 48% of the male respondents across the study areas was “water saving was a historical ‘practice” and therefore there was no immediate need for changing water use behaviour.

Female respondents (52%) on the other hand indicated that municipal water restrictions and increasing monthly water costs as the main reasons for implementing water savings in their households. The analysis indicates an increased awareness of females in the City of Durban. Overall, bother male and female respondents did not save water for any environmental reasons but females indicated that the cost of water and constantly increasing bills/tariffs were the main drivers for water saving within the household.

In relation to the gender composition and the main reason(s) for saving water cited by over 48% of the male respondents was that “water saving is a historically inherent practice” and there were very few respondents stating any need towards long term water security, being a key driver of their water usage patterns at home. The ‘conservation’ of water seemed to have been excluded from their everyday life

activities. However, the females in the study cited water restrictions and ever rising water costs as the core reasons for implementing water saving techniques, which suggests to an increased awareness of the water scarcity challenges being faced in Durban and more widely in South Africa.

6.5.1.4 Racial composition and water use behaviour

The racial composition of the selected areas for this study are presented in Figure 6.1 below.

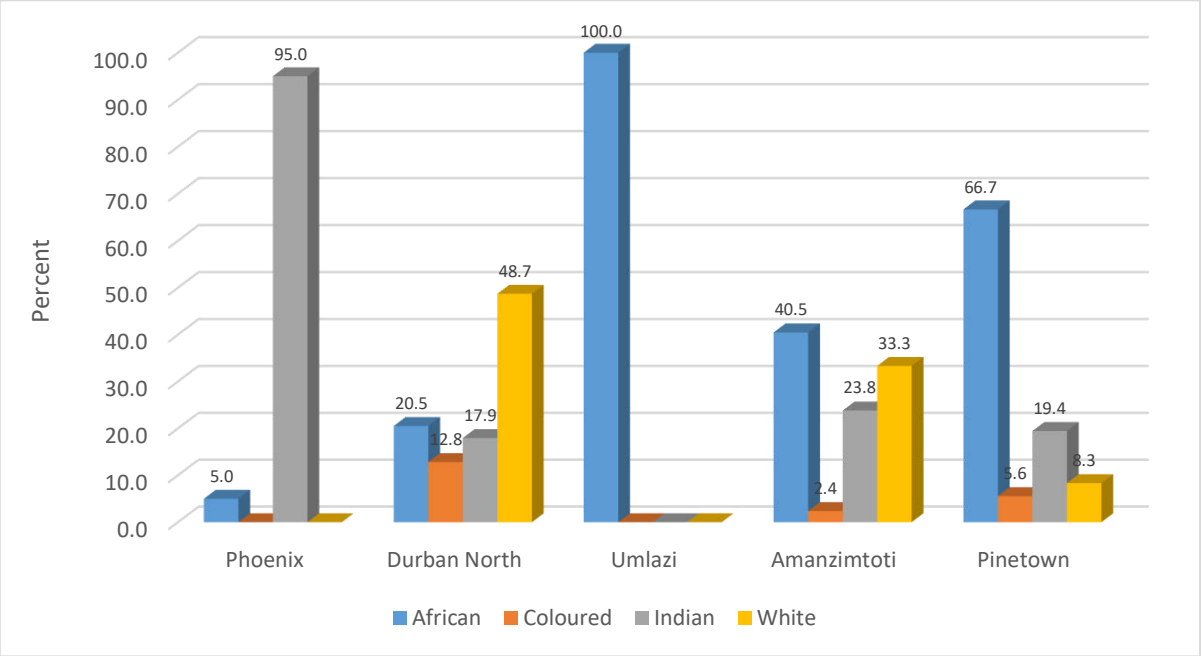

Figure 6.1: Racial composition of households

The areas of Phoenix (95%) and Umlazi (100%) were predominantly Indian and African, respectively. There is a spread of race groups in Durban North, Amanzimtoti and Pinetown, with more African respondents in the latter two, and more Whites in Durban North ($p < 0.001$). These statistics indicate consistency with demographic profiles of the respective areas within the Durban metropolitan area (StatsSA, 2014). Responses were therefore considered extremely valuable and the insights provided had a good racial representation between African, Indian and White respondents and therefore prevented any cultural or racial bias towards water conservation or

usage behaviour between the races groups residing in the City of Durban. The varying socio-economic groupings and the associated responses provided several critical insights to water use behaviour across the city (e.g. access to water in Umlazi, regular pipe bursts and water restrictions in Phoenix and Amanzimtoti which now has a mixed race demographic profile and contrasted to Durban North, where respondents main concerns was their ability to wash vehicles, irrigation and topping up swimming pools.

6.5.1.5 Age of head of household

There were similar numbers of respondents who were younger than 50 years as compared to those who were older than 50 years (binomial p-value = 0.156, cut-off = 50 years).

Table 6.6: Age of head of household

N	Minimum	Maximum	Mean	Std. Deviation
161	24	87	50.02	13.429

The mean and standard deviation was 50.02 (± 13.43) years. The average age for the head of the household being 57 years and the average age of the respondent being 48 years. These ranges suggest a variance for both the head of the household and the study respondents. This range prevented any age response biases; however, the study results does acknowledge a limitation in that fewer millennials or post ‘2000 born’ individuals (the urban household residents and water consumers of the future) that have contributed to this study.

6.5.1.6 Dwelling type and water use behaviour

Table 6.5 presents the percentage distribution of the dwelling types of the respondents by area.

Table 6.7: Dwelling type distribution by area

			Area					
			Phoenix	Durban North	Umlazi	Amanzi mtoti	Pinetown	Total
What is your dwelling type?	Free standing house	Count	11	19	29	20	16	95
		% within Area	44.0%	57.6%	78.4%	51.3%	47.1%	56.5%
	Single-storey duplex	Count	4	3	3	3	0	13
		% within Area	16.0%	9.1%	8.1%	7.7%	0.0%	7.7%
	Double-storey flats/housing complexes	Count	8	5	1	7	6	27
		% within Area	32.0%	15.2%	2.7%	17.9%	17.6%	16.1%
	Multi-storey flats	Count	1	0	0	5	3	9
		% within Area	4.0%	0.0%	0.0%	12.8%	8.8%	5.4%
	Informal dwelling /shack	Count	0	0	3	2	2	7
		% within Area	0.0%	0.0%	8.1%	5.1%	5.9%	4.2%
	Residential	Count	1	6	1	1	6	15
		% within Area	4.0%	18.2%	2.7%	2.6%	17.6%	8.9%
	Don't know	Count	0	0	0	1	0	1
		% within Area	0.0%	0.0%	0.0%	2.6%	0.0%	0.6%
	Refuse to answer	Count	0	0	0	0	1	1
		% within Area	0.0%	0.0%	0.0%	0.0%	2.9%	0.6%
	Total	Count	25	33	37	39	34	168
		% within Area	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

A total of 95 respondents (56.5%) of the respondents indicated that they were living in free standing houses. The remaining dwelling types accounted small percentages of the total which included single story duplexes (7.7%), double story flats/apartments/complexes (16.1%) and informal dwellings (4.2%). It is important to highlight that the study sample is predominated by respondents who lived in free-standing houses. Further research into urban household water use behaviour in the City of Durban will need to consider larger numbers of alternative dwelling types and respondents associated behaviour towards water conservation practices. A particular focus will need to be placed on surveying dwellings such as multi-storey flats, formal and informal settlements. It is asserted that these water consumers

could provide additional and novel water conservation practices insights due to their confined living spaces and their limited access and needs for water.

6.5.1.7 Household size and water use behaviour

The household size pertains to the number of individuals that permanently reside at the given respondents' residence, thus providing important information on how big the household is in terms of population and associated water consumption and saving practices. Table 6.8 illustrates the percentage distribution of the population size residing in the respective dwellings across the study area.

Table 6.8: Household size by area

			Area					
			Phoenix	Durban North	Umlazi	Amanzimtoti	Pinetown	Total
Household size	Small or single parent (1-3 members)	Count	11	10	8	14	13	56
		% within Area	37.9%	29.4%	21.6%	34.1%	38.2%	32.0 %
	Average/nuclear (4 members)	Count	10	9	5	5	8	37
		% within Area	34.5%	26.5%	13.5%	12.2%	23.5%	21.1 %
	Extended (4-8 members)	Count	5	8	15	12	10	50
		% within Area	17.2%	23.5%	40.5%	29.3%	29.4%	28.6 %
	Large extended (more than 8 members)	Count	1	5	5	2	3	16
		% within Area	3.4%	14.7%	13.5%	4.9%	8.8%	9.1%
	Multiple family (more than one household but with one municipal bill)	Count	0	1	4	3	0	8
		% within Area	0.0%	2.9%	10.8%	7.3%	0.0%	4.6%
	Don't know	Count	1	1	0	3	0	5
		% within Area	3.4%	2.9%	0.0%	7.3%	0.0%	2.9%
	Refuse to answer	Count	1	0	0	2	0	3
		% within Area	3.4%	0.0%	0.0%	4.9%	0.0%	1.7%
	Total	Count	29	34	37	41	34	175
		% within Area	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %

The study area had a similar proportion by household size (p = 0.141). The most populous house size had an average of 1- 4 persons, defined as a nuclear family or a ‘small’ household (53%). The majority of households (32%) had one to three members residing permanently at that household. Very few households had more than 8 members or had multiple families residing at that residence, with the latter indicating a cumulative total of 8 or 4.6%. A typical 4 - person South African household consumes much more water when compared to international benchmarks (Mata *et al*, 2018). The average urban domestic water use in SA is around 237 litres per person per day, 64 litres per person per day more than the world average of 173 litres per person per day (NWSMP, 2018).

The Durban metro study sample shows consistency with the SA average urban household ‘excessive’ water consumption profile. It is worth noting that the study sample was somewhat limited in the analysis of the different household sizes and may not necessarily be fully representative of the extended nuclear family households living within the City of Durban.

6.5.1.8 Education levels

Table 6.9 shows the percentage distribution of the levels of education obtained by respondents who resided in the households.

Table 6.9: Education level of the respondents

			Area					
			Phoenix	Durban North	Umlazi	Amanzimtoti	Pinetown	Total
What is your highest level of education obtained?	Completed senior primary school (Grade 7)	Count	1	0	1	2	0	4
		% within Area	3.3%	0.0%	2.7%	5.1%	0.0%	2.3%
	Completed Grade 10	Count	2	2	4	3	4	15
		% within Area	6.7%	5.7%	10.8%	7.7%	11.8%	8.6%
	Completed high school (Grade 12)	Count	17	9	18	11	16	71
		% within Area	56.7%	25.7%	48.6%	28.2%	47.1%	40.6 %
	Completed undergraduate degree	Count	3	13	3	9	7	35
		% within Area	10.0%	37.1%	8.1%	23.1%	20.6%	20.0 %
	Completed TVET and/or other college	Count	3	6	6	8	3	26
		% within Area	10.0%	17.1%	16.2%	20.5%	8.8%	14.9 %
	Completed postgraduate degree	Count	2	4	3	4	2	15
		% within Area	6.7%	11.4%	8.1%	10.3%	5.9%	8.6%
	No schooling	Count	2	0	1	1	0	4
		% within Area	6.7%	0.0%	2.7%	2.6%	0.0%	2.3%
	Refuse to answer	Count	0	1	1	1	2	5
		% within Area	0.0%	2.9%	2.7%	2.6%	5.9%	2.9%
	Total	Count	30	35	37	39	34	175
		% within Area	100.0%	100.0%	100.0%	100.0%	100.0%	100.0 %

There were similar qualification levels amongst the respondents by area (p = 0.401). Most respondents had completed matric (40.6%), with 20% having done an undergraduate degree. This is an important finding as a little less than half of the respondents had a post school qualification. This would imply that the responses were received from an informed educated viewpoint regarding water conservation and saving practices, with approximately 60% of respondents having had some form of basic and tertiary educational qualifications.

6.5.1.9 Household tenure and water use behaviour

Overall, the data contained in Figure 6.2 indicates that 119 (69.2%) of the respondents owned their property, whereas 29.1% (50) of the respondents were renting at the time of the study. A very small number of respondents (1.2%) refused to answer. It is evident from Table 6.7 above, regarding dwelling types, that the majority of the respondents lived in free-standing houses and this allowed for the assumption that the majority of respondents were homeowners and probably received a monthly water bill and water was not included in a rental price or through a fixed levy (such as in sectional title agreements). The vast majority of respondents can therefore be considered to be paying (monthly) for the water that they utilise within their households and this variable had a direct bearing and reflected causal relationship on their water saving practices and consumption behaviour.

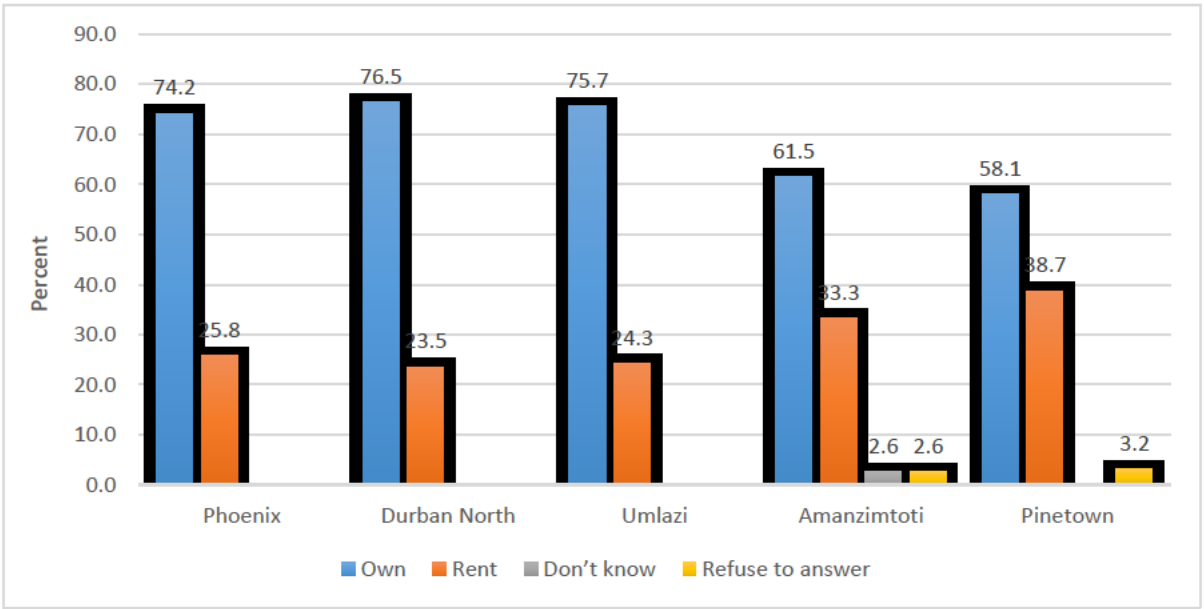

Figure 6.2: Household Tenure

6.5.1.10 Household water use(s) and behaviour

From the eight activities listed, 4 of them showed no significant statistical variances between the areas. However, the highlighted p-values in Table 6.10 below indicates the significant differences found between the areas in relation to following water consumptive practices:

- Consumption by persons and animals i.e. for drinking and cooking food
- Topping up water features
- Topping up swimming pool
- Washing vehicles

An inspection of the ANOVA tests adjusted for Kruskal Wallis, identifies the differences by areas where this occurred. For example, when it came to “Consumption by persons and animals i.e. for drinking and cooking food”, it was found that there were significant differences between Durban North - Amanzimtoti ($p = 0.008$) and Pinetown-Umlazi ($p = 0.048$). Furthermore, it is observed that in all areas, most respondents (34.4% on average) indicated that water was used for consumption by persons and animals i.e. for drinking and cooking food. Durban North had a significantly lower value than the other areas. The consumptive practices in Durban are consistent with the reviewed literature studies indicating that the largest increase in water demand by 2035 will come from the municipal sector in SA. Municipal water demand is predicted to increase from 5.5 km3 in 2014 to 7.2 km3 by 2035 (Hedden and Cilliers 2014: 5). As a result, larger and far-reaching WDM initiatives in this sector are required to narrow the expanding water supply-demand gap in South Africa. Rising income levels and increased rural-urban migration, particularly in the provinces of Kwa-Zulu Natal, Gauteng, and the Western Cape, are mostly to blame for the increase in municipal water demand (Go *et al*. 2013: 13)

Table 6.10: Household water use and water use behaviour

	Phoenix				Durban North				Umlazi				Amanzimtoti				Pinetown				
	Count	Mean	Median	Standard Deviatio	Count	Mean	Median	Standard Deviatio	Count	Mean	Median	Standard Deviatio	Count	Mean	Median	Standard Deviatio	Count	Mean	Median	Standard Deviatio	Krushka l Wallis p-value
Consumption by persons and animals i.e. for drinking and cooking food	40	37.31	30.00	17.51	39	25.58	22.50	7.79	39	39.46	40.00	18.82	42	38.65	35.00	19.21	36	31.00	27.50	16.11	0.018
Household activities resulting in 'black water' i.e. water from toilets	40	20.00	20.00	7.36	39	22.50	22.50	4.30	39	20.36	20.00	7.81	42	18.27	20.00	5.82	36	21.50	20.00	6.90	0.053
Household activities resulting in 'grey water'	40	20.00	20.00	8.16	39	18.65	20.00	4.14	39	16.43	17.50	7.05	42	16.73	20.00	6.62	36	22.00	20.00	11.29	0.183
Irrigation for watering of lawns, gardens and pot plants	40	15.38	15.00	7.76	39	13.85	15.00	3.82	39	13.75	15.00	7.41	42	13.08	12.50	6.01	36	13.75	12.50	5.59	0.740
Irrigation for fruit and vegetable gardens	40	1.92	0.00	3.25	39	0.19	0.00	0.98	39	1.61	0.00	2.74	42	3.65	0.00	6.57	36	1.25	0.00	3.19	0.085
Topping up water features	40	2.31	0.00	4.84	39	2.88	0.00	4.04	39	0.36	0.00	1.89	42	0.38	0.00	1.36	36	1.25	0.00	2.75	0.009
Topping up swimming pool	40	0.38	0.00	1.39	39	6.35	5.00	5.93	39	0.18	0.00	0.94	42	2.69	0.00	4.74	36	3.25	0.00	4.06	0.000
Washing vehicles	40	2.69	0.00	3.30	39	10.00	10.00	6.00	39	8.04	10.00	5.67	42	6.54	5.00	4.64	36	6.25	5.00	3.93	0.004

From a further analysis as represented in Figure 6.3 of water use specifically for the purposes washing of vehicles, it was found that there were significantly different correlations relating to the frequency of vehicles being washed in the different areas ($p = 0.002$). Two-thirds of the respondents from Umlazi (65.6%) do not wash their vehicles at all whilst residents in Durban north washed their vehicles every week (25,7%) and every two weeks (34,3%), which indicates a significantly higher residential water consumption, for this particular water use activity. This could be ascribed to the contrasting socio-economic status of the two areas in terms of income levels. The data indicates that unlimited access to water supply and the ability to pay for water consumed is influenced by the socio-economic status of the two areas in terms of income levels and the desire or need to wash their vehicles frequently. It will be important that any public policy on water conservation and water demand management, take cognizance of these economic inequality boundaries as they relate to access and water use in the metro.

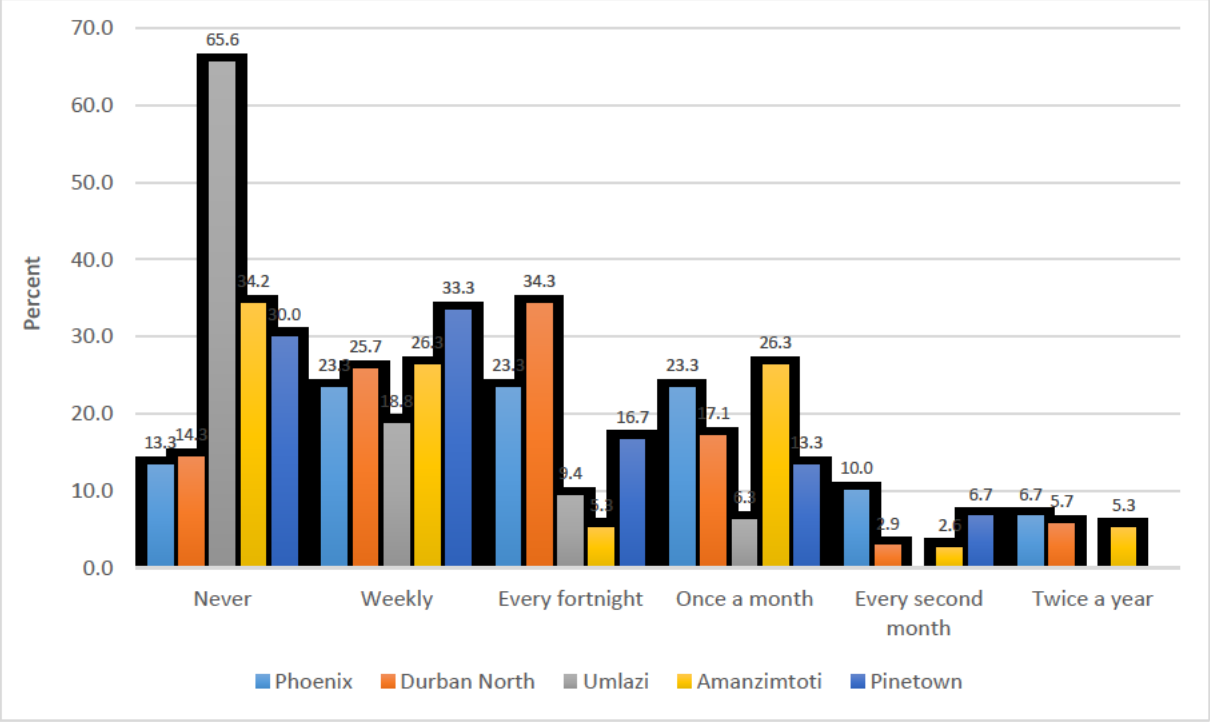

Figure 6.3: Frequency vehicle washing

6.5.1.11 Water supply and water use behaviour

The main source(s) of water supply was municipal water (average 96.7%) received municipal water (p = 0.139). Only one respondent from Amanzimtoti indicated that they received water from a tanker service and this was due to municipal restrictions and water rationing at the time of the survey. Data indicates a total reliance on municipal water supply as their primary water source and no other supply sources or alternate water supply sources were prevalent in the City of Durban. Therefore, it will be imperative that any water saving interventions aimed at reducing household water consumption will have to be devised and implemented at the utility level i.e. via eThekwini Municipality to support an overall water demand reduction at the urban household level.

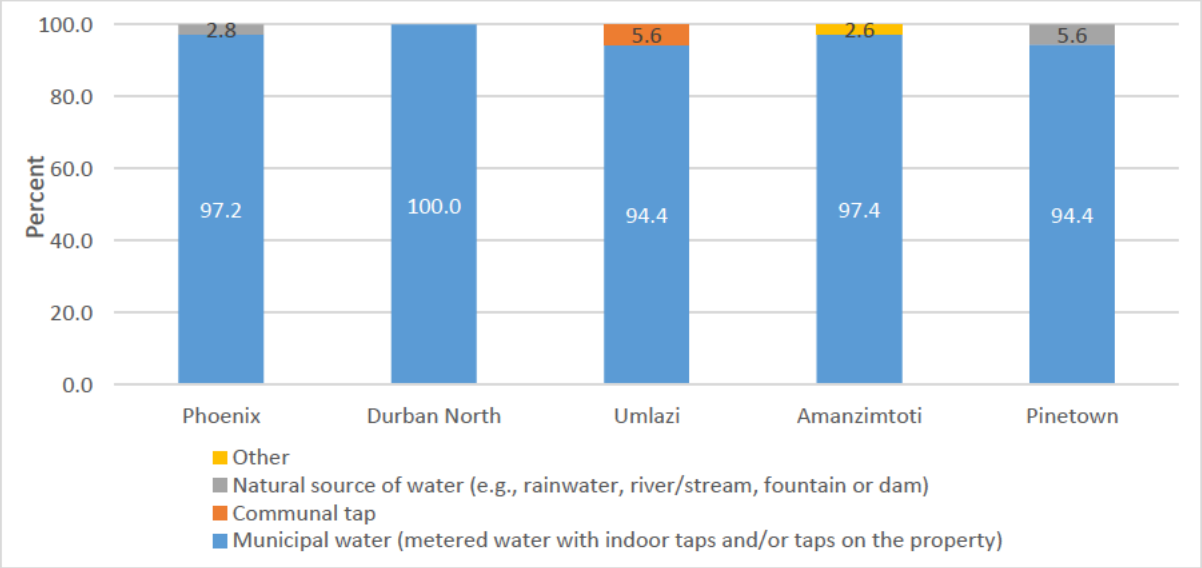

Figure 6.4: Main source of water for drinking and food preparation

6.5.1.12 Water saving practice(s)

In relation to the most significant water saving practices or measures that residents deployed, it can be noted from Table 6.11 that there was no significant variances of note between the areas except for manual grey-water reuse (p = 0.010). Several

respondents from Umlazi used grey water, as compared to the other areas surveyed in the study. This finding once again reflected the vast socio-economic inequalities prevalent in the City of Durban in terms of access and use of water, as residents in Umlazi who generally are low to middle income earners have inherently adopted grey water reuse in their households, as compared to the more affluent and higher income earning residents residing in Durban North and Amanzimtoti. Residents in such areas are economically advantaged and are financially able to pay for their water use and therefore, do not generally reuse their grey water. It is also noted that most residents within the City of Durban, did not invest or use readily available water saving technologies and devices (e.g. low flow regulators, smart meters or dual flush toilets). Once again, such water saving practices will need to be driven by the Municipality either in the form policy and legislation, including incentivizing the adoption of these technologies. Water saving practices which are linked to social norms are important factors when it comes to water conservation behaviour and they symbolise the pressure of moral obligation (Russell and Fielding 2010: 8). Such norms will encourage people to either conserve water or to continue using water wastefully. In order to promote positive water conservation behaviour at the level of society or a community, it is important to develop a shared identity with a common interest to conserve water. Regarding such positive behaviour, it is important to mention social desirability, which is defined as the extent to which individuals feel they should display behaviours that others will positively evaluate.

However, social norms can also encourage undesirable water use behaviour. For example, people can use the perceived excessive or wasteful use of water by others as an excuse to justify their own wasteful water use. Furthermore, social norms often make it difficult for positive environmental behaviour to be adopted. Several behavioural theories reviewed in this study have confirmed that individual behaviour is shaped by the society in which it exists. The study by Troy and Randolph (2006) found that wasteful household members were not socialised to conserve water when they were growing up (Troy and Randolph 2006: 9). This seems to be case in the City of Durban residents' water saving practices patterns as well.

Table 6.11: Water-saving measures deployed by households

		Phoenix		Durban North		Umlazi		Amanzimtoti		Pinetown		Chi Square p-value
		Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	
Constant flow regulator	Yes	2	5.0%	3	7.7%	3	7.7%	3	7.1%	2	5.6%	0.983
	No	38	95.0 %	36	92.3 %	36	92.3 %	39	92.9 %	34	94.4 %	
Smart metering	Yes	2	5.0%	4	10.3 %	1	2.6%	5	11.9 %	5	13.9 %	0.351
	No	38	95.0 %	35	89.7 %	38	97.4 %	37	88.1 %	31	86.1 %	
Water-saving shower heads	Yes	5	12.5 %	7	17.9 %	1	2.6%	8	19.0 %	6	16.7 %	0.200
	No	35	87.5 %	32	82.1 %	38	97.4 %	34	81.0 %	30	83.3 %	
Dual flush toilets	Yes	8	20.0 %	8	20.5 %	4	10.3 %	5	11.9 %	5	13.9 %	0.610
	No	32	80.0 %	31	79.5 %	35	89.7 %	37	88.1 %	31	86.1 %	
Eco-settings on dishwashers and washing machines	Yes	4	10.0 %	10	25.6 %	4	10.3 %	4	9.5%	2	5.6%	0.071
	No	36	90.0 %	29	74.4 %	35	89.7 %	38	90.5 %	34	94.4 %	
Timed sprinklers	Yes	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	-
	No	40	100. 0%	39	100. 0%	39	100. 0%	42	100. 0%	36	100. 0%	
Manual grey-water reuse	Yes	8	20.0 %	9	23.1 %	21	53.8 %	12	28.6 %	10	27.8 %	0.010
	No	32	80.0 %	30	76.9 %	18	46.2 %	30	71.4 %	26	72.2 %	
Other	Yes	1	2.5%	0	0.0%	0	0.0%	0	0.0%	1	2.8%	0.524
	No	39	97.5 %	39	100. 0%	39	100. 0%	42	100. 0%	35	97.2 %	
Don't know	No response	39	97.5 %	38	97.4 %	39	100. 0%	41	97.6 %	35	97.2 %	0.642
	Yes	0	0.0%	1	2.6%	0	0.0%	0	0.0%	0	0.0%	
	Don't know	1	2.5%	0	0.0%	0	0.0%	1	2.4%	1	2.8%	
Not applicable	No response	30	75.0 %	28	71.8 %	30	76.9 %	28	66.7 %	32	88.9 %	0.037
	Yes	6	15.0 %	4	10.3 %	2	5.1%	1	2.4%	0	0.0%	
	Not applicable	4	10.0 %	7	17.9 %	7	17.9 %	13	31.0 %	4	11.1 %	

6.5.1.13 Water use attitudes, perceptions and behaviour

The respondents were required to provide information of known household level water saving techniques or behaviours and it can be noted from Figure 6.5 that all households within the 5 areas indicated some degree of water saving behaviour being adopted within their homes.

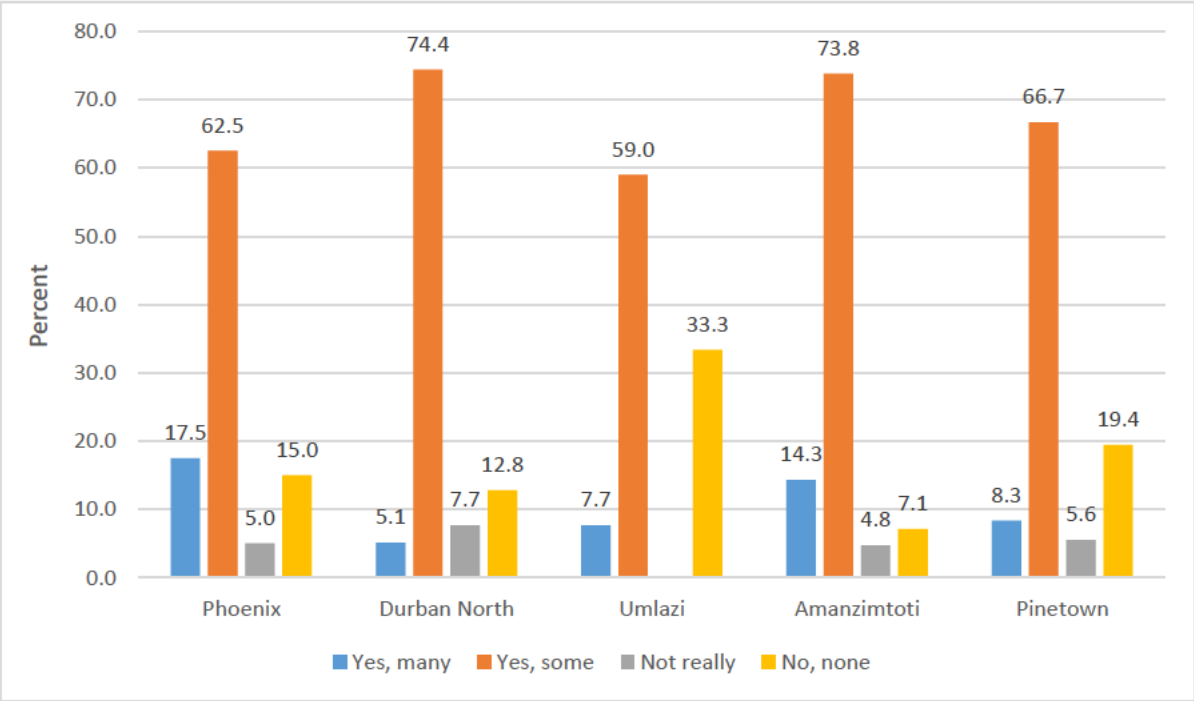

Figure 6.5: Water saving practices and behaviour

The scoring patterns from the analysis done across the areas were similar ($p = 0.165$). In all the areas, there were many respondents making some efforts to increase their water saving practices as compared to those not making any effort at all. Respondents from Phoenix (62.5%), Durban North (74.4%) and Amanzimtoti (73.8%) had the largest level of participation. This demonstrates that residents in the metro would be willing to adopt any proposed water saving opportunities that maybe introduced by the Municipality. Overall, significantly more respondents in each area ($p < 0.001$) undertook some form of water saving practices.

The respondents were also questioned about the period around when they had started to save water or introduced any water saving technologies or practices within their households. There was no significant difference in the patterns between the different areas (p = 0.786). Figure 6.6 indicates that on average, 27.4% of the respondents started water saving practices more than 10 years ago, with similar numbers having started between 5-10 years, and between 2 to 5 years ago. This analysis reflects that approximately 30% of the Durban metro's residents have been practicing some form of water saving from as far back as 10 years ago.

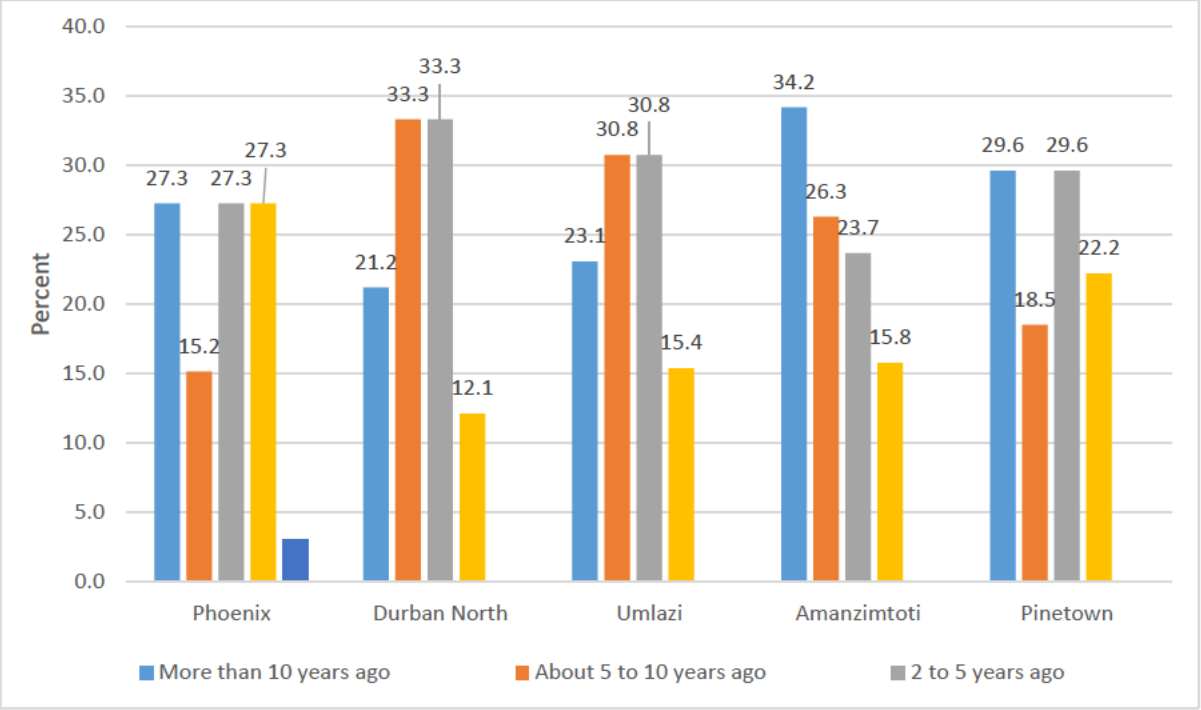

Figure 6.6: Time period of water saving practices

The analysis further suggests that more recent water saving practices between i.e. 2-5 years ago, have also been driven by recent droughts and water restrictions in the Durban Metro. Overall, many residents' attitudes and perceptions of water saving were attributed to recent droughts and water restrictions instituted across SA. Several respondents indicated the City of Cape Town 'day zero' case example, and rising water costs, as the main reasons for saving water within the household for both indoor and outdoor discretionary uses.

6.5.2 Objective 2 (Sub themes (D, E) - Key drivers of responsible urban household water use behaviour in support of effective WDM

6.5.2.1 Water saving influences on consumption behaviour

This objective aimed at identifying the key drivers or influences of responsible urban household water use behaviour in support of effective water conservation and water demand management. Table 6.12 and Figure 6.7 below presents the ranked descriptive statistics for factors that contributed to households reducing their water use. These are considered to be the most significant drivers that could influence water saving practices in the Durban metro and inform future policy on WDM.

Table 6.12: Factors causing households to reduce municipal water use

	Phoenix				Durban North				Umlazi				Amanzimtoti				Pinetown				Total					
	N	Mean	Median	Std. Deviation	N	Mean	Median	Std. Deviation	N	Mean	Median	Std. Deviation	N	Mean	Median	Std. Deviation	N	Mean	Median	Std. Deviation	N	Mean	Median	Std. Deviation	Krushkal Wallis p-value	
General water restrictions	28	3.71	3.00	2.07	30	4.00	4.00	2.13	23	3.04	2.00	2.27	28	3.79	4.00	1.95	27	4.56	5.00	2.31	136	3.85	4.00	2.16	0.354	Q14a
Assistance to implement water-saving measures (e.g., constant flow regulators, smart metering, water-saving shower heads, etc.)	30	2.63	2.00	1.87	31	2.45	2.00	1.36	22	3.23	3.00	1.82	30	3.40	3.50	2.21	25	3.32	2.00	2.01	138	2.98	2.00	1.89	0.753	Q14b
Assistance to implement water-sensitive design measures (e.g., water harvesting, grey-water recycling, permeable paving, etc.)	27	3.78	3.00	1.89	27	2.67	2.00	1.92	24	3.04	3.00	1.76	28	3.00	3.00	1.81	22	3.32	3.00	2.03	128	3.16	3.00	1.89	0.236	Q14c
Tax incentives for reducing or limiting water use	26	3.12	2.50	2.16	27	3.63	4.00	2.00	23	3.35	4.00	1.90	29	3.83	4.00	1.97	21	3.33	3.00	1.53	126	3.47	3.00	1.93	0.650	Q14d
Water rate increases (simply increasing the cost of water to meet demand)	28	4.07	4.00	2.37	26	5.27	5.00	1.43	22	4.45	5.00	1.99	28	5.18	6.00	2.02	22	4.45	5.00	2.06	126	4.70	5.00	2.03	0.567	Q14e
Fines for increasing use or using water above a certain quantity	26	4.50	5.00	2.16	26	4.38	5.00	1.68	23	4.17	5.00	1.97	27	3.96	5.00	2.05	21	4.05	4.00	1.80	123	4.22	5.00	1.92	0.512	Q14f
Naming and shaming of our neighbourhood for increasing use or using water above a certain quantity	27	4.81	5.00	2.30	26	5.46	6.00	1.98	23	5.43	6.00	1.80	27	4.93	5.00	2.13	22	4.64	4.00	1.92	125	5.06	6.00	2.04	0.758	Q14g
Not applicable – I/we do not intend to reduce our future municipal water use	2	3.50	3.50	3.54	2	1.00	1.00	0.00	6	2.00	1.00	2.45	2	1.00	1.00	0.00	3	1.00	1.00	0.00	15	1.73	1.00	1.94	0.484	Q14h

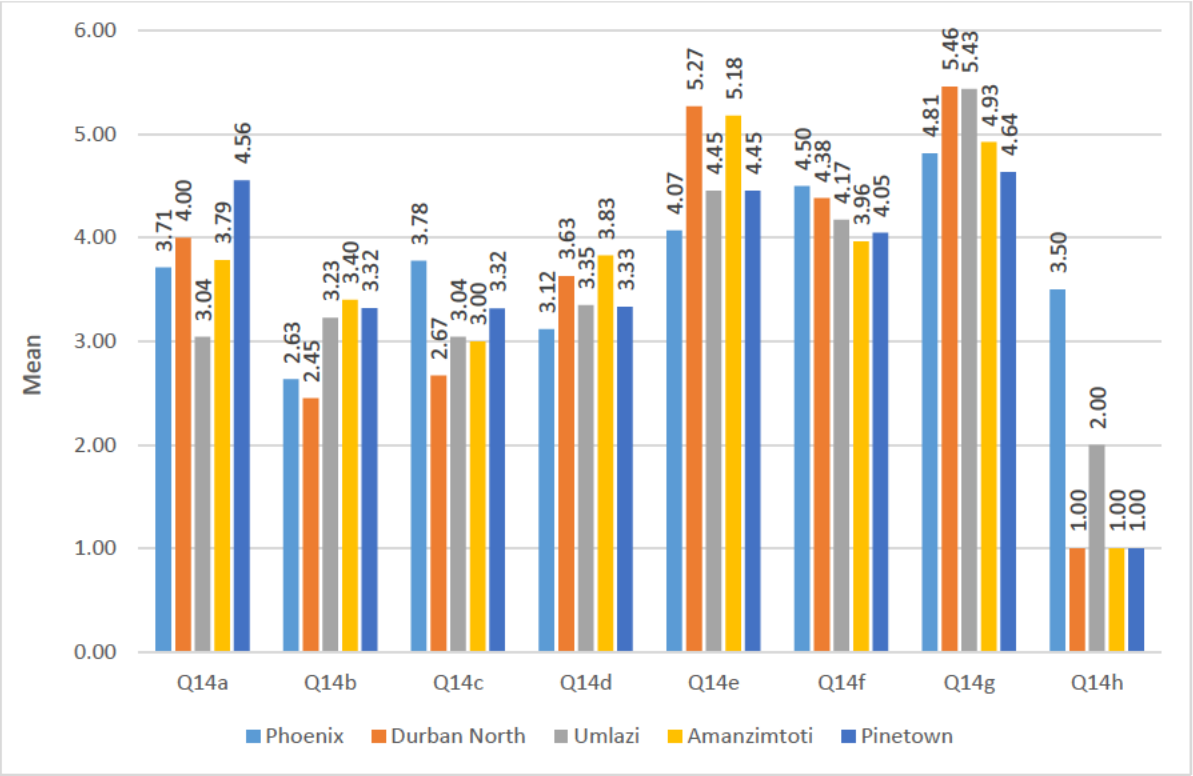

Figure 6.7: Ranking of factors influencing water saving (1 - being most effective) to 7 - being least effective)

From the ranking analysis it is evident that many respondents from Durban North, Amanzimtoti and Pinetown indicated that they had no plans to change their water usage patterns which is quite concerning given a predicted water deficit in SA by 2030 of 17% (NWSMP, 2018). Moreover, there were no significant statistical differences by area for each of the key factors. Most important to note is the statements that ranked the most effective in terms positively influencing or driving water saving practices were 14b, 14c and 14d and these are further reflected upon in Table 6.13 below.

Table 6.13: Top 3 drivers influencing water saving practices

	Weighted Mean	Rank	
Not applicable – I/we do not intend to reduce our future municipal water use	1.73	1	Q14h
Assistance to implement water-saving measures (e.g., constant flow regulators, smart metering, water-saving shower heads, etc.)	2.98	2	Q14b
Assistance to implement water-sensitive design measures (e.g., water harvesting, grey-water recycling, permeable paving, etc.)	3.16	3	Q14c
Tax incentives for reducing or limiting water use	3.47	4	Q14d
General water restrictions	3.85	5	Q14a
Fines for increasing use or using water above a certain quantity	4.22	6	Q14f
Water rate increases (simply increasing the cost of water to meet demand)	4.70	7	Q14e
Naming and shaming of our neighbourhood for increasing use or using water above a certain quantity	5.06	8	Q14g

Respondents' top-ranked driver was regulatory in nature, and it refers to tax rebates or financial incentives that water service authorities should offer to people who implement and practice water conservation in their households. This appears to be in line with the international and national literature, and many water utilities throughout the world have employed financial incentives as a key water conservation and demand management tool. The second ranked driver was noted to be providing assistance to urban household water users with information and support to implement water-sensitive design measures (e.g. onsite water harvesting systems, grey-water recycling). The third highest ranked driver was the need for government/utility assistance to implement water-saving technology measures (e.g. constant flow regulators, smart metering, water-saving shower heads, dual flush toilets, or zero flush toilets). The findings in the City of Durban are consistent with the reviewed literature as pricing of water is arguably the most common factor influencing water conservation and demand management in SA. Water is generally accepted to be price-inelastic, especially for indoor water demand; whilst in contrast, outdoor water demand is highly responsive to price in SA (Jacobs et al. 2006: 4). This is explained by the increase in price elasticity during the summer months when people become more conscious of water usage. However, Kashian et al. (2012: 100) point out that most people do not realise the marginal prices paid for water, thus they are not as likely to be affected by a slight price increase. By reviewing studies in several developed countries, Kashian et al, have justified why an

individual's water bill is a very small portion of their total monthly expenditure, thus unless water prices become exorbitantly higher month on month, not much attention will be given to the price (Kashian et al. 2012: 100). Therefore (pricing) via tax rebates or financial incentives as successfully used in several international cities, is regarded as a "low hanging fruit" in the water conservation and demand management toolbox and should be adopted in the City of Durban.

6.5.2.2 Information influences on water consumption and saving behaviour

This objective aimed at identifying the key information drivers of responsible urban household water use behaviour in support of informing effective WDM policy. Table 6.14 and Figure 6.8 below presents the ranked descriptive statistics for factors that could support households to reduce reliance on municipal water use. These were considered to be the most significant drivers that could positively influence water saving practices in the Durban metro.

Table 6.14: Information drivers to assist in water savings

	Phoenix				Durban North				Umlazi				Amanzimtoti				Pinetown				Total				Kruskal Wall	
	N	Mean	Median	Std. Deviation	N	Mean	Median	Std. Deviation	N	Mean	Median	Std. Deviation	N	Mean	Median	Std. Deviation	N	Mean	Median	Std. Deviation	N	Mean	Median	Std. Deviation		
Receiving water saving tips	23	3.35	2.00	2.67	29	3.07	3.00	2.03	24	3.04	2.00	2.39	25	3.20	2.00	2.52	23	5.13	6.00	2.82	124	3.52	3.00	2.56	0.129	Q15a
Receiving a breakdown of the tariff structure and placing your household's consumption in the tariff blocks	24	3.29	2.50	2.29	28	3.43	3.00	1.97	21	3.86	4.00	2.08	26	3.96	3.50	2.58	22	4.45	4.00	2.13	121	3.78	3.00	2.23	0.405	Q15b
Receiving information about monthly and annual financial gain from reducing consumption	24	3.08	3.00	2.22	27	3.48	4.00	2.05	21	3.33	3.00	2.03	26	3.19	3.00	1.86	23	3.96	4.00	2.12	121	3.40	3.00	2.04	0.301	Q15c
Receiving information about monthly and annual financial loss from not reducing consumption	22	3.36	3.00	2.11	27	4.11	4.00	1.93	21	3.57	3.00	2.11	24	4.17	4.00	1.93	22	3.45	3.00	1.87	116	3.76	4.00	1.98	0.912	Q15d
Receiving a comparison of your household's consumption to the average consumption in the neighbourhood	22	4.00	4.00	2.14	27	4.07	4.00	2.15	22	6.50	6.50	1.37	25	4.44	5.00	1.94	22	3.91	4.00	2.20	118	4.56	5.00	2.17	0.003	Q15e
Receiving a plea to save water by reducing your consumption by 10%	23	5.13	6.00	2.34	27	4.93	6.00	2.15	21	5.19	5.00	2.09	24	5.21	5.50	2.21	22	4.86	4.50	1.93	117	5.06	5.00	2.12	0.941	Q15f
Receiving a plea to save water in order to avoid future water restrictions	23	5.22	5.00	2.70	27	5.22	6.00	2.50	21	4.48	5.00	2.36	24	4.25	4.00	2.19	22	5.09	6.00	2.33	117	4.86	5.00	2.42	0.435	Q15g
Receiving a recognition by having the name of your neighbourhood published…	23	4.78	6.00	3.01	27	5.56	7.00	2.67	21	5.48	6.00	2.54	24	5.92	7.00	2.57	22	5.86	7.50	2.70	117	5.52	6.00	2.69	0.549	Q15h
Not applicable – I/we do not intend to reduce our future municipal water use	4	3.00	3.00	2.31	4	1.75	1.00	1.50	4	1.00	1.00	0.00	2	1.00	1.00	0.00	3	1.00	1.00	0.00	17	1.65	1.00	1.46	0.292	Q15i

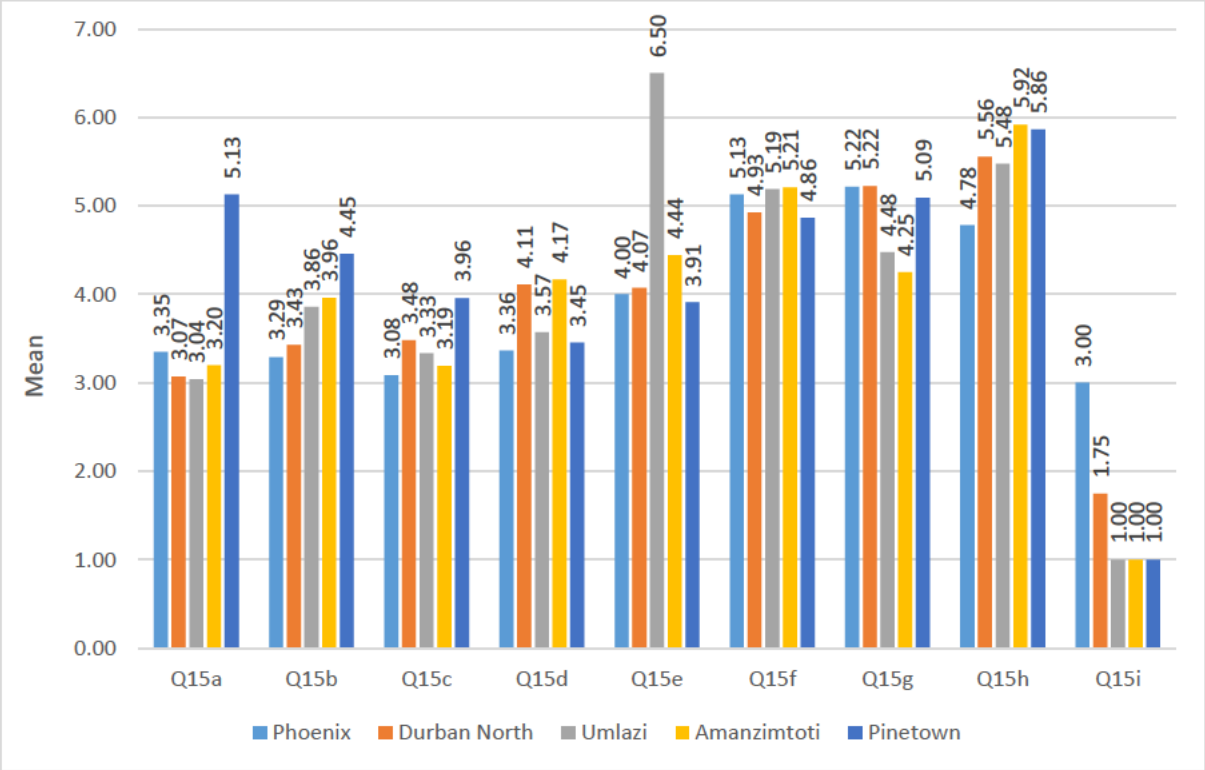

Figure 6.8: Ranking of information factors influencing water saving (1 - being most effective) to 7 - being least effective)

Similarly to the behavioural influences discussed above, the ranking analysis for the key information influences suggests that respondents from Durban North, Amanzimtoti and Pinetown had no intent to change their water usage patterns and their sole reliance on municipal water supply. Moreover, there were no significant statistical variances by area for each of the key factors. Most important to note is the statements that ranked the most effective in terms positively influencing the types of information that would assist with water saving practices were identified to be 15a, 15c and 15d and these are highlighted in yellow in Table 6.15 below.

Table 6.15: Main information drivers influencing water saving practice and behaviour (1 - being most effective) to 7 - being least effective)

	Mean	Rank	
Not applicable – I/we do not intend to reduce our future municipal water use	1.65	1	Q15i
Receiving information about monthly and annual financial gain from reducing consumption	3.40	2	Q15c
Receiving water saving tips	3.52	3	Q15a
Receiving information about monthly and annual financial loss from not reducing consumption	3.76	4	Q15d
Receiving a breakdown of the tariff structure and placing your household's consumption in the tariff blocks	3.78	5	Q15b
Receiving a comparison of your household's consumption to the average consumption in the neighbourhood	4.56	6	Q15e
Receiving a plea to save water in order to avoid future water restrictions	4.86	7	Q15g
Receiving a plea to save water by reducing your consumption by 10%	5.06	8	Q15f
Receiving a recognition by having the name of your neighbourhood published…	5.52	9	Q15h

The 2nd highest ranked driver identified by respondents was again regulatory in nature and relates to providing information to residents on financial incentives and savings that water service authorities return to residents who implement and practice water saving in their households (monthly and annually, as part of billing). This once again is consistent with the extant literature reviewed internationally and nationally and many global and local water utilities have successfully used financial incentives for water saving as a key behavioural water conservation and water demand management tool. The third ranked driver was noted to be providing water saving tips to urban household water users with information and financial support to implement water-sensitive design measures and to implement water-saving technology measures, in their households. Examples of such measures would include information on constant flow regulators, smart metering, water-saving shower heads, dual flush toilets, or zero flush toilets.

6.5.2.3 Influence of city level water restrictions

Interestingly, there was no significant difference (p = 0.504) in the scoring patterns by area in relation to the influence that city level water restrictions may have had on residents' water usage (Table 6.16). The Phoenix area indicated the highest response to water restrictions and Amanzimtoti recorded the lowest percentage at 41.7%. Across the city the overall percentage was close to 60% and this indicates that metro wide water restriction can be an effective tool in promoting water demand reduction at the household level. Such events should also be used to embed longer term water saving behaviour as would have been adopted during the periods of the water restrictions. Bennet *et al*. (2015: 5) and several other authors have noted that prohibitions or water restrictions on lawn watering, car washing and filling swimming pools, or reducing the amount of water used in these activities, can significantly reduce water demand (Lawton *et al*., 2008; Dela Cruz and Gray 2012). However, such restrictions are usually difficult to sustain and only effective for a short period of time (Maggioni 2015: 3). Restrictions also require intensive compliance monitoring (Datta *et al*. 2015: 9). However, in Durban there is still a considerable amount of effort needed to change overall water consumer behaviour, in that, 40% of the residents indicated that current or past city restrictions had little to no effect on their water use and consumption behaviour.

Table 6.16: Water restrictions

			Phoenix	Durban North	Umlazi	Amanzimtoti	Pinetown	Total
Has your water use been influenced by the announcement of current or past city water restrictions?	Yes	Count	12	6	6	5	5	34
		% within Area	75.0%	54.5%	60.0%	41.7%	62.5%	59.6%
	No	Count	4	5	4	7	3	23
		% within Area	25.0%	45.5%	40.0%	58.3%	37.5%	40.4%
Total		Count	16	11	10	12	8	57
		% within Area	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

6.5.2.4 New ecological paradigm (NEP): environmental and water use behaviour beliefs and perceptions

Respondents were asked to rate NEP scale statements to determine their response to negatively and positively worded statements on general environmental awareness and their water use and consumption behaviour. The NEP statements are either positive or negative and this needs to be determined for the internal reliability test and conducting an average mean calculation.

The section that follows analyses the scoring patterns of the respondents per variable and NEP statement. The results are first presented using summarised percentages for the variables that constitute each section of the NEP scale. Results are then further analysed according to the importance of the statements and are reflected in Table 6.14. To determine whether the scoring patterns per statement were significantly different by area, a chi square test was done. The null hypothesis claims that similar numbers of respondents scored across each option for each statement (one statement at a time), by area. The alternate states that there is a significant difference between the levels of agreement and disagreement by area. The highlighted sig. values (p-values) are less than 0.05 (the level of significance), and it implies that the distributions were not similar by area. That is, the differences between the way respondents scored (agree, neither agree nor disagree, disagree) were significant.

Table 6.17: NEP- Environmental and Water use behaviour beliefs and perceptions

		Phoenix		Durban North		Umlazi		Amanzimtoti		Pinetown		Chi square p-value
		Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	
We are approaching the limit of the number of people the earth can support	Strongly agree	8	23.5%	9	25.0%	5	15.6%	7	18.4%	6	18.2%	0.795
	Agree	15	44.1%	17	47.2%	18	56.3%	23	60.5%	16	48.5%	
	Neither agree nor disagree	7	20.6%	3	8.3%	3	9.4%	2	5.3%	4	12.1%	
	Disagree	1	2.9%	4	11.1%	6	18.8%	5	13.2%	5	15.2%	
	Strongly disagree	3	8.8%	3	8.3%	0	0.0%	1	2.6%	2	6.1%	
Humans are severely abusing the environment	Strongly agree	15	41.7%	14	38.9%	14	45.2%	21	53.8%	14	42.4%	0.467
	Agree	18	50.0%	14	38.9%	11	35.5%	11	28.2%	11	33.3%	
	Neither agree nor disagree	1	2.8%	3	8.3%	1	3.2%	0	0.0%	5	15.2%	
	Disagree	1	2.8%	2	5.6%	5	16.1%	5	12.8%	3	9.1%	
	Strongly disagree	1	2.8%	3	8.3%	0	0.0%	2	5.1%	0	0.0%	
The so-called "ecological crisis" facing humankind has been greatly exaggerated	Strongly agree	0	0.0%	2	6.1%	3	10.0%	2	5.3%	2	6.9%	0.561
	Agree	6	16.2%	10	30.3%	10	33.3%	14	36.8%	6	20.7%	
	Neither agree nor disagree	9	24.3%	3	9.1%	3	10.0%	6	15.8%	8	27.6%	
	Disagree	14	37.8%	12	36.4%	13	43.3%	14	36.8%	12	41.4%	
	Strongly disagree	8	21.6%	6	18.2%	1	3.3%	2	5.3%	1	3.4%	
There is enough water in the city for us to use as much as we want to use	Strongly agree	0	0.0%	0	0.0%	1	3.2%	1	2.7%	0	0.0%	0.023
	Agree	1	2.7%	5	14.7%	13	41.9%	8	21.6%	5	16.7%	
	Neither agree nor disagree	7	18.9%	0	0.0%	3	9.7%	3	8.1%	3	10.0%	
	Disagree	16	43.2%	15	44.1%	11	35.5%	16	43.2%	17	56.7%	
	Strongly disagree	13	35.1%	14	41.2%	3	9.7%	9	24.3%	5	16.7%	

There is enough water in South Africa for each household to use as much as they want to use	Strongly agree	0	0.0%	1	3.0%	0	0.0%	2	5.4%	1	3.3%	0.040
	Agree	2	5.6%	3	9.1%	7	22.6%	6	16.2%	5	16.7%	
	Neither agree nor disagree	4	11.1%	1	3.0%	0	0.0%	1	2.7%	5	16.7%	
	Disagree	14	38.9%	12	36.4%	15	48.4%	18	48.6%	14	46.7%	
	Strongly disagree	16	44.4%	16	48.5%	9	29.0%	10	27.0%	5	16.7%	
Nobody owns water so it should be free	Strongly agree	5	14.3%	3	9.1%	10	33.3%	4	10.8%	5	17.2%	0.009
	Agree	4	11.4%	4	12.1%	6	20.0%	10	27.0%	11	37.9%	
	Neither agree nor disagree	11	31.4%	3	9.1%	1	3.3%	4	10.8%	6	20.7%	
	Disagree	8	22.9%	17	51.5%	11	36.7%	15	40.5%	7	24.1%	
	Strongly disagree	7	20.0%	6	18.2%	2	6.7%	4	10.8%	0	0.0%	
There is enough water in SA, the government just needs to plan better	Strongly agree	3	8.6%	4	12.1%	5	16.1%	5	13.5%	4	13.3%	0.371
	Agree	7	20.0%	8	24.2%	11	35.5%	14	37.8%	15	50.0%	
	Neither agree nor disagree	11	31.4%	7	21.2%	4	12.9%	6	16.2%	5	16.7%	
	Disagree	10	28.6%	8	24.2%	7	22.6%	9	24.3%	6	20.0%	
	Strongly disagree	4	11.4%	6	18.2%	4	12.9%	3	8.1%	0	0.0%	
Technologies are available to supply the water required	Strongly agree	3	8.6%	4	12.1%	5	16.7%	6	16.2%	6	20.0%	0.718
	Agree	13	37.1%	14	42.4%	13	43.3%	16	43.2%	12	40.0%	
	Neither agree nor disagree	9	25.7%	6	18.2%	3	10.0%	5	13.5%	5	16.7%	
	Disagree	8	22.9%	8	24.2%	6	20.0%	8	21.6%	7	23.3%	
	Strongly disagree	2	5.7%	1	3.0%	3	10.0%	2	5.4%	0	0.0%	

In all areas, there are no differences in the scoring patterns for the first three and last two statements. In all instances, the levels of agreement were higher than those for disagreement in all areas, with similar scoring patterns. However, the figures in bold indicate that there were higher levels of disagreement in some areas for the following respective statements, ‘there is enough water in the city for us to use as much as we want to use’, ‘there is enough water in South Africa for each household to use as much as they want to use’, nobody owns water so it should be free’.

The disagreement with these statements at a localised level (i.e. within the Durban metro), suggests a general environmental belief that ‘water is common good and as such nobody owns water and therefore it should be free’, are quite important and significant findings from this study. The higher disagreement levels with the 2 statements relating to water resource availability at the city and national level is clearly indicative of a serious lack of knowledge and information relating to SA’s water security challenges. The NWSMP (2018), states that SA is predicted to have national water deficit of 17% by 2030 if current consumption continues to rise unabated and if no concurrent water demand management initiatives are undertaken immediately.

In relation to the statement relating to ‘ownership’ of water in SA, it is encouraging to discern from the results that there is a general understanding within the City of Durban’s residents, that water is a shared national natural resource and as such the custodians of water supply and reticulation (e.g. Municipality, DWS, Water Boards) are not regarded as the owners of water in SA. Therefore, it will be imperative that any water conservation or water demand management initiatives that are undertaken by such entities to conserve and sustainably utilise this resource, needs to be done in an equitable manner and with a great degree of transparency. Equally important will be the need to have citizen science inputs.

6.5.3 Objective 3 – (Sub themes F, G) Effectiveness of water demand management tools, instruments and interventions targeted water saving

The respondents were required to identify and evaluate the effectiveness of various WDM awareness tools, instruments and interventions that water authorities use as targeted campaigns towards changing water use and consumption behaviour. For example, respondents were to record on how they primarily hear/find out about any municipality instituted water restrictions in their neighborhoods' or receive information on water outages, saving tips and technologies. The results in Table 6.18 reflect the various types of WDM communication tools used by the municipality and the respondent's awareness or "use" of them.

Table 6.18: WDM communication tools

		Phoenix		Durban North		Umlazi		Amanzimtoti		Pinetown		Chi Square p-value
		Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	Count	Column N %	
Municipal - printed bill /notice	Yes	19	47.5%	13	33.3%	12	30.8%	17	40.5%	16	44.4%	0.505
	No	21	52.5%	26	66.7%	27	69.2%	25	59.5%	20	55.6%	
Municipal - email message	Yes	4	10.0%	3	7.7%	0	0.0%	1	2.4%	0	0.0%	0.079
	No	36	90.0%	36	92.3%	39	100.0 %	41	97.6%	36	100.0 %	
Municipal – website	Yes	4	10.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0.003
	No	36	90.0%	39	100.0 %	39	100.0 %	42	100.0 %	36	100.0 %	
Printed newspaper	Yes	7	17.5%	4	10.3%	1	2.6%	3	7.1%	1	2.8%	0.093
	No	33	82.5%	35	89.7%	38	97.4%	39	92.9%	35	97.2%	
Online newspaper	Yes	3	7.5%	0	0.0%	0	0.0%	1	2.4%	1	2.8%	0.200
	No	37	92.5%	39	100.0 %	39	100.0 %	41	97.6%	35	97.2%	
Radio	Yes	5	12.5%	4	10.3%	2	5.1%	7	16.7%	4	11.1%	0.591
	No	35	87.5%	35	89.7%	37	94.9%	35	83.3%	32	88.9%	
Television	Yes	9	22.5%	4	10.3%	2	5.1%	3	7.1%	5	13.9%	0.125
	No	31	77.5%	35	89.7%	37	94.9%	39	92.9%	31	86.1%	
Social media	Yes	11	27.5%	4	10.3%	1	2.6%	5	11.9%	2	5.6%	0.007
	No	29	72.5%	35	89.7%	38	97.4%	37	88.1%	34	94.4%	
Word-of-mouth	Yes	6	15.0%	4	10.3%	8	20.5%	5	11.9%	3	8.3%	0.554
	No	34	85.0%	35	89.7%	31	79.5%	37	88.1%	33	91.7%	

The data reflects that the primary tool residents used for accessing WDM information and their residential water use, was the monthly municipal bill (p=0.505). However, the highlighted values show some differences in the patterns by area. There was minimal awareness of tools such as emails, municipal website (p=0.003) or social media (p= 0.007). However, it is worth noting that in some areas (e.g. Phoenix, Dbn North), preference was given to increased use of online tools such smart, phones, apps, smart TV's (online advertising), emails and other social networking apps. This is reflected in Figure 6.9 which indicates the future preference of the respondents with regards to WDM communication.

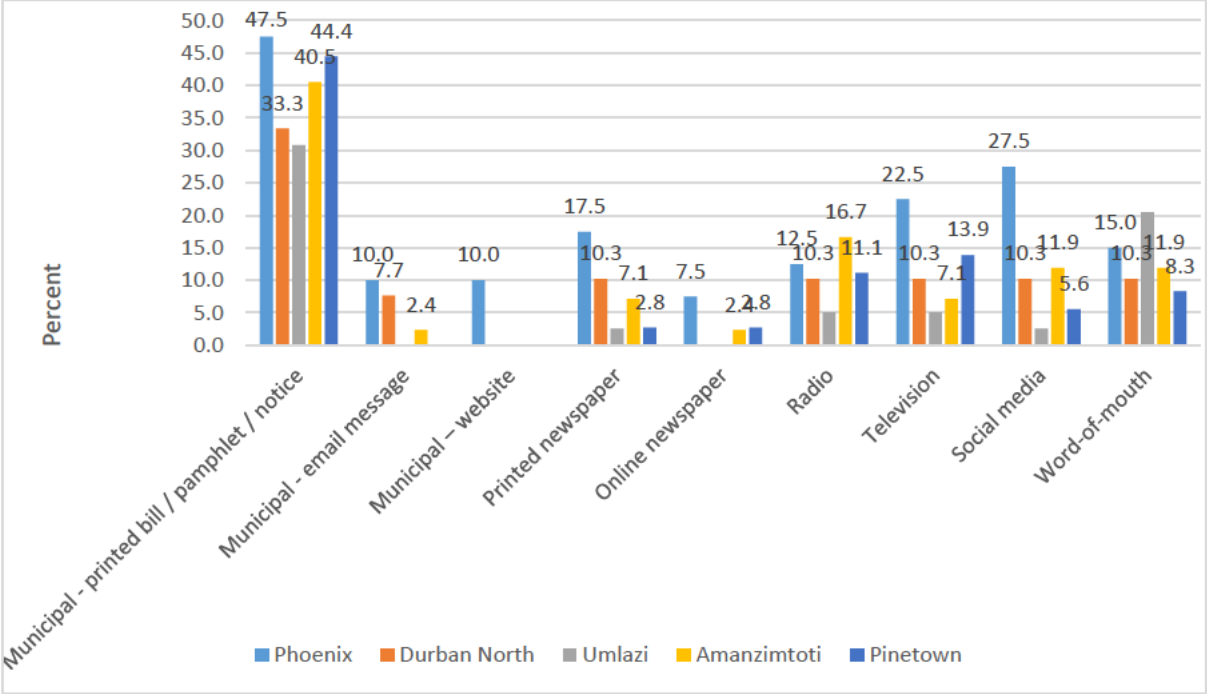

Figure 6.9: Preference for future WDM communication

The strong reliance on municipal bills for information needs to be carefully considered by the water authorities in terms of diversifying its planned communications with the metro's residents. There is an increasing shift to wider adoption and usage of digital communication platforms on smart devices, via advertising, social media, emails and websites. It will therefore be very important for the municipality to implement future WDM communications with systems and platforms which are more digitised on the back of South Africa's present drive towards 4IR and future use of 5G networking systems and technologies.

Objective 4 – (Sub themes – I, J, K, L) Strategies that inform policy on water management and effective decision making relating urban household water use demand reduction.

Thematic content analysis was used to analyse the data obtained for this goal, which made up the qualitative component of the study. The purpose of the qualitative data analysis was to acquire a better understanding of the subject and complexity of meanings by delving into the transcript of one interview, before moving on to the next. This followed an idiographic technique to the analysis, starting with a specific case and working up to broad categorizations or groupings. In keeping with the method's iterative methodology, preceding transcripts were constantly reviewed in light of new sub-ordinate themes that emerged, and examples from those earlier transcripts were also included in the continuing qualitative research. The qualitative data analysis focused on finding and categorising significant speech fragments into conceptual categories. To establish more basic overarching themes, common categories were identified and analysed. The technique was inductive in the sense that it moved from the synthesis of small conceptual units to the construction of broader basic categories of significance and experience that represented the individual's comments.

The specific cognitions, representations, behaviours, and concerns related to strategies that inform policy on water demand management and effective decision making as it relates to urban household water use demand reduction were developed and explained using qualitative analysis. The was based on identifying common themes in the data using subsample categories, themes, and super-ordinate themes. Thematic content analysis allowed significant causal linkages and relationships to emerge between themes that grouped well together. As part of the clustering procedure, participants' phrases that supported connected themes were collated into specific directories, and instances of comments were reported as key points of reference. For the qualitative component of measuring this objective the following thematic areas were determined and identified to be of most significance to this study:

- Water conservation and demand strategy
- Policy, regulation and systemic issues
- Specific instruments and interventions for household water demand management
- Public / customer education and awareness
- Use or alternative water sources
- Learning and collaboration

The study findings highlighted several links between themes and sub themes that were grouped together, resulting in the following focus points of interest:

- The utilities tasked with encouraging urban household water conservation have a number of positive organizational initiatives in place to address attitudes toward urban water conservation and demand management. Strategies were cognitively linked to certain values such as a) the value of water, b) water conservation and economy, c) environmental awareness and sensitivity, and d) water investment.
- According to the research participants, there is a robust and progressive policy framework already in place, but the largest challenge is NRW water loss. "When compared to persons who live in non-urban areas, urban households can utilize less water (yet believe they do not need to preserve water at all) in their daily lives." This statement is in line with the social comparison theory, which states that people seek correct comparisons with comparable persons in order to accurately judge themselves (Festinger 1954).

- Participants shared a number of positive tools and instruments for raising awareness and interest in urban household water demand management, which was largely concerned with identifying people as part of a group that is positively invested and recognised to be doing the right thing environmentally and socially. Retrofitting domestic appliances with water-saving technology and targeted marketing campaigns are some examples of such instruments. "It should not just be advertisements," participants said emphatically, "but specific campaigns and programs on all available social media and public engagement platforms."
- The participants selected the utilization of alternative water sources as a significant management method. Rainwater harvesting and smart metering (which will soon be part of local development plans and municipal legislation) were prioritized as ways to encourage water conservation and reduce demand in the city.

6.6 CONCLUSION

The largest group gathered from the survey relates to the dwelling type, being free standing houses with the second biggest group of respondents being homeowners instead of renters. Most of the respondents were well educated with more than half having a tertiary education and being in their middle ages from the calculated average mean for both the respondent and head of the household ages. A small percentage of households had more females than males and the racial make-up of the households were relatively similar between African, Coloured, White and Indian respondents and in keeping with racial geographical distribution of the Durban metro. Additionally, more than 80% of the households had 8 or less people permanently residing at the residence. This point also puts the study into perspective and provides information on the some of the limitations of the study, with the dwelling type predominantly being that of, free-standing houses. Although the study provided valuable insights through the situational and socio demographic

factor analysis, the study was limited to 5 suburban areas within the Durban metropolitan area. The study however does not fully represent all water users in the metro and has not considered any other water and land uses outside of the residential categories surveyed.

The combinational conclusions of the two social research methodological approaches allowed for an in-depth understanding of Durban residents water attitudes, perceptions, cognitions and attributions and has explained their water use behaviours and decision-making processes with regards to their water use. The quantitative research method resulted in a high percentage of people reporting that they generally behave in a water saving manner. Simple conservation behaviours (such as closing the tap when brushing teeth, soaping and washing the dishes, checking if pipes and taps are dripping) are adopted by the majority of the sample.

However, only a small fragment of the quantitative survey sample adopts wider water conservation practices, such as limitations of daily showers, grey water re-use or implementation of water saving technologies in their homes. Based on the qualitative research insight, this contradiction appears attributed to a cognitive misunderstanding which characterises the utilitarian representation on what water savings in everyday citizens lives should mean. The participants accounts on water saving was limited to fairly stereotypical descriptions including only a very basic and general understanding of water saving habits. Some of the other concluding observations suggest a medium and low preference for water efficiency behaviour change and the interrelated investments needed on water saving technologies, such as smart metering. This appears related to specific characteristics such as age, socio-economic variations, suspiciousness, interest and level of trust in new technologies. There are also specific drivers that appear to act well together in order to motivate individuals to adopt more water saving practices and invest in modern water efficiency technologies. Such behavioural drivers appeal to strong psychosocial needs and processes within the person and include social identity, positive self-image, social reward and social comparison in combination with some extrinsic (material) motivation (reduced costs for water use). The data analysis

suggests that the strongest deterrents for adopting water saving behaviours are deeply idiosyncratic with embedded negative cultural and political connotations as well.

Respondents also demonstrated a general negative attitude towards water service providers and water utilities in terms of water services provision. Such deterrents are reinforced in a current political environment in SA which is characterised as mass unemployment, low economic growth, poverty and service delivery crisis. Therefore, any attempt to change behaviour to adapt to more modern and useful new technologies is immediately regards as ‘meaningless; or useless for an urban resident, due to the perceived inefficiency and corruption of government and governmental departments that are mandated to manage water resources in SA.

Hence, consumers appear to have adopted attitudes of “there is enough water for all in SA”, so no need to conserve” suggests an ideology that water saving as totally unimportant and demand management is more related to economic and/or political gain or interests. Lastly, there are also issues of ‘mistrust’ in relation to urban household water use behaviour and water use and this has translated into cognitive confusion, biases and conflictive behaviours towards water demand management and water saving practice, in general.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

The extent to which the research goals and objectives were met, are discussed in this chapter. The study's purpose was to analyse urban household water use behaviour in Durban, with the goal of improving our understanding of household water usage and existing water wise behaviour in the city. The research was carried out in a number of dwelling types and included a variety of indoor and outdoor activities. Perceptions of the most beneficial water-saving behaviours by individuals, were also examined in the study. The study identified a number of water saving, public awareness and water demand management tools, and this chapter integrates some of the main findings for public policy. To recap, the study's primary goals were:

- To examine public levels of knowledge, awareness and perceptions of water wise behaviour in urban households.
- To examine the impact or influence that socio-economic, behavioural and technological factors have on water saving practices.
- To identify the key drivers and perceptions of responsible urban household water use behaviour.
- To identify and evaluate the effectiveness of water demand management awareness tools, instruments and interventions targeted at changing water use behaviour.
- To inform policy and decision making on future water demand management planning.

The following section of this chapter provides an outline of the study's most important findings and conclusions, as they relate to the extant literature that has been reviewed.

7.2 OVERVIEW OF LITERATURE

A review of the extant literature highlighted several theories relating to individual, social, technological and environmental awareness. The relevance of the theories has been further explained in terms of their links and applicability to the wider concepts of WDM. The theoretical review focused on advancing an understanding of water use and WDM against the backdrop of water scarcity and security in SA. This study suggests that it is imperative that all water users (especially domestic users) play an active role in sustainable water use and demand reduction in order to avert an impending future water crisis in SA. The research area on behaviour theory and water conservation, particularly in relation to WDM, yielded diverse and sometimes contradictory findings. This suggests that theories on water conservation behaviour are complex in nature. It is also important to indicate that it was very difficult to analyse and discuss the core influencers, drivers and barriers of water conservation behaviour separately or as stand-alone factors as they can easily become two sides of the same coin. In other words, a positive driver of water conservation behaviour can easily become a potential barrier, if implemented ineffectively.

Increasingly, both current urban water infrastructure and technologies, as well as water use practices and culture, are in need of social and political reform. Such reform can be described as the need for a more ecologically sensitive and socially just approach to water use in urban cities in order to question the deeply entrenched ‘normal or current’ practices and social norms in public and private life in terms of everyday water consumption. What is further required is a move away from the current traditional consumerist and capitalist models of water supply and demand management, towards more sustainability focused approaches which are based on preservation and long-term sustainability of the most important natural resource in the world today. This needs to work concurrently with a general shift in focus away from material water consumption towards a greater emphasis on meeting non-material water use needs. Regarding water use knowledge, awareness and perceptions in particular, a further urgent behavioural shift is required from currently

accepted intimate water use practices, habits and expectations, linked to personal hygiene and cleanliness and those uses that demand high volumes of water (e.g. swimming pools, gardens and lawns).

Regarding the review of WDM policy, strategies and planning, many authors such as (Hand 2003) have clearly stated that it is not effective to develop a single 'catch-all' WDM strategy for all water consumers in a city. This is due to the variability of households in terms of income levels, types of dwelling, levels of education and more importantly, the general attitudes, perceptions and behaviour of household members themselves. Interestingly, the extant literature on WDM and urban household water use behaviour places a strong focus on reducing discretionary uses of water or reducing water wastage and increasing the efficiency of water use in appliances and devices. Discretionary use commonly refers to outdoor water use such as watering gardens, filling swimming pools, washing cars and driveways. By contrast, indoor water use is left rather untouched by most policy and strategies locally and internationally as many of them have not really questioned or analysed the cultural norms and value systems that underpin indoor water consumption practices within urban households. While it is acceptable to suggest behaviour changes to practices that take place outdoors in the public domain, such as washing one's car or gardening and swimming, it is not deemed to be acceptable to attempt to control more intimate and 'private' activities such as for example frequency of bathing that take place indoors, as such is considered to be beyond the limits of public policy discourse.

Regarding the urgent role of policy makers in developing more efficient and effective WDM strategies and policies, the core research questions that need to be addressed as comprehensively and urgently as possible are the following: Who are the water consumers? How much water do they need and how much to do they actually utilise? What are the key economic, environmental, social, technological and cultural aspects that are going to motivate or drive smart water use in the future (i.e. consumption externalities)? What governance and institutional framework is required to respond effectively to WDM to reduce demand? and, what policy

measures and institutional governance instruments are in need of urgent policy reform in order to directly influence current water consumption patterns and reduce water demand? The literature has also suggested that previously adopted traditional policy approaches to South Africa's water conservation and demand management strategies, require urgent review.

Future WDM policy and interventions should adopt a citizen-science approach that is aimed at influencing water demand and improving current water distribution and use efficiency with smart water use technologies. In order to achieve and enhance water use sustainability, a wide range of water conservation and WDM interventions and tools are required, in addition to continuing with all current national plans of advancing water supply. Lastly, the literature review has also highlighted that there is a sound policy and legal framework already in place for the implementation of many WDM instruments in SA. Effective billing strategies (NRW reduction), revised water tariffs models, hydrological modelling, political will, stakeholder buy-in as well as the establishment of dedicated WDM task teams, are all critical factors for success. In addition to public awareness and participation, other structural, operational and technological measures are equally important tools and instruments that are needed to support the continued success of effective WDM in the City of Durban. In support of such a paradigm shift in the city, the eThekwini Municipality, who are the water 'custodians' for the city, have already instituted some positive interventions and actions to achieve its WDM objectives and targets and this is regarded as an important first step in the right direction towards providing benchmarks for measuring WCWDM successes. The supporting policy and legal framework for WDM in SA is well-established and a review of these national policies and plans has revealed that current awareness-raising and educational campaigns have provided mixed successes. This confirms the need for more focus on educating civil society, not only on the need for water conservation, but also on how to practically conserve water. With regard to the key factors influencing water demand, such as smart metering, billing and tariffs, the study findings suggest that these are widely adopted and highly successful WDM instruments but can also become highly contested strategies in achieving the South African government's policy of 6 kl of free water (basic right to water). Therefore, other instruments, such

as social media campaigns on retrofitting smart meters, water saving devices and general water saving tips targeted at the urban household level, need to be urgently developed and implemented at scale.

7.3 STUDY FINDINGS AND KEY CONCLUSIONS

The study's findings revealed that residents of Durban's urban households are generally conscious of the need for water conservation and have intent to reduce their water consumption even further. Water conservation has also been shown to have practical constraints for many households. This supports other research findings (Hand, 2003; Shove, 2002) who suggest that ‘the image isn't straightforward' and that much more research and thought is required in the formulation of a ‘fit for purpose’ WDM public policy and strategy. The conclusions have been summarised within the context of the sub-themes that have been described in the data analysis chapter.

- Situational/Socio/Economic and Demographic factors

Several key conclusions about the situational elements and how they relate to urban water demand management behavior have been obtained from this study. The first is that the type of home individuals live in, that is whether people own or rent, has an impact not only on overall water consumption but also on how they see water use in general. This is crucial in the larger policy discussions over the environmental benefits of shifting housing demand from low-density to higher-density dwelling. Due to their bigger size, households in free standing houses consume significantly more water than those in shared living spaces, such as flats and apartments. It is possible that the effects of personal behaviour dynamics add a certain amount of societal control in smaller residences and this constrains usage simply because amenities are often more likely to be shared. Larger households, on the other hand, are more likely to obtain economies of scale in water savings, which high density dwelling households cannot.

- Water use Attitudes, Perceptions and Consumption Practices

With regards to attitudes to water use, for the majority of Durban metro residents, water conservation is not a 'top of mind' issue. Residents do not stop to think about where their water comes from, and generally take it for granted that water was abundantly available. Some critical barriers to water conservation in city of Durban included questions over whose actual responsibility it really was to conserve water and lifestyle factors and while environmental concerns were an incentive and important to some, for the majority, saving water was most often a by-product of saving money on rising water tariffs and costs.

- Drivers of Water Saving behaviour

In relation to the most significant water saving practices or measures that residents deployed, it was found that there was no significant differences across the city of Durban. More than 50% of respondents from Umlazi used grey water compared to the other areas in the metro. This finding suggested a need to reflect on the vast situational/socio-economic inequalities prevalent in the City of Durban in terms of access to water as residents in Umlazi who generally are low to middle income earners have inherently adopted grey water reuse as compared to the more affluent and higher income earning residents residing in areas such as Durban North and Amanzimtoti. Residents who are economically advantaged and financially able to pay for their water use, do not generally save or reuse their water. It is also noted that most residents within the City of Durban, did not invest or use readily available water saving technologies (e.g. low flow regulators, smart meters, dual flush toilets). The municipality will need to drive the adoption of water saving practices either in the form policy, legislation and/or incentivising such technology use at the household level.

- Tools and Instruments

The highest ranked water saving behavioural driver identified by respondents was regulatory in nature and related to providing information to residents on financial incentives and 'rand' savings that water service authorities should rebate to residents who implement and practice water saving in their households. This was

consistent with the literature reviewed internationally and nationally and several utilities have successfully used financial incentives/benefits from household level water saving as a key behavioural water conservation and water demand management tool. The second highest ranked tool was noted to be providing water saving tips to urban household water users with information and financial support to implement water-saving design measures and to implement water-saving technologies within their households. Examples of such measures would include information and subsidies for installation of constant flow regulators, smart metering, water-saving shower heads, dual flush toilets or zero flush toilets and rainwater harvesting systems.

- Effectiveness of tools, instruments use for water saving

Interestingly, there was no significant difference in the analysis and the scoring patterns in relation to the influence and effectiveness that city level water restrictions may have/had on residents' water usage. The Phoenix area indicated the highest response to water restrictions and Amanzimtoti recorded the lowest percentage. This finding indicates that water restrictions/rationing can be effective in promoting water demand reduction at the household in Durban. Such programmes should also be used to embed longer term water saving behaviour as would have been adopted during the periods of mandatory water restrictions.

- Water Demand Policy and Strategy

There was general agreement and an environmental belief that 'water is a common good and as such nobody owns water and therefore it should be free'. These are quite important and significant findings from this study as water resource availability at the city and national level is clearly reflective of a serious lack of public knowledge and information relating to SA's water supply and demand challenges at present. In relation to the study findings relating to 'ownership' of water in SA, it can be concluded that there is a general understanding within the City of Durban's residents, that water is a shared natural resource and as such the custodians of water supply and reticulation (i.e. Municipality, DWS, Water Boards) are not regarded as the owners of water in SA. Therefore, it will be imperative that any water conservation or water demand management initiatives that are undertaken by such entities to conserve and sustainably utilise water, needs to be done in an equitable

manner and with a great degree of public trust and transparency. Equally important will be the need to have extensive citizen science inputs into policy and strategy development.

- Public / customer education and awareness

The was a strong reliance on municipal bills for information and this should be carefully considered by the water authorities in terms of diversifying its planned information dissemination and communications with the metro's residents. There is an increasing shift to wider adoption and usage of digital communication platforms on smart devices, via AI, digital marketing, online advertising, social media applications, emails and websites. It will therefore be very important for the municipality to implement future WDM communications with systems and platforms which are more digitised on the back of South Africa's and the city of Durban's present drive towards digital integration into 4IR, Fibre and 5G networking technologies and systems.

- Learning and collaboration

The key conclusion that can be drawn from the study was a general negative attitude towards water service providers and water utilities in terms of water service provision. Such deterrents are reinforced in a current political environment in SA which is characterised with mass unemployment, low economic growth rates, poverty and social crisis. Therefore, any attempt to change water use behaviour to adapt to more modern and novel technologies is immediately regarded as 'meaningless; or useless for the urban resident, due to the perceived inefficiency and corruption of government and governmental departments that are mandated to manage water resources in SA. Policy and strategy responses will need to promote the increased use of alternative water sources as this was co-identified as a key management mechanism by all the participants in the study. Such initiatives should be fast tracked and some examples include installation of rainwater harvesting and smart water metering systems (enforced for legal compliance with local building plans and municipal bylaws) to promote water conservation and reduce demand in the city of Durban.

7.3.1 Barriers

Some of the main reasons people were not doing more to conserve water included, not believing there is a need to conserve, having little or no feedback on their water use, lifestyle factors, including cost and time and questions of whose actual responsibility it was to conserve water. A perceived lack of need or concern for water conservation came through strongly in the research. It was noted as the most commonly voiced barrier in the quantitative analysis. The research concluded that in the short term, only a real crisis situation will result in a significant increase in water conservation efforts. When discussing technology improvements such as household level smart water metering, participants were unsure of what the motives would be for introducing such metering, because water was perceived to be plentiful. This belief is likely to be a barrier preventing many people from doing more to conserve water. Once it was established that there may be a need to be more frugal in resident water consumption in the future, some research participants still questioned who their water-saving efforts would benefit. They did not mind making savings to benefit 'everyday' people, but not the Municipality/WSA's (who they believe are responsible for water shortages in the first place). Similarly, the research found that there was a relatively high level of agreement with statement that "other water users such as agriculture and businesses are the highest water users in SA – so water conservation should be their responsibility only". However, the research also found that if consumers could be convinced that water is potentially in short supply and residential demand reduction is indeed needed, then they were prepared to share equal responsibility to do so. Lifestyle factors were also a common barrier, with many participants in the research defending their right to use water in ways that historically pleased them. Similarly, it was observed in the research that water use appears to be very personal matter to urban residents in Durban, and requests asking them to modify their water use behaviour were often seen as an intrusion into their personal lives and were generally politically motivated. People did not do more to preserve water for a variety of reasons including, lack of knowledge on the need to save water, no feedback on their actual water usage, lifestyle choices, and questions about who was actually responsible for conserving water. The analysis revealed a complete lack of necessity or concern for water conservation in the city.

7.3.2 Incentives

The lack of a perceived need to conserve water, as mentioned above, is a major impediment to sustained success with water conservation and demand management. While environmental concerns are significant to some, the majority of people are motivated by the desire to save money on their water usage. While many people have some level of environmental motivation, they do not link it to water consumption because they do not recognise or grasp the environmental benefits of water conservation, except from a general belief that it is the responsible thing to do. Water conservation was discovered to be a by-product of cost savings for many participants in this study. Water savings that were "unintentional" included purposefully using less hot water to save electricity, purchasing new equipment that were often more water efficient, using recycled water in the garden and toilets, and rainwater collection. This study findings indicate that saving money on water bills was the number one motivation for saving water in the City of Durban. This was shortly followed by a focus on reducing the ever-increasing cost of electricity. According to the study, there is also a direct link between attitudes about water resources and readiness to use water more efficiently if costs are incentivized or reduced. When compared to those who disagreed with the statement, those who agreed that "water is a limited resource, and we shouldn't waste it" were also willing to do more to conserve water by, for example, replacing their homes with more efficient water saving technologies, installing rainwater tanks, and reducing the volume of their toilet flush tanks.

7.4 RECOMMENDATIONS

The next section discusses some recommendations that can be made from the study.

7.4.1 Researched applications needed to promote water demand management

The study provided an exhaustive summary of Durban metro inhabitants' attitudes, behaviours, and perceptions regarding household water use. Any future demand management measures should have an impact on all urban homes, therefore understanding the perspective of homeowners is critical to effectively engaging with the public about water conservation and WDM. Every household has different attitudes, beliefs, habits and behaviour towards implementing water conservation and it is these nuances that the developers and implementers of WDM policy and strategies, need to take into consideration moving forward. One way of diversifying these strategies is through education and awareness-raising of the sensitivities associated with managing the water demand expectations of a wide variety of demographic and varying socio-cultural water user profiles within a city. A key focus area in terms of such education and awareness raising actions should therefore be on ‘fit for purpose’ decision support systems (DSS) and interventions which are aimed at directly promoting sustainable water use behaviour practices in the city of Durban.

7.4.2 Prioritising awareness and effectively communicating with the general public

Except in times of crisis, encouraging Durban metro residents to adopt new water saving behaviours is difficult. While most residents engage in some fundamental and rudimentary water-saving behaviours on a fairly regular basis, they do so more out of habit, rather than a conscious decision or attempt to conserve water. They also have a fragmented view and opinion of the necessity to save water, primarily due to their misconceptions that water in Durban is plentiful. As a result, the research yielded numerous essential recommendations and concepts for conveying water conservation to the general population more effectively and efficiently, some of which are detailed below.

7.4.2.1 Don’t assume an understanding of the need to conserve water exists

Although the value of water is widely recognised, many resident of the Durban metro area feel that water is abundantly available. Statements like "it rains all the time, so there is enough of water to use" clearly demonstrate this. While most accept that they could do more to preserve water in a drought or a catastrophe, very few believe that there are any immediate or short-term threats to drinkable water supplies. This means that, even in a moment of crisis, authorities should not presume that the general population will comprehend or believe in the importance of conserving water in urban households. As a result, communications will need to critically address this broad lack of public trust by emphasizing an already projected 17 percent water deficit for SA by 2030.

7.4.2.2 Saving the ‘planet or environment’ is not a key motivator

Even though there are some environmentally conscious people in the Durban metro area, the planet/environment is not a key driver for water conservation. When urging people to change their water-use patterns, appeals to environmental sustainability and values are highly unlikely to succeed as a significant motivation. While some people are motivated by environmental concerns such climate change, most are not. Most frequently lifestyle choices, personal attitudes, beliefs, and perceptions around water use and personal hygiene dominate water use behaviour in the metro.

7.4.2.3 Saving money is extremely important

The study found that conserving money is a powerful motivator for water use behaviour change. The number one driver for lowering urban residential water use is in Durban is cost savings on water and energy bills. The study indicates that electricity use is thought to be higher than water use in the City of Durban. WSAs have a golden opportunity to tap into and respond to this public discourse and the urgent desire to save money on ever-increasing water and energy and data bills. Such an interventions requires a new tariff model that includes rebates, "cash-back," or other such incentive-based schemes. Incentives such providing free data (internet access - 2gigs for the household) with the installation of low-cost smart water metering devices as well as lowering monthly costs based on metered use rather than current conventional metering estimations for billing purposes (e.g. prepaid smart meters).

7.4.2.4 Influencing “once-off” actions will be easier than changing old habits.

Even with the best intentions, changing subconscious habitual behaviours is challenging, and hence sustained change is difficult to achieve. On the other hand, once-off activities such as purchasing a new washing machine, dishwasher, fridge, geysers etc, necessitate careful deliberation, and environmental or water use, and conservation factors are highly likely to be considered as a direct result of any cost savings from lowered water use in the household. Future public policy and strategies should take this into account when choosing behavioural nudges in awareness raising efforts that encourage consumers to spend their money on goods that can substantially minimize their water consumption at home. Several such appliances and technologies are readily available in the market presently and dedicated public campaigns are urgently needed to encourage wider adoption.

7.4.2.5 Water-use attitude and behaviours can be quite personal

Water use is very personal to Durban metro users and it is a core component of their way of life living in coastal city which is commonly regarded as South Africa’s playground. Residents are therefore very hesitant to change their water use practices. So, while they avoid overt water waste, unless forced to, they are unlikely to change their water usage habits anytime soon. Frugal appeals to change their water use habits that are overly regulated, enforced, or directed could be regarded as an interference into their personal lives. As a result, public awareness campaigns and communications must take into consideration and recognise, either directly or indirectly, the extremely personal character of Durban residents relationships with water use, particularly when it comes to discretionary intimate indoor water use practices.

7.4.2.6 Show people what water use and water waste really means

Filling swimming pools, leaving sprinklers on all day, watering gardens and lawns, and evident pipe/system leaks were all mentioned as examples of wasteful water consumption. However, the majority of individuals have no notion what 'average' water usage looks like, or where in their homes they consume the most water. So, while people may be aware of overt water waste to some extent, many are utterly unconscious of subtle water waste in their homes. There is a need for further research study and engagement with local residents to demonstrate what normal water use actually looks like (as measured by global averages), thereby increasing the possibility that their activities will shift towards more sustainable water use practices.

7.4.2.7 Blaming urban residents for water shortage or problems will not work

Water shortages and wasteful water consumption are not topics that the general City of Durban residents demonstrate much awareness of. It is also obvious that some people believe that government agencies bear a disproportionate share of responsibility for water wastage. If people perceive they are being blamed for wasting water, they are less likely to respond to any communications about water conservation and demand management. The policy and strategic approach would be to explore increasing campaigns and awareness of the general public about an integrated approach to water conservation and WDM for the city of Durban. The message should clearly reflect a position that all water consumers in South Africa share an equal and shared obligation to save water for the collective good of all citizens living in the country.

7.4.2.8 Use trusted messengers

The study found that some communicators and messages are more efficient than others in communicating water conservation and demand management to city of Durban water consumers. The extremely personal character of Durban metro residents' relationship with water, along with apprehension about political motivations for contemplating household smart water metering, suggests that trusted public entities will be more effective ambassadors than water service authorities themselves. When encouraging urban inhabitants to save water, water service authorities will have to consider this aspect very carefully. The most influential force in promoting urban household water use behaviour change, will be for such messages to be delivered by well-respected public research organizations, (universities, science councils, NPOs, NGOs') who can demonstrate scientifically plausible and robust arguments for water conservation and need to reduce water demand.

7.5 SUGGESTIONS FOR FURTHER RESEARCH

Research could be undertaken to determine whether there are any issues or problems with effective public communication in the implementation of localized WDM policies strategies and initiatives. A comparable study might be carried out at the provincial (KZN) and national levels to get a more comprehensive perspective of the general South African household water use behaviour trends. A study of public utilities and water service providers' roles and responsibilities in promoting and improving urban household water conservation can also be done.

7.6 LIMITING FACTORS TO THE RESEARCH STUDY

The study may be limited due to the narrow segments of the entire population one desires to study, or due to the research method one has chosen (Sekeran and Bougie 2009: 46). As a result, there is a need to expand the geographical area and number of urban residents in order to be a more fully representative sample of the city's urban dwellers and their respective water consumption profiles and practices. As this study only focused on the selected 5 suburbs within the City of Durban, it is recommended that further investigations consider the inclusion of informal housing settlements as these are a common feature in the urban landscape within the Ethekwini metro. However, the sample used in this study was considered to be sufficiently inclusive to ensure representation of the generalised water user profile of the urban residents currently dwelling within the city.

7.7 CONCLUSION

The largest group gathered from the survey relates to the dwelling type, being that of free-standing houses, with the second biggest group of respondents being homeowners instead of renters. Most of the respondents were well educated with more than half having a tertiary education and being in their middle-ages. A small percentage of households had more females than males and the racial make-up of the households were relatively similar between African, Coloured, White and Indian respondents and in keeping with racial geographical distribution of the Durban metro region. Additionally, more than 80% of the households had 8 or less people permanently residing at the residence. This puts the study into perspective in terms of its limitations, as the dwelling types was predominantly that of free-standing houses. The combined findings of the two research methods led to a better knowledge of Durban residents' water attitudes, perceptions, cognitions, as well as their water saving attributions. The quantitative research method indicated a high percentage of people reporting that they generally behave in a water-saving manner through simple and rudimentary water conservation behaviours like closing the tap

when brushing their teeth or washing the dishes, and it appears that the participants' account of water saving was limited to fairly stereotypical descriptions including only basic and general water saving habits, such as leak detection and checking if a pipe is leaking. The majority of the sample seemed to agree with this.

However, only a small percentage of the quantitative survey sample adopted more extensive water conservation practices, such as limiting daily showers or installing smart water-saving devices and technologies in their homes. According to qualitative research findings, this discrepancy appears to be due to a cognitive mistake that characterizes the utilitarian representation of what water conservation in everyday life should mean. Other concluding observations point to a medium to low desire for water efficiency behaviors and the accompanying expenditures required in water-saving devices like rainwater harvestings devices and smart water meters. These appear to be linked to specific traits such as age, socioeconomic differences, suspicion and trust in newer/smarter technology and political motivation.

Nevertheless, there appear to be positive forces that function coherently to encourage people to practice more water conservation and invest in advanced water efficiency devices. Such behavioural drivers would need to appeal to strong psycho-social demands and water use habits within urban families, including social identity and comparison, positive self-image, rewards as well as some extrinsic (material) motivation like monthly cost savings on the utility bills. The data analysis also revealed that there are some significant barriers to adopting water-saving behaviors, which are very unique and include some inherent negative cultural connotations of water waste behaviour. Respondents had generally negative attitudes towards water service providers and water utilities and such deterrents were reinforced in an environment in SA which is currently characterised by economic and social crisis. Therefore, any suggestions or attempts to request adaptation to more modern and newer WDM tools or technologies is not only meaningless but would be considered futile to most urban households. This is due to the general public perception of inefficiency and corruption of governmental departments who are mandated to manage the water resources in SA at all 3 levels of tiered governance.

Hence, participants appeared to have adopted attitudes of “there is enough water for all in SA, so there is no need to conserve’. This clearly suggests a dominant ideology that water saving as completely unimportant. Water conservation and demand management failures and success were attributed to economic and/or political interests and there were also several issues of trust in relation to requests for water wise behaviour change and this has translated to cognitive confusion, biases and conflictive behaviour patterns towards water conservation and demand management in City of Durban.

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APPENDICES

APPENDIX 1 - QUESTIONNAIRE

Control information	
Team number:	**Interview number:**
Interviewer names:	
Suburb:	**Municipality:**
Sex of person interviewed (please circle): M/F/Other/Unsure	**Race of person interviewed (please circle): Black/White/Coloured/Indian/Other**

Date			Result	Results code	Time Beg	Time End
DD	MM	YYYY		1. Complete		
				2. Partial		
				3. Refused		
				4. No one currently at home/residents temporarily absent		
				5. Uninhabited house		

SECTION 1 – WATER SAVING PRACTICES

1. What do you think are water saving techniques?

2. Does your household implement any water saving techniques (i.e. try to save water)? Tick only one option.

☐ Yes, many ☐ Yes, some

☐ Not really ☐ No, none [If you select this option, then go to **SECTION 2**]

3. What does your household do to save water?

4. Of the things you have mentioned to save water, what do you find easy to do?

5. Of the things you have mentioned to save water, what do you find difficult to do? Why is it difficult?

6. Which one of your water saving techniques do you think saves the most water? And why?

7. When did you start to save water? Tick only one option.

☐ More than 10 years ago ☐ About 5 to 10 years ago

☐ 2 to 5 years ago ☐ Less than 2 years ago

☐ We have not really started to save water, yet [If you select this option, then go to **SECTION 2**]

8. What was the main trigger to start saving water in your household?

a. Why would you say it was the main trigger to save water?

9. **If the respondents' answer to Question 8 was 'water restrictions' as the main trigger, answer this question (Question 9). If the respondent did not mention 'water restrictions' as the main**

trigger, skip Question 9 and move to Question 10. If the water restrictions are lifted, which of the water saving techniques you have mentioned will you keep on doing? And why?

10. Apart from the water saving techniques you have mentioned above, is there anything else you think your household could do to save more water?

☐ Yes ☐No

a. If yes, what else could you do to save water?

Go to SECTION 3

Skip SECTION 2 (questions in red)

SECTION 2 - These questions are only for households that up to this point have indicated that they do not save water i.e. you have skipped Questions 3 – 10.

11. What do you think your household could do to save water?

12. Of the techniques mentioned, what do you think would be:

a. Easy to do?

b. The most difficult to do?

c. Would save the most water?

13. What would be needed to convince your household to start saving water?

Continue to SECTION 3

SECTION 3: WATER USE PERCEPTIONS

Please show the show cards for Questions 14, 15 and 16 to the respondent and ask them to choose the most appropriate options.

14. Please rank the following municipal instruments from 1 (being most effective) to 7 (being least effective) that would cause your household to reduce future municipal water use:	**Ranking out of 7**
General water restrictions	
Assistance to implement water-saving measures (e.g., constant flow regulators, smart metering, water-saving shower heads, etc.)	
Assistance to implement water-sensitive design measures (e.g., water harvesting, grey-water recycling, permeable paving, etc.)	
Tax incentives for reducing or limiting water use	
Water rate increases (simply increasing the cost of water to meet demand)	
Fines for increasing use or using water above a certain quantity	
Naming and shaming of our neighbourhood for increasing use or using water above a certain quantity	
Not applicable – I/we do not intend to reduce our future municipal water use	

15. Please rank the following information packaging options from 1 (being most effective) to 8 (being least effective) that would cause your household to reduce future municipal water use:	**Ranking out of 8**
Receiving water saving tips	
Receiving a breakdown of the tariff structure and placing your household's consumption in the tariff blocks	
Receiving information about monthly and annual financial gain from reducing consumption	
Receiving information about monthly and annual financial loss from not reducing consumption	
Receiving a comparison of your household's consumption to the average consumption in the neighbourhood	
Receiving a plea to save water by reducing your consumption by 10%	
Receiving a plea to save water in order to avoid future water restrictions	
Receiving a recognition by having the name of your neighbourhood published on a municipal website if your neighbourhood is one of the top water savers	
Not applicable – I/we do not intend to reduce our future municipal water use	

16. Please indicate the extent to which you agree or disagree with the following statements (followed by 5-point Likert scale, i.e., 'strongly agree', 'agree', 'neither agree nor disagree', 'disagree', and 'strongly disagree'):	**Strongly agree**	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**
We are approaching the limit of the number of people the earth can support.					
Humans have the right to modify the natural environment to suit their needs.					
Humans are severely abusing the environment.					

16. Please indicate the extent to which you agree or disagree with the following statements (followed by 5-point Likert scale, i.e., 'strongly agree', 'agree', 'neither agree nor disagree', 'disagree', and 'strongly disagree'):	**Strongly agree**	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**
The earth has plenty of natural resources if we just learn how to develop them.					
Plants and animals have as much rights as humans to exist.					
The balance of nature is strong enough to cope with the impacts of modern industrial nations.					
Despite our special abilities humans are still subject to the laws of nature					
The so-called "ecological crisis" facing humankind has been greatly exaggerated					
The balance of nature is very delicate and easily upset					
Humans will eventually learn enough about how nature works to be able to control it					
The so-called "ecological crisis" facing humankind has been greatly exaggerated					
The balance of nature is very delicate and easily upset					
Humans will eventually learn enough about how nature works to be able to control it					
We are willing to pay more to be able to use more water					
There is enough water in the city for us to use as much as we want to use					
There is enough water in South Africa for each household to use as much as they want to use					
Nobody owns water so it should be free					
There is enough water in SA, the government just needs to make a plan to get it to us					
Technologies are available to supply the water required					

SECTION 4: PERCEIVED HOUSEHOLD WATER USE (PAST, PRESENT AND FUTURE)

17. What is the estimated average monthly amount of municipal water **<u>in litres</u>** that your household used this time last year compared to now, and what do you think it will be this time next year? You do not have to provide exact amounts, estimates will do. If you moved to this address in the last 12 months, skip the column 'this time last year'. If you are planning to move from this address within the next 12 twelve months, please make an estimation as if you would have stayed.	**This time last year**	**Now**	**This time next year**
Estimated average monthly amount of municipal water in litres			
Not sure			

18. Please provide a rough breakdown (out of 100) of the proportion of municipal water that your household typically used for each of the following this time last year compared to now, and what you think it will be this time next year. You do not have to provide exact percentages, estimates will do, but please check that your percentages for each column adds up to 100. If you moved to this address in the last 12 months, skip the column 'this time last year'. If you are planning to move from this address within the next 12 twelve months, please make an estimation as if you would have stayed.	**This time last year**	**Now**	**This time next year**
Consumption by persons and animals i.e. for drinking and cooking food			
Household activities resulting in 'black water' i.e. water from toilets			
Household activities resulting in 'grey water' i.e. water from bathroom basins, baths and showers, kitchen sinks and dishwashers, as well as laundry basins and washing machines			
Irrigation for watering of lawns, gardens and pot plants			
Irrigation for fruit and vegetable gardens			
Topping up water features (fountains and ponds)			
Topping up swimming pool			
Washing vehicles			
Other (Please specify……)			

19. How often do you wash your car or have your car washed? Tick only one option.

☐ Never (Skip a and move to Question 20) ☐ Weekly

☐ Every fortnight (2 weeks) ☐ Once a month

☐ Every second month ☐ Twice a year

a. If you wash your car, how do you wash your car?

SECTION 5: WATER SOURCES

20. What is your main source of household drinking water and preparing food (tick only one option):	**Tick the appropriate box**
Municipal water (metered water with indoor taps and/or taps on the property) (Skip Question 21)	
Borehole water	
Communal tap	
Natural source of water (e.g., rainwater, river/stream, fountain or dam)	
Other (Please specify……)	

21. **Skip this question if you ticked 'municipal water' for Question 20.** If you answered 'borehole water', 'communal tap', 'natural source of water' or 'other' to Question 20, how far is this source from the house? **Note to interviewer: if the respondent does not know the distance but can point it out to you, please estimate what the distance is.** Tick only one option.

☐ Less than 200 metres
☐ 201 – 500 metres
☐ 501 metres – 1 kilometre
☐ More than 1 kilometre
☐ Do not know

22. What is your main source of water for the following (tick only one per column):	**Other in-house domestic uses e.g. bathing, washing dishes and laundry?**	**Outdoor purposes e.g. for a swimming pool, ponds and fountains, gardening and washing cars?**	**Irrigation purposes i.e. a system to water your plants outside?**
Municipal water (metered water with indoor taps and/or taps on the property)			
Borehole water			
Communal tap			
Natural source of water (e.g., rainwater, river/stream, fountain or dam)			
Other (Please specify……)			

23. How do you irrigate? And how often?

24. Have you been supplementing (i.e. an additional water source other than your primary water source) your water supply during the past few years with a borehole or well or rainwater harvesting tank etc.?

☐ No (Skip a – c and move to Question 25) ☐ Yes If Yes, then:

a. With what did you supplement your water supply? And what are you using it for?

b. When did you start to supplement your water supply, and why? Estimate number of years/months/days

c. How much water that you use comes from this alternative source? Estimate a percentage.

SECTION 6: CURTAILMENT MEASURES (PAST, PRESENT AND FUTURE)

Please show the show cards for Question 25 to the respondent and ask them to tick all applicable options.

25. Which of the following water-saving measures with regard to municipal water did your household use this time last year compared to now, and which do you think you will use this time next year? If you moved to this address in the last 12 months, skip the column 'this time last year.' If you are planning to move from this address within the next 12 twelve months, please make an estimation as if you would have stayed. Tick all applicable options.	**This time last year**	**Now**	**This time next year**
Constant flow regulator			
Smart metering			
Water-saving shower heads			
Dual flush toilets			
Eco-settings on dishwashers and washing machines			
Timed sprinklers			
Manual grey-water reuse (using buckets)			
Other (Please specify……)			
Don't know			
Not applicable			

SECTION 7: EFFICIENCY MEASURES (WATER-SENSITIVE DESIGN) (PAST, PRESENT AND FUTURE)

Please show the show cards for Question 26 to the respondent and ask them to tick all applicable options.

26. Which of the following measures did your household use this time last year compared to now, and which do you think you will use this time next year? If you moved to this address in the last 12 months, skip the column 'this time last year.' If you are planning to move from this address in the next 12 months, please make an estimation as if you would have stayed. Tick all applicable options.	**This time last year**	**Now**	**This time next year**
Rainwater harvesting (the collection of rainwater from roofs into storage tanks, e.g., JoJo Tanks)			
Grey-water reuse systems (retrofitting plumbing in order to reuse water from bathroom basins, baths and showers, or kitchen sinks and dishwashers, or laundry basins and washing machines for irrigation, flushing toilets, outdoor purposes, etc.)			

Permeable paving (using sustainable materials and techniques that allows water to seep through the paving into the ground)			
Don't know			
Not applicable			

SECTION 8: WATER RESTRICTIONS AND REGULATIONS

The following questions are about current and past water restrictions in your area. **Please show the show cards for Questions 28 and 29 to the respondent and ask them to tick all applicable options.**

27. When was the last time your municipality implemented municipal water restrictions in your neighbourhood? Tick only one option.

☐ There have never been municipal water restrictions in my neighbourhood, or at least none in the last 12 months (Skip a – c and move to Question 28)

☐ Municipal water restrictions are currently in place in my neighbourhood! (Go to question a - c)

☐ The last time was more-or-less…… [month and year] (Go to question a - c)

☐ Not sure (Skip a – c and move to Question 28)

a. What did/do the water restrictions entail?

b. Has your water use been influenced by the **announcement** of current or past city water restrictions?

☐ Yes ☐ No

c. Has your water use been influenced by the **enforcement** of city water restrictions i.e. issuing of fines or warnings.

☐ Yes ☐ No

i. [If water restrictions are still in place] When did the city start to enforce the water restrictions? _____

ii. How did/does the city enforce the water restrictions?

28. How did you primarily hear/find out about the last time your municipality implemented municipal water restrictions in your neighbourhood? Tick all applicable boxes and circle the one that was the most effective in creating awareness/conveying the message to you.	**Tick all applicable boxes**
Municipal - printed bill/pamphlet/notice	
Municipal - email message	
Municipal – website	
Management agency/body corporate/residents' association - printed pamphlet/notice	
Management agency/body corporate/residents' association - email message	
Management agency/body corporate/residents' association - website	
Printed newspaper	
Online newspaper	
Radio	
Television	
Social media (e.g., Facebook, Twitter, WhatsApp group, etc.)	
Word-of-mouth (e.g., talking to family, friends, or neighbours, etc.)	
Other (Please specify……)	
Don't know	

29. How would you primarily prefer to hear/find out about future municipal water restrictions in your neighbourhood? Tick all applicable boxes.	**Tick all applicable boxes**
Municipal - printed bill/pamphlet/notice	
Municipal - email message	
Municipal – website	
Management agency/body corporate/residents' association - printed pamphlet/notice	
Management agency/body corporate/residents' association - email message	
Management agency/body corporate/residents' association - website	
Printed newspaper	
Online newspaper	
Radio	
Television	
Social media (e.g., Facebook, Twitter, WhatsApp group, etc.)	
Word-of-mouth (e.g., talking to family, friends, or neighbours, etc.)	
Other (Please specify……)	
Don't know	
Not applicable – I/we usually ignore municipal water restrictions	

30. What is the reason/s for your choices in Question 29?

SECTION 9: REPARATORY MEASURES (PAST, PRESENT AND FUTURE)

Please show the show cards for Question 31 to the respondent and ask them to tick the most appropriate options.

31. In the last year how frequently did your household experience the following leakages on the property or inside the dwelling? Tick all applicable options	None	Infrequently	Sometimes	Frequently
Outdoor pipes				
Outdoor taps				
Indoor pipes				
Indoor taps				
Geyser(s)				
Toilet cistern(s)				
Other (Please specify……)				
Don't know				

SECTION 10: ACTUAL HOUSEHOLD WATER USE (PRESENT)

32. Would you be willing to share a typical month's municipal bill with us (e.g. when all household members were at home for the whole month)? Kindly ask your fieldworker to help you with the bill if necessary

Note: If you rent would you be able to obtain these figures from the landlord?

a. Actual amount and date of bill _____

b. Not applicable (e.g., sectional title, or borehole, communal standpipe, or natural source as primary source

of water for household use)

c. No municipal bill available at the moment

33. How do you think **your water** bill compares to other households similar to your household in your area?

☐ Much lower ☐ Lower ☐ Similar ☐ Higher ☐ Much higher

☐Don't know ☐Refuse to answer

SECTION 11: SITUATIONAL FACTORS

Please show the show cards for Questions 39, 40, 44, 45, 51, 52, 53 to the respondent and ask them to tick the most appropriate options.

34. Age of house in years:

☐ less than 10 years ☐ 10-25 years ☐ 26-50 years

☐ more than 50 years ☐Don't know ☐Refuse to answer

a. If you know the exact number of years, what is it? _____

35. What is your dwelling type (tick one option only)?	
Free standing house (on a separate stand or yard)	
Single-storey duplex	
Double-storey flats/housing complexes	
Multi-storey flats (more than 3 floors)	
Informal dwelling /shack	
Duet	
Residential (other) Please specify:……..	
Don't know	
Refuse to answer	

36. Please provide a rough breakdown (out of 100) of the proportion of coverage on your property of each of the following: (You do not have to provide exact percentages, estimates will do, but please check that your percentages add up to 100.)	
Roof	
Impermeable paving (i.e., paving through which water cannot seep)	
Permeable paving (i.e., paving through which water can seep)	
Swimming pool	
Lawn (i.e., short grass)	
Garden (i.e., area of the plot with plants for aesthetic value)	
Fruit / vegetable garden	
Natural/indigenous vegetation	
Other (Please specify……..)	

37. Size of stand: Tick one option only.	
<500 sq m	
500-1000	
1001-1500	
>1500 sq m	
Don't know	
Refuse to answer	

38. Size of house: Tick one option only.	
<35sq m	
35 – 60	
61 – 120	
121 - 240	
241 - 480	
>480 sq m	
Don't know	

Refuse to answer	

39. Household size: Tick one option only.	
Small or single parent (1-3 members)	
Average/nuclear (4 members)	
Extended (4-8 members)	
Large extended (more than 8 members)	
Multiple family (more than one household but with one municipal bill)	
Don't know	
Refuse to answer	

40. Of everybody in the household, what is the highest level of education obtained? Tick one option only.	
Completed junior primary school (Gr 3)	
Completed senior primary school (Gr 7)	
Completed Gr 10	
Completed high school (Gr 12)	
Completed undergraduate degree	
Completed TVET and/or other college	
Completed postgraduate degree	
No schooling	
Don't know	
Refuse to answer	

41. What is your highest level of education obtained? Tick one option only.	
Completed junior primary school (Gr 3)	
Completed senior primary school (Gr 7)	
Completed Gr 10	
Completed high school (Gr 12)	
Completed undergraduate degree	
Completed TVET and/or other college	
Completed postgraduate degree	
No schooling	
Don't know	
Refuse to answer	

42. Age of head of household (if you don't know, estimate an age group i.e. in their twenties, in their thirties etc)

_____

☐Don't know ☐Refuse to answer

43. What is your age in years?

_____

☐Don't know ☐Refuse to answer

44. Sex representation in the house:

☐ More males than females ☐ Equal number of males and females

☐ More females than males ☐Don't know ☐Refuse to answer

45. Dominant race group in household:

_____ ☐Don't know ☐Refuse to answer

46. Do you own or rent the house?

☐ Own ☐Rent ☐Don't know ☐Refuse to answer

47. Which of the following descriptions best resonates with the way you think society should be organised? Tick the most dominant belief you have.	
The best government is absolutely no government. Everything about governments is repressive and therefore must be abolished entirely.	
A single ruler should have control over every aspect of the government and of the people's lives. Everything should be carefully structured, including society. The law must be obeyed.	
The individual takes priority over society. Individuals have the right to make choices for themselves. No person is morally or politically superior to others. Hierarchies are rejected.	
Stability is a precious thing, and change must be made gradually in order to preserve it. Excessive freedom is bad, lets people ignore societal responsibilities and overlook social customs.	
Human beings are social by nature, and society should respect this. Individualism is poisonous. Society, not individuals, should own the property. The government plans the economy; there is no free market.	
Don't know	
Refused to answer	

48. Which of the following descriptions best resonates with the way the majority of people living in your neighbourhood may think? Tick the most dominant belief that you think they share.	
The best government is absolutely no government. Everything about governments is repressive and therefore must be abolished entirely.	

A single ruler should have control over every aspect of the government and of the people's lives. Everything should be carefully structured, including society. The law must be obeyed.	
The individual takes priority over society. Individuals have the right to make choices for themselves. No person is morally or politically superior to others. Hierarchies are rejected.	
Stability is a precious thing, and change must be made gradually in order to preserve it. Excessive freedom is bad, lets people ignore societal responsibilities and overlook social customs.	
Human beings are social by nature, and society should respect this. Individualism is poisonous. Society, not individuals, should own the property. The government plans the economy; there is no free market.	
Don't know	
Refused to answer	

49. What type of water meter is fitted to your municipal water inlet? – show image card with number to each picture and tick the most appropriate option.	
A	
B	
C	
E	
F	
G	
H	
N - None of the above	
Don't know	
Refused to answer	

THANK YOU FOR PARTICIPATING IN THIS SURVEY!

APPENDIX 2 – INTERVIEW SCHEDULE

1. **Interview number:**
2. **Date:**
3. **Interviewer name:**
4. **Details of respondent (if shared):**

Questions		Additional probes	Secondary probes
Organisational Water Demand Strategy			
1	Could you please describe the water demand strategy (-es) which (name of organisation) is currently implementing?	Does it only apply during drought conditions, or more broadly? Put differently: Is it proactive (i.e. runs continuously) or reactive (only in reaction to drought or water stress situations)? Over what time frame is it applicable? Short term/long term/ permanent?	Can you provide us with a written document detailing (name of organisation's) water demand strategy?
2	Has (name of organisation) made any changes to the demand management strategy over the past 5 years? If so, why? If not, why were changes not considered necessary?		
3	Which components of the strategies have worked well?	Why have components worked well?	How did you determine success?
4	How might you modify your demand management strategy in the future?	How might you accommodate for example, or regular drought conditions and climate change?	
Policy, Regulation and systemic Issues			
5	What policies, laws/by-laws regulate water demand management in (name of organisation) / (name of region)? Are there any challenges with the implementation of these policies/by-laws?		
6	In the overall integrated water management process within (name of organisation), how much emphasis is placed on household water demand management in relation to, for example, the management of water losses from the water supply and reticulation infrastructure?		
Public / customer education and awareness			
7	Could you describe any public education and awareness campaigns that (name of organisation) has had for water demand management – whether	Have these been focused on curtailment of water use or use efficiency?	Which media do you use / or have you used in the

	currently or in the past? How successful would you say they have been?		past for these campaigns?
8	Could you elaborate on any customer engagement processes which (name of organisation) has in place around water demand management?	In what ways does (name of organisation) engage directly with customers on an ongoing basis/ regularly / sporadically, regarding water demand management?	
Specific instruments and interventions for household water demand management			
9	Please could you elaborate on what kinds of incentives / disincentives form part of (name of organisation's) water demand management strategy?	Which kinds of incentives / disincentives have been successful in reducing household water demand? Which ones work and why? What doesn't work and why?	
10	What specific water saving interventions have been used in this municipality / supply area? E.g. *Punitive measures:* fines / penalties on bill water restrictions naming and shaming (radio) *Reward measures:* pay less if you use less competitions / prizes for water saving technologies recognition – "pat on the back" or other rewards		
11	Has (name of organisation) ever done surveys of resident's attitudes and behaviours regarding their household water use? If so, what were the findings? Could these data be made available to us?		
12	Are there specific water use behaviours that are evident in the region in which (name of organisation) supplies water? For example – certain residents saving a lot of water? Which areas are these? What could the reasons for this behaviour be?		
13	Does (name of organisation) promote the use of water saving technologies? If so, which technologies? For example: low flow shower heads rainwater harvesting systems low / dual flush toilets grey water reuse systems drip irrigation systems	Has (name of organisation) provided / facilitated access by residents to any of these technologies? Or are there plans to do this in the future? (similar to the Eskom campaign many years ago to provide free compact fluorescent light bulbs to consumers so they would reduce electricity consumption.)	
Use or alternative water sources			
14	What is (name of organisation's) perspective on and strategy regarding	How does (name of organisation) manage the	Are there any changes to

	the use of groundwater and the drilling of boreholes for domestic use?	groundwater resource in your supply area? Do you monitor and / or place restrictions on the use of groundwater?	your groundwater management strategies during drought conditions?
15	What is (name of organisation's) perspective on and strategy regarding the installation and use of household rainwater harvesting systems and grey water systems?	Does (name of organisation) have a policy or regulation that deals with these household installations?	
Learning and collaboration			
16	In what ways do you interact or collaborate with other water supply organisations in this region, across the country or internationally around water demand management?	With whom do you collaborate and / or share learning?	Is there a forum where you formally or informally share ideas, learning and experiences with regard to household water demand management in your supply areas?
17	How do you ensure coherence between (name of organisation's) demand management strategy and that of your: • bulk supplier • downstream customer / municipality (municipal water supply entities) • other role players in the water supply system nationally and regionally *(as applicable)*	Is there any formal collaboration or interaction with (up or downstream organisation as applicable) regarding water demand management?	

APPENDIX 3 - ETHICS CLEARANCE

MANAGEMENT SCIENCES: FACULTY RESEARCH ETHICS COMMITTEE (FREC)

30 July 2020

Student Name: **Mr I Banoo**
Student No: 21959867

Dear Mr I Banoo

DOCTOR OF PHILOSOPHY IN MANAGEMENT SCIENCES: PUBLIC MANAGEMENT

TITLE: An analysis of water use behaviour in urban households. Case Study: City of Durban.

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: 30 July 2020

Approval has been granted for a period of two years from the above FRC date, after which you are required to apply for safety monitoring and annual recertification. Please use the form located at the Faculty. This form must be submitted to the FREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the FREC according to the FREC SOP's.
Please note that ANY amendments in the approved proposal require the approval of the FREC as outlined in the FREC SOP's.

Yours sincerely

Prof JP Govender
Chairperson: Faculty Research Ethics Committee

APPENDIX 4 – LETTER OF INFORMATION

1. PURPOSE OF THE STUDY

The research is investigating household water use behaviour in the EThekwini municipality region within KZN province, by collecting information relating to perceived water use in different dwelling types (houses, flats, informal settlements) and, for a variety of indoor and outdoor activities. The research will support stakeholders and residents with a better understanding of household water use at local government level and the measures that could curb excessive household water use by designing more informed policies and more nuanced household water use practices.

2. PROCEDURES

Your participation will involve the following:

- The survey will take no more than an hour of your time to finish.
- The questions in the survey are about your household's water use patterns.
- A research team member will ask you the survey questions.
- You will need to sign a consent form to protect your rights before the survey starts.

3. POTENTIAL BENEFITS TO SOCIETY

You will not receive direct benefits such as payment. There could be some benefit to society as the knowledge that comes out of the research aims to improve the ability of the eThekwini Metro to design better water demand management strategies that are more aligned with water use behavioural patterns of their residents.

4. POTENTIAL RISKS AND DISCOMFORTS

There are no risks to participants taking part in this study. Additionally, no person will be harmed or negatively impacted upon if they do not take part in the research. You can also refuse to take part in the study without any negative impacts on you or your household.

5. PAYMENT FOR PARTICIPATION

We cannot pay you to take part in the survey.

6. CONFIDENTIALITY

We will only report on the research results in general. We will not link your name to anything you say during the surveys, interviews or group discussions that then gets written in reports and other documents.

A research team member will record your answers by completing a survey form. The investigator of the study will be responsible for storing all of the electronic research data and documents in his data archives. The hard copy data and documents will be stored in offices that will be locked. The electronic data will be code word protected and only the research team members will be able to access these.

The research results will be published in peer-reviewed journals, popular media, policy briefs and guidelines. We will not mention your name as part of these research outputs.

7. PARTICIPATION AND WITHDRAWAL

You can choose if you want to take part in this study or not. If you decide to take part, you can withdraw at any time. Nothing bad will happen to you if you do not take part in the research. You may also choose to take part in the study but refuse to answer any questions that you do not want to answer.

If you have any questions or concerns about the research, please feel free to contact:

Mr. I. Banoo
Investigator
Email: ismailbanoo@gmail.com
Tel: (031) 242 2378
Cell: 084 6678680

APPENDIX 5 - CONSENT FORM OF PARTICPANTS

The proposed research is investigating household water use behaviour in the Ethekwini Municipality region within KZN province by collecting information relating to perceived water use in and for a variety of indoor and outdoor activities.

Please indicate if you are willing to participate in an interview and/or questionnaire/survey. Your contact details address will be kept strictly confidential and will not be linked to any of your responses.

A. Are you prepared to participate?

Yes I am willing ☐

No, I am not willing ☐

If yes, please provide your name and contact details below:

Name: _____

Contact number: _____

Email: _____

Consent - Signature of Participant

I hereby consent voluntarily to participate in this study. I have been given a copy of the information document.

_____ _____ _____

Name of Participant Date Signature

Verbal consent (if preferred)

The participant requests verbal consent to be given.

The investigator/interviewer declares that the participant has given verbal consent.

Place: _____

Date: _____

Signature of investigator/interviewer

I _____declare that I explained the information given in this document to _____ [*name of the participant]. [H*e/she] was encouraged and given ample time to ask me any questions.

_____ _____

Signature of Investigator/Interviewer Date